

User's Guide for the AMS/EPA Regulatory Model (AERMOD)

EPA-454/B-26-001
July 2026

User's Guide for the AMS/EPA Regulatory Model (AERMOD)

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Research Triangle Park, NC

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Preface

This User's Guide for the AMS/EPA Regulatory Model (AERMOD) provides user instructions for the AERMOD model. The technical description of the AERMOD algorithms is provided in a separate AERMOD Model Formulation document (EPA, 2026a). Additional resources provided by the USEPA that may be helpful with respect to the application of AERMOD can be accessed via the Support Center for Regulatory Atmospheric Modeling (SCRAM) website at https://www.epa.gov/scram.

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1.0 Introduction

This section provides an overall introduction to the AERMOD model and to the AERMOD user's guide. Some suggestions are offered on how various users would best benefit from using the manuals. Additionally, an overview of the model's applicability, range of options, and basic input data and hardware requirements are provided. The input file required to run the AERMOD model (commonly referred to as the control file) is based on an approach that uses descriptive keywords and allows for a flexible structure and format.

1.1 How to use the AERMOD manuals

The AERMOD model user's guide has been designed to meet the needs of various users with differing levels of experience with the model. This section describes briefly how users can benefit from using the manual.

1.1.1 Novice users

Novice users are those with limited exposure to or experience with the AERMOD model. They may be new to dispersion modeling applications in general, or new to the AERMOD model and therefore unfamiliar with the keyword/parameter approach utilized for the input file. These users should review the remainder of this Introduction to gain an overall perspective of the use of the AERMOD model, particularly for regulatory modeling applications. They should then focus their attention on Section 2.0, which provides an overview of the types of input and output files and setting up an input file that illustrates the more commonly used options of the AERMOD model. Section 2.0 provides a basic description of the input file structure and explains some of the advantages of the keyword/parameter approach to specifying modeling options and inputs. Section 3.0 then provides a more detailed and complete reference of the various options for running the model.

1.1.2 Experienced modelers

Experienced modelers have considerable experience in applying the AERMOD model in various situations. They should have basic familiarity with the overall goals and purposes of regulatory modeling and with the scope of options available in the AERMOD model. Experienced modelers who are new to the AERMOD model will benefit from first reviewing the contents of Section 2.0 of this guide, which provides a basic orientation to the structure, organization, and philosophy of the keyword/parameter approach used for the input control file. Once they have a basic grasp of the input file structure and syntax rules, they will benefit most from using Section 3.0 of this volume as a reference to learn the overall capabilities of the model, or to understand the mechanics for implementing specific options. The information in Section 3.0 has functional organization with detailed descriptions of each of the individual keyword options by functional pathway. Once they are familiar with the keywords, they may find the functional keyword reference provided in APPENDIX A useful to quickly review the proper syntax and available options/parameters for a particular keyword.

Experienced modelers may also need to refer to the description of model formulation for AERMOD (EPA, 2026a) to gain a more complete understanding of the technical basis for the AERMOD model.

1.1.3 Management/decision makers

Those involved in a management or decision-making role for dispersion modeling applications will be especially interested in the remainder of this section, which provides an overview of the model, including its role in various regulatory programs, a brief description of the range of available options, and basic input and output data and computer hardware requirements needed to run the model. From this information, they should understand the basic capabilities of the AERMOD model well enough to judge the suitability of the model for specific applications. They may also want to review the overview provided in Section 2.0 to learn about the nature and structure of the input control file to better review the modeling results.

1.2 Overview of the AERMOD model

This section provides an overview of the AERMOD model, including a discussion of the regulatory applicability of the model, a description of the basic options available for running the model, and an explanation of the basic input data and hardware requirements needed for executing the model.

1.2.1 Regulatory applicability

The U.S. Environmental Protection Agency (EPA) maintains a *Guideline on Air Quality Models* (EPA, 2024b), hereafter, Guideline, which is published as Appendix W to 40 CFR Part 51 (as revised). The Guideline provides the agency's guidance on regulatory applicability of air quality dispersion models. In general, regulatory modeling applications should be carried out in accordance with a modeling protocol that is reviewed and approved by the appropriate agency prior to conducting the modeling. The modeling protocol should identify the specific model, modeling options, and input data (e.g., meteorology, emission source parameters, etc.) to be used for a particular application.

1.2.2 Basic input data requirements

One of the basic inputs to AERMOD is the control file which contains the selected modeling options, as well as source location and parameter data, receptor locations, meteorological data file specifications, and output options. Another type of basic input data needed to run the model is the meteorological data. AERMOD requires two types of meteorological data files that are provided by the AERMET meteorological preprocessor program (EPA, 2026c). One file consists of surface scalar parameters, and the other file consists of vertical profiles of meteorological data. These meteorological data files are briefly described later in this section, and in more detail in Sections 2.0 and 3.0. For applications involving elevated terrain effects, the receptor and terrain data will need to be processed by the AERMAP terrain preprocessing program (EPA, 2024a) before input to the AERMOD model.

1.2.3 Computer hardware requirements

The current version of the AERMOD model was developed within the Microsoft Windows operating system (Windows) and has been designed to run on Windows PCs within a Command-prompt using command-line arguments to initiate a model run. The amount of storage space required on the hard disk for a particular application will depend greatly on the output options selected. Some of the optional output files of concentration data can be rather large. More information on output file products is provided in Sections 2.1 and 3.7.

The AERMOD model includes a wide range of options for modeling air quality impacts of pollution sources, making it a popular choice among the modeling community for a variety of applications. The following sections provide a brief overview of the options available within the AERMOD model.

1.2.4 Dispersion options

Since the AERMOD model is designed to support the EPA's regulatory modeling programs, the regulatory modeling options will be the default mode of operation for the model. These options include the use of stack-tip downwash and a routine for processing averages in cases of calm winds or missing meteorological data. The model also includes various non-default options (e.g., suppress the use of stack-tip downwash, deposition modeling, NO_2 conversion, special processing for low wind conditions, and disable the date checking for non-sequential meteorological data files, to list a few). The latter option listed is needed to facilitate model evaluation. The AERMOD model also includes a non-default screening mode added specifically for integration with the AERSCREEN model interface (EPA, 2021). The user can specify several short-term averages to be calculated in a single run of the AERMOD model, as well as request the overall period (e.g., annual) averages.

1.2.5 Source options

The model is capable of handling multiple sources, including point, volume, area, open pit, and both buoyant and non–buoyant line source types. AERMOD models non-buoyant line sources as elongated area sources or a series of volume sources. If elongated area sources are used to represent a narrow non-buoyant line source, the user can specify a line source in the control file, and the input required to define the source is simplified from the typical input required for an area source.

The buoyant line source algorithm from the Buoyant Line and Point Source (BLP) model (Schulman and Scire, 1980) has been incorporated into the AERMOD model beginning with version 15181. Several source groups may be specified in a single run, with the source contributions combined for each group. This is particularly useful for PSD applications where combined impacts may be needed for a subset of the modeled background sources that consume increment, while the combined impacts from all background sources (and the permitted source) are needed to demonstrate compliance with the National Ambient Air Quality Standards (NAAQS). The model contains algorithms for modeling the effects of aerodynamic downwash due to nearby buildings on point source emissions and depositional effects on particulate emissions.

Source emission rates can be treated as constant throughout the modeling period, or may be varied by month, season, hour-of-day, or other optional periods of variation. Variable emission rate factors may be specified for a single source or for a group of sources. The user may also specify one or more files of hourly emission rates for all source or some subset of sources that are included in a model run.

1.2.6 Receptor options

The AERMOD model has considerable flexibility in the specification of receptor locations. The user has the capability of specifying multiple receptor networks in a single run and may also mix Cartesian grid receptor networks and polar grid receptor networks in the same

run. This is useful for applications where the user may need a coarse grid over the whole modeling domain, but a denser grid over the area of maximum expected impacts. There is also flexibility in specifying the location of the origin for polar receptors, other than the default origin at (0,0) in x,y, coordinates.

The user can input elevated receptor heights to model the effects of terrain above (or below) the stack base elevation and may also specify receptor elevations above ground level to model flagpole receptors. There is no distinction in AERMOD between elevated terrain below release height and terrain above release height, as is with earlier regulatory models that distinguished between simple terrain and complex terrain. For applications involving elevated terrain, the user must also input a hill height scale along with the receptor elevation. To facilitate the generation of hill height scales for AERMOD, a terrain preprocessor, called AERMAP, has been developed (EPA, 2024a).

1.2.7 Meteorology options

The AERMOD model utilizes a file of surface boundary layer parameters and a file of profile variables including wind speed, wind direction, and turbulence parameters. These two types of meteorological inputs are generated by the meteorological preprocessor for AERMOD, which is called AERMET (EPA, 2026c). Both meteorological input files are sequential ASCII files, and the model automatically recognizes the format generated by AERMET as the default format. The model will process all available meteorological data in the specified input file by default, but the user can easily specify selected days or ranges of days to process.

1.2.8 Output options

The basic types of printed output available by AERMOD are:

- Summaries of high values (highest, second highest, etc.) by receptor for each different combinations of averaging period and source group;
- Summaries of overall maximum values (e.g., the maximum 50) for each averaging period and source group combination; and

- Tables of concurrent values summarized by receptor for each combination of averaging period and source group, for each day of data processed. These "raw" concentration values may also be output to unformatted (binary) files, as described below.

The summaries of high values by receptor and summaries of maximum values can be output for one or more groups of sources and individual sources in the same model simulation. In addition, when maximum values for individual sources are output, the user has the option of specifying whether the maximum source values are to be the maximum values for each source independently, the contribution of each source to the maximum group values, or both.

In addition to the tabular printed output products described above, the AERMOD model provides options for several types of file output products. One of these options for AERMOD is to output an unformatted ("binary") file of all concentration values as they are calculated. These files are often used for special postprocessing of the data. In addition to the unformatted concentration files, AERMOD provides options for several additional types of file outputs. One option is to generate a file of (X, Y) coordinates and design values (e.g., the second highest values at each receptor for a particular averaging period and source group combination) that can be easily imported into many graphic plotting packages to generate contour plots of the concentration values. Separate files can be specified for all the averaging period and source group combinations of interest to the user.

Another output file option from the AERMOD model is to generate a file of all occurrences when a concentration value equals or exceeds a user-specified threshold. Again, separate files are generated for only those combinations of averaging period and source group that are of interest to the user. These files include the date on which the threshold violation occurred, the receptor location, and the concentration value.

AERMOD includes options for two types of output files that are designed to facilitate model evaluation. One type of file lists concentrations by rank, where only one value per date is included. This file may be used to generate Q-Q (quantile) plots of results, where values from

different models and/or observed data are paired by rank. The other type of output file provides arc maxima results, along with detailed information about the plume characteristics associated with the arc maximum.

Finally, there are output options specifically for comparing model results to the 24-hour PM2.5, 1-hour NO_2 and 1-hour SO_2 NAAQS. The forms of these standards are based on averages of ranked values across years which complicate their evaluation, especially the 1-hour NO_2 and SO_2 standards which are based on ranked values from the distribution of daily maximum 1-hour averages.

1.2.9 Source contribution analyses

In air quality dispersion modeling applications, the user may have a need to know the contribution that a particular source makes to an overall concentration value for a group of sources. This section provides a brief introduction to how these types of source contribution (sometimes referred to as source culpability) analyses are performed using the AERMOD model. More detailed information about exercising these options is provided in Section 3.0.

The AERMOD model provides the option of specifying source groups for which the model calculates high values independently. However, users may often have to run the model a second time selecting only specific days where the high values occurred and setting up each source in its own source group to obtain source contribution results. An EVENT processor has been incorporated into AERMOD to simplify this task when required. Also, special processing and output options mentioned above are included that are specific to determining source contributions with respect to the PM2.5, NO_2 and SO_2 standards.

2.0 Getting started - a brief tutorial

This section provides a brief tutorial for setting up a simple application problem with the AERMOD model, which serves as an introduction for novice users to the AERMOD model. The example illustrates the usage of the more commonly used options in the AERMOD model. A more complete description of the available options for setting up the AERMOD model is provided in Section 3.0.

The example problem presented in this section is a simple application of the AERMOD model to a single point source. The source is a hypothetical stack at a small, isolated facility in a rural setting. Since the stack is below the Good Engineering Practice (GEP) stack height, the emissions from the source are subject to the influence of aerodynamic downwash due to the presence of nearby buildings. The tutorial guides the user through selection and specification of modeling options, specification of source parameters, definition of receptor locations, specification of the input meteorological data, and selection of output options. Since this discussion is aimed at novice users of the AERMOD model, general overviews of input and output files, as well as control file keyword/parameter approach, is provided first.

2.1 Controlling input and output files

This section describes the various input and output files used by the AERMOD model and discusses control of input and output (I/O) in the Microsoft Windows PC environment. Much of this discussion also applies to operating the model in other environments.

2.1.1 Description of AERMOD input files

The two basic types of input files required to run the AERMOD model are: 1) the input control file containing the modeling options, source data and receptor data, and 2) the meteorological data files including a file of surface parameters and a separate file of multilevel parameters. Each of these is discussed below, as well as a third file type that may be used to initialize the AERMOD model with intermediate results from a previous run.

2.1.1.1 Input control file

The input control file contains the user-specified options for running the various AERMOD model (with a default filename, AERMOD.INP), includes the source parameter data and source group information, defines the receptor locations, specifies the location and parameters regarding the meteorological data, and specifies the output options. Details regarding the keywords and parameters used in the input control file are provided in Section 3.0, and APPENDIX A.

2.1.1.2 Meteorological data files

The input meteorological data is read into the AERMOD model from two separate data files, one corresponding to surface (scalar) parameters, and the other corresponding to multi-level profiles of data. The meteorological data filenames and formats are specified within the input control file using the ME SURFFILE and PROFFILE keywords. The AERMOD model accepts meteorological data that has been preprocessed by the AERMET meteorological preprocessor program (EPA, 2026c). The data are read from formatted ASCII files of hourly sequential records.

2.1.1.3 Initialization file for model re-start

The AERMOD model has an optional capability to store intermediate results to an unformatted (sometimes called binary) file for later re-starting of the model in the event of a power failure or user interrupt. This unformatted file may, therefore, be used as an input file to initialize the model. This option is controlled by the SAVEFILE (saves intermediate results to a file) and the INITFILE (initialize result arrays from a previously saved file) keywords on the CO pathway.

When initializing the model for the re-start option, the user specifies the name of the unformatted results file on the INITFILE keyword. The default filename used if no parameter is provided is TMP.FIL.

2.1.2 Description of AERMOD output files

The AERMOD model can produce a variety of output files, including a main file of model results, an unformatted file of intermediate results for later re-start of the model (AERMOD only), and several output data files for specialized purposes. These files are described below.

2.1.2.1 Main output file

The AERMOD model produces a standard output file of model results called AERMOD.OUT, by default, unless a unique name is provided by the user when AERMOD is executed at the command prompt. The contents and organization of this file are shown in Figure 2-5. This file includes a duplication of the contents of the input control unless 'NO ECHO' is encountered in the input control file. The contents of the input control file will be duplicated in the output file up to the place in the file where 'NO ECHO' is specified. The contents of the input control file beyond 'NO ECHO' will not be duplicated in the output file. A summary of control file setup messages and a summary of the inputs follow the echo of inputs. The input summary includes a summary of modeling options, source data, receptor data, and meteorological data, following the same order as the pathways in the control file. If model calculations are performed, then the model results are summarized next. The content and order of the model result summaries depend on the output options selected. Following the detailed model results are summary tables of the high values for each averaging period and source group. The final portion of the main output file is the summary of messages for the complete model run.

2.1.2.2 Detailed error message file

The user may select an option for the model to save a separate file of detailed error and other messages, through use of the CO ERRORFIL keyword. The format and syntax of these messages is described in APPENDIX B. The order of messages within the file is the order in which they were generated by the model. The file includes all types of messages that were generated.

2.1.2.3 Intermediate results file for model re-start

The AERMOD model has an optional capability to store intermediate results to an unformatted (sometimes called binary) file for later re-starting of the model in the event of a power failure or user interrupt. This unformatted file may therefore be used as an input file to initialize the model. This option is controlled by the SAVEFILE (saves intermediate results to a file) and the INITFILE (initialize result arrays from a previously saved file) keywords on the CO pathway.

When saving the intermediate results for the re-start option, the user specifies the name of the unformatted results file on the SAVEFILE keyword. The user has the option of specifying a single filename, two filenames (for alternate saves), or specifying no filename. The default filename used if no parameter is provided is TMP.FIL. If a single file is used, then the intermediate results file is overwritten on each successive dump, with the chance that the file will be lost if the interrupt occurs during the time that the file is opened. If two filenames are provided, then the model also saves to the second file on alternate dumps, so that the next most recent dump will always be available.

2.1.2.4 Maximum value/threshold file

The user may select an option for the AERMOD model to generate a file or files of concentration values exceeding a user-specified threshold. The OU MAXIFILE keyword controls this option. The user may select separate files for each averaging period and source group combination for which a list of threshold violations may be needed. Each file includes several records with header information identifying the averaging period, source group and threshold value, and then a record for every occurrence where the result for that averaging period/source group equals or exceeds the threshold value. Each of these records includes the averaging period, source group ID, date for the threshold violation (ending hour of the averaging period), the x, y, z and flagpole receptor height for the receptor location where the violation occurred, and the concentration value.

The structure of the threshold violation file is described in more detail in APPENDIX C. Each of the files selected by the user is opened explicitly by the model as a formatted file. The filenames are provided in the input control file. The user may specify the file unit on the MAXIFILE card through the optional FUNIT parameter or let AERMOD assign a file unit. Please note, when specifying the FUNIT, to ensure there will be no file conflicts, it is recommended that user-specified units begin at a large integer value such as 10,000 and increment by one. If no file unit is specified, then the file unit is determined internally.

2.1.2.5 Sequential results file for postprocessing

The user may select an option for the AERMOD model to generate a file or files of concentration values suitable for postprocessing. The OU POSTFILE keyword controls this option. The user may select separate files for each averaging period and source group combination for which postprocessing may be needed. For each file requested, the user has the option of specifying whether to use unformatted files suitable for postprocessing or to use a plot format which could allow for importing the x, y concentration files into a graphics package for plotting. For the unformatted file option, each file consists of sequential unformatted records of values at each receptor location for every averaging period calculated. For the plot file format option, each file consists of formatted records listing the x-coordinate, y-coordinate and concurrent concentration values for each receptor and for all averaging periods calculated. For certain applications, these files may become quite large, and should only be used when needed, especially when using the plot format.

The structure of both types of postprocessing file is described in more detail in APPENDIX C. Each of the postprocessing files selected by the user is opened explicitly by the model as either an unformatted or a formatted file, depending on the option selected. The filenames are provided in the input control file. The user may specify the file unit on the POSTFILE card through the optional FUNIT parameter. Please note, when specifying the FUNIT, to ensure there will be no file conflicts, it is recommended that user-specified units begin at a large integer value such as 10,000 and increment by one. If no file unit is specified, then the file unit is determined internally

2.1.2.6 High value summary file for plotting

The user may select an option for the AERMOD model to generate a file or files of the highest concentration values at each receptor suitable for importing into a graphics package in order to generate contour plots. The OU PLOTFILE keyword controls this option. The user may select separate files for each averaging period, source group and high value combination for which a plot file may be needed. Each file includes several records with header information identifying the averaging period, source group and high value number of the results, and then a record for each receptor which contains the x and y coordinates for the receptor location, the appropriate high value at that location, and the averaging period, source group and high value number.

The structure of the plot file is described in more detail in APPENDIX C. Each of the plot files selected by the user is opened explicitly by the model as a formatted file. The filenames are provided in the input control file. The user may specify the file unit on the PLOTFILE card through the optional FUNIT parameter. Please note, when specifying the FUNIT, to ensure there will be no file conflicts, it is recommended that user-specified units begin at a large integer value such as 10,000 and increment by one. If no file unit is specified, then the file unit is determined internally.

2.1.2.7 TOXX model input files

The user may select an option for the AERMOD model to generate an unformatted file or files of concentration values exceeding a user-specified threshold for use with the TOXX model component of TOXST. The OU TOXXFILE keyword controls this option. The user may select separate files for each averaging period for which a threshold violation file may be needed. Each file includes several records with header information identifying the title, averaging period, threshold value, and receptor network information, and then records including every occurrence where the result of any source group for that averaging period equals or exceeds the threshold value. Records are also output that identify the averaging period (hour number of the year), source group number and receptor number corresponding to the concentration values.

The structure of the threshold exceedance file for use with the TOXX model component of TOXST is described in more detail in APPENDIX C. Each of the files specified by the user is opened explicitly by the model as an unformatted file. The filenames are provided in the input control file. The user may specify the file unit on the TOXXFILE card through the optional FUNIT parameter. Please note, when specifying the FUNIT, to ensure there will be no file conflicts, it is recommended that user-specified units begin at a large integer value such as 10,000 and increment by one. If no file unit is specified, then the file unit is determined internally.

2.1.3 Controlling file inputs and outputs (I/O)

2.1.3.1 Controlling I/O on PCs.

The main input control file and the main output print file are specified internally by AERMOD as AERMOD.INP and AERMOD.OUT by default, respectively. The user has the option to provide command-line arguments when executing the model at the command prompt to specify a user-defined input control input filename and main output filename. When using the default names of AERMOD.INP and AERMOD.OUT, a standard command line to execute the AERMOD model might look something like this:

```
C:\>AERMOD
```

where the command prompt has been given as "C:\>", but may look different on different systems, or may include a subdirectory specification. Refer to Section 2.4.8 for details on specifying user-defined filenames when running AERMOD from the command prompt.

2.2 Description of keyword/parameter approach

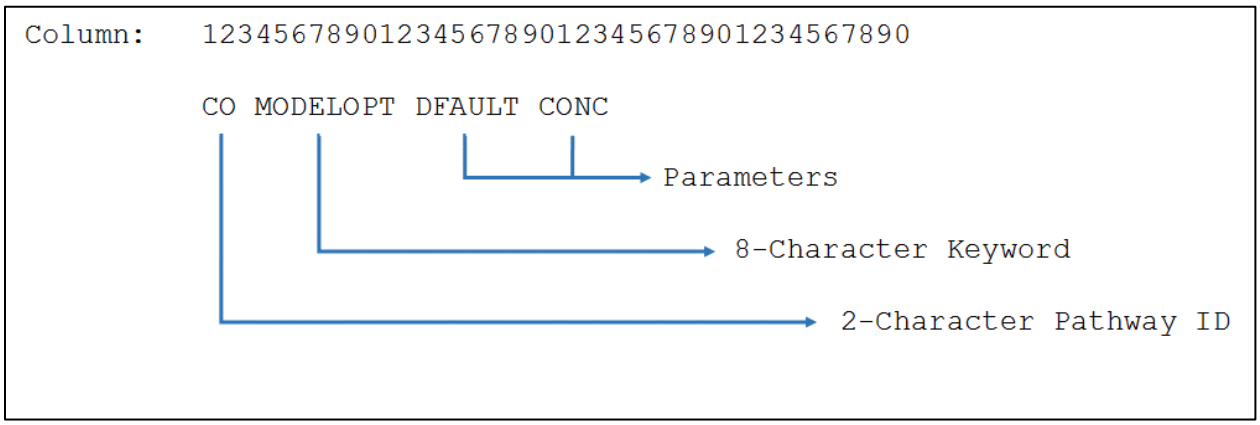
The input control file for the AERMOD model makes use of a keyword/parameter approach to specifying the options and input data for running the model. The descriptive keywords and parameters that make up this control file may be thought of as a command language through which the user communicates with the model what he/she wishes to accomplish for a particular model run. The keywords specify the type of option or input data

being entered on each line of the input file. An individual line or record in the control file is often referred to as a "card" throughout this manual and is commonly identified by the primary keyword associated with the information entered on the record. The parameters following the keyword define the specific options selected or the actual input data. Some of the parameters are also input as descriptive secondary keywords.

The control file is divided into five functional "pathways." These pathways are identified by a two-character pathway ID placed at the beginning of each line of the control file. The pathways and the order in which they are input to the model are as follows:

CO - for specifying overall job **CO**ntrol options;
SO - for specifying **SO**urce information;
RE - for specifying **RE**ceptor information;
ME - for specifying **ME**teorology information;
EV - for specifying **EV**ent processing;
OU - for specifying **OU**tput options.

Each line of the input control file consists of a pathway ID, an 8-character keyword, and a parameter list. An example of a line of input from a control file, with its various parts identified, is shown below:



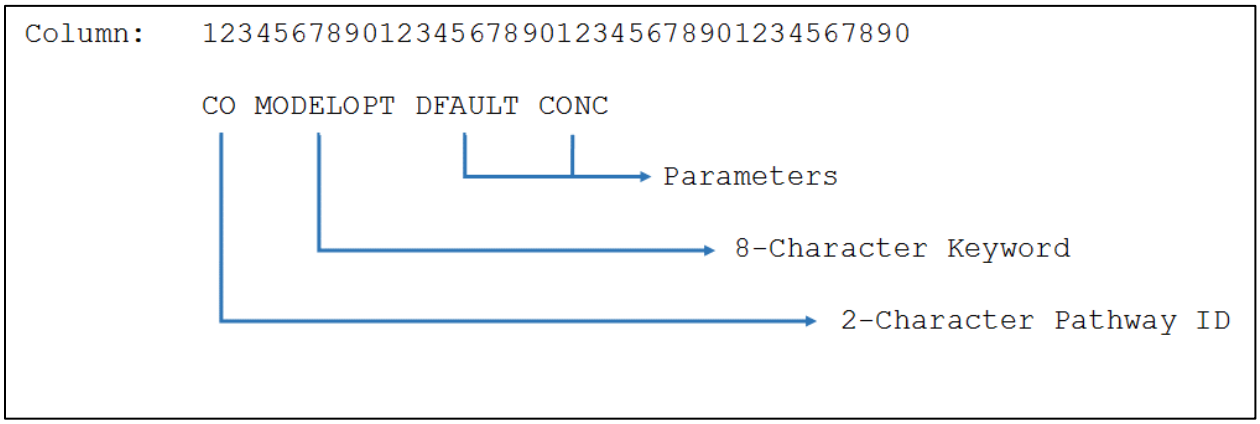
The following sections describe the rules for structuring the input control file and explain some of the advantages of the keyword/parameter approach.

2.2.1 Basic rules for structuring input control files

While the input control file has been designed to provide the user with considerable flexibility in structuring the input file, there are some basic syntax rules that need to be followed. These rules serve to maintain some consistency between input files generated by different users, to simplify the job of error handling performed by the model on the input data, and to provide information to the model in the appropriate order wherever order is critical to the interpretation of the inputs. These basic rules and the various elements of the input control file are described in the paragraphs that follow.

One of the most basic rules is that all inputs for a particular pathway must be “grouped within that specific pathway” and occur in the accepted order, i.e., all inputs for the CO pathway must come first, followed by the inputs for the SO pathway, and so on. The beginning of each pathway is identified with a "STARTING" keyword, and the ending of the pathway with the "FINISHED" keyword. Thus, the first functional record of each input file must be "CO STARTING" and the last record of each input file must be "OU FINISHED." The rest of the input control file commands will define the options and input data for a particular run.

Each record in the input control file is read into the model as a 512-character image beginning with version 09292. The information on each input image consists of a "pathway," a "keyword," and one or more "parameters." Each of these "fields" on a line in the control file command must be separated from other fields by at least one blank space. To simplify the interpretation of the control file command by the model, the control file must be structured with the two-character pathway in columns 1 and 2, the eight-character keyword in columns 4 through 11, followed by the parameters beginning in column 13 through the end of image, limited to 512 characters. For most keywords, the order of parameters following the keyword is important -- the exact spacing of the parameters is not important as long as they are separated from each other by at least one blank space and do not extend beyond the 512-character limit. The example of a control file command from the CO pathway shown above is repeated here:



Alphabetical characters can be input as either lower case or uppercase letters. The model converts all character input to upper case letters internally, except the title fields and file names to be discussed later. Throughout this document, the convention of using upper case letters is followed. For numeric input data, it should be noted that all data are assumed to be in metric units, i.e., length units of meters, speed units of meters per second, temperature units of degrees Kelvin, and emission units of grams per second. In a few instances, the user has the option of specifying units of feet for length and the model will perform the conversion to meters. These exceptions are the input of receptor heights for elevated terrain and the specification of anemometer height since these values are often more readily available in feet than in meters.

Certain keywords are mandatory and must be present in every control file, such as the MODELOPT keyword shown in the example above which identifies the modeling options. There are also keywords that are optional and are only needed to exercise specific options, such as the option to allow for the input of flagpole receptor heights. Some of the keywords are repeatable, such as the keywords to specify source parameters, while other keywords may only appear once. The keyword references are provided in Section 3.0 and APPENDIX A.

With a few exceptions that are described below, the order of keywords within each pathway is not critical. For the SO pathway, the LOCATION keyword must be specified before other keywords for a particular source, and the SRCGROUP keyword must be the last keyword before SO FINISHED unless the PSDCREDIT keyword is specified on the MODELOPT card, in

which case, SRCGROUP is replaced with the PSDGROUP keyword. For keywords on the SO pathway that accept a range of source IDs, the source parameters specified by those keywords will only be applied to the sources already defined and will exclude any sources that are specified latter in the input file.

The PARAMETER ILEN_FLD is used to specify the maximum length of individual fields on the input control file command and to declare the length of all filename and format variables. This PARAMETER is currently assigned a value of 200 beginning with version 09292 and is in MODULE MAIN1 in MODULES.FOR.

2.2.2 Advantages of the keyword approach

The keyword approach provides some advantages over the type of input file used by other models that require formatted input of several numeric switches. One advantage is that the keywords are descriptive of the options and inputs being used for a particular run, making it easier for a reviewer to ascertain what was accomplished in a particular run by reviewing the input file. Another advantage is that the user has considerable flexibility in structuring the inputs to improve their readability and understandability if they adhere to the few basic rules described above.

Some special provisions have been made to increase the flexibility to the user in structuring the input files. One provision is to allow for blank records in the input file. This allows the user to separate the pathways from each other, or to separate a group of images, such as source locations, from the other images. Another provision is for the use of "comment lines," identified by a "**" in the pathway field. Any input image that has "**" for the pathway ID will be ignored by the model. This is especially useful for labeling the columns in the source parameter input images, as illustrated in the example problem later in this section. It may also be used to "comment out" certain options for a particular run without deleting the options and associated data (e.g., elevated terrain heights) completely from the input file. Because of the descriptive nature of the keyword options and the flexibility of the inputs it is generally much easier to make modifications to an existing input control file to obtain the desired result.

Another reason for improved "user-friendliness" is that detailed error-handling has been built into the model. The model provides descriptions of the location and nature of all the errors encountered for a particular run. Rather than stopping execution at each occurrence of an input error, the model will read through and attempt to process all input records and report all errors encountered. If a fatal error occurs, then the model will not attempt to execute the model calculations.

2.3 Regulatory default modeling options

The regulatory default option is controlled from the MODELOPT keyword on the CO pathway. As its name implies, this keyword controls the selection of modeling options. It is a mandatory, non-repeatable keyword, and it is an especially important keyword for understanding and controlling the operation of the AERMOD model. Unless specified otherwise through the available keyword options, the AERMOD model implements the following default options:

- Use the elevated terrain algorithms requiring input of terrain height data;
- Use stack-tip downwash (except for building downwash cases);
- Use the calms processing routines;
- Use the missing data processing routines; and
- Use a 4-hour half-life for exponential decay of SO_2 for urban sources.

  Note that beginning with AERMOD version 18081, the 4-hour half-life is included by default for SO_2 urban sources for regulatory default applications and non-regulatory applications.

The parameters used to specify options on the MODELOPT keyword are character strings, called "secondary keywords," that are descriptive of the option being selected. For example, to ensure that the regulatory default options listed above are used for a particular model simulation, the user would include the secondary keyword "DFAULT" on the MODELOPT input. Upon initial execution, the model reads the control file to identify any conflicts in the options specified. In most cases, the model will issue an error message to inform the user of the conflict and abort before the simulation begins. For regulatory modeling applications, it is

strongly suggested that the DFAULT switch be set to ensure the regulatory default options listed above are used and non-regulatory options are not used.

In addition to the default regulatory options listed above, AERMOD includes several other regulatory options that are application dependent and are required to be set explicitly by the user in the control file. Most of these can be set with the use of secondary keywords associated with the MODELOPT keyword. The MODELOPT keyword is described in more detail in the Section 3.2.2. Throughout this user's guide, there has been an effort to clearly distinguish regulatory options that are required to be set by the user and can be used simultaneously with the DFAULT keyword from non-regulatory options that cannot be used along with the DFAULT keyword. These non-regulatory options are sometimes referred to as "non-DFAULT" options since they cannot be used along with the DFAULT keyword.

2.4 Setting up a simple control file

This section goes through a step-by-step description of setting up a simple application problem, illustrating the more commonly used options of the AERMOD model. The example problem is based on a simple industrial source application. The input file for AERMOD for the example problem is shown in Figure 2-1. The remainder of this section explains the various parts of the input file for the AERMOD model and illustrates some of the flexibility in structuring the input file.

```
CO STARTING
CO TITLEONE A Simple Example Problem for the AERMOD-PRIME Model
CO MODELOPT CONC FLAT
CO AVERTIME 3 24 PERIOD
CO POLLUTID SO2
CO RUNORNOT RUN
CO FINISHED

SO STARTING
SO LOCATION  STACK1  POINT 0.0 0.0 0.0
SO SRCPARAM  STACK1  500.0 65.00 425. 15.0 5.
SO BUILDHGT  STACK1  36*50.
SO BUILDWID  STACK1  62.26   72.64   80.80   86.51   89.59   89.95
SO BUILDWID  STACK1  87.58   82.54   75.00   82.54   87.58   89.95
SO BUILDWID  STACK1  89.59   86.51   80.80   72.64   62.26   50.00
SO BUILDWID  STACK1  62.26   72.64   80.80   86.51   89.59   89.95
SO BUILDWID  STACK1  87.58   82.54   75.00   82.54   87.58   89.95
SO BUILDWID  STACK1  89.59   86.51   80.80   72.64   62.26   50.00
SO BUILDLEN  STACK1  82.54   87.58   89.95   89.59   86.51   80.80
SO BUILDLEN  STACK1  72.64   62.26   50.00   62.26   72.64   80.80
SO BUILDLEN  STACK1  86.51   89.59   89.95   87.58   82.54   75.00
SO BUILDLEN  STACK1  82.54   87.58   89.95   89.59   86.51   80.80
SO BUILDLEN  STACK1  72.64   62.26   50.00   62.26   72.64   80.80
SO BUILDLEN  STACK1  86.51   89.59   89.95   87.58   82.54   75.00
SO XBADJ     STACK1 -47.35  -55.76  -62.48  -67.29  -70.07  -70.71
SO XBADJ     STACK1 -69.21  -65.60  -60.00  -65.60  -69.21  -70.71
SO XBADJ     STACK1 -70.07  -67.29  -62.48  -55.76  -47.35  -37.50
SO XBADJ     STACK1 -35.19  -31.82  -27.48  -22.30  -16.44  -10.09
SO XBADJ     STACK1  -3.43    3.34   10.00    3.34   -3.43  -10.09
SO XBADJ     STACK1 -16.44  -22.30  -27.48  -31.82  -35.19  -37.50
SO YBADJ     STACK1  34.47   32.89   30.31   26.81   22.50   17.50
SO YBADJ     STACK1  11.97    6.08    0.00   -6.08  -11.97  -17.50
SO YBADJ     STACK1 -22.50  -26.81  -30.31  -32.89  -34.47  -35.00
SO YBADJ     STACK1 -34.47  -32.89  -30.31  -26.81  -22.50  -17.50
SO YBADJ     STACK1 -11.97   -6.08    0.00    6.08   11.97   17.50
SO YBADJ     STACK1  22.50   26.81   30.31   32.89   34.47   35.00
SO SRCGROUP  ALL
SO FINISHED

RE STARTING
RE GRIDPOLR  POL1 STA
RE GRIDPOLR  POL1 ORIG STACK1
RE GRIDPOLR  POL1 DIST 175. 350. 500. 1000.
RE GRIDPOLR  POL1 GDIR 36 10 10
RE GRIDPOLR  POL1 END
RE FINISHED

ME STARTING
ME SURFFILE AERMET2.SFC
ME PROFFILE AERMET2.PFL
ME SURFDATA 14735 1988 ALBANY,NY
ME UAIRDATA 14735 1988 ALBANY,NY
ME SITEDATA
ME PROFBASE  0.0 METERS
ME FINISHED

OU STARTING
OU RECTABLE ALIVE FIRST-SECOND
OU MAXTABLE ALIVE 50
OU FINISHED
```

Figure 2-1. Example Input File for AERMOD for Sample Problem

2.4.1 A simple industrial source application

For this simple tutorial, an application is selected involving a single point source of SO_2 that is subject to the influences of building downwash. The source consists of a 50-meter stack with a buoyant release that is adjacent to a building. It is assumed that the stack is situated in flat terrain in a rural setting. A polar receptor network will be placed around the stack location to identify areas of maximum impact.

2.4.2 Selecting modeling options - CO pathway

The modeling options are input to the model on the Control pathway. The mandatory keywords for the CO pathway are listed below. A complete listing of all keywords is provided in Section 3.2 and APPENDIX A

STARTING -	Indicates the beginning of inputs for the pathway; this keyword is mandatory on each of the pathways.
TITLEONE -	A user-specified title line (up to 68 characters) that will appear on each page of the printed output file (an optional second title line is also available with the keyword TITLE TWO).
MODELOPT -	Controls the modeling options selected for a particular run through a series of secondary keywords.
AVERTIME -	Identifies the averaging periods to be calculated for a particular run.
POLLUTID -	Identifies the type of pollutant being modeled. At the present time, this option has no influence on the results.
RUNORNOT -	A special keyword that tells the model whether to run the full model executions or not. If the user selects not to run, then the control file will be processed and any input errors reported, but no dispersion calculations will be made.
FINISHED -	Indicates that the user is finished with the inputs for this pathway; this keyword is also mandatory on each of the other pathways.

The first two keywords are self-explanatory. As discussed above in Section 2.3, the MODELOPT keyword on the CO pathway is pivotal to controlling the modeling options used for a particular run. For this example, we intend to use the regulatory default option, and have specified for the model to output concentration values. After the first three input records our input file will look similar to this:

```
CO STARTING
CO TITLEONE A Simple Example Problem for the AERMOD-PRIME Model
CO MODELOPT CONC  FLAT
```

Note that the title parameter field does not need to be in quotations, even though it represents a single parameter. The model simply reads whatever appears beginning in column 13 out to a length of 200 characters of the TITLEONE card as the title field, without changing the lower case to upper case letters. Leading blanks are therefore significant if the user wishes to center the title within the field. Note that in the output files, only the first 68 characters of TITLEONE are printed. Note also that the spacing and order of the secondary keywords on the MODELOPT card are not significant. A MODELOPT card that looked like this:

```
CO MODELOPT CONC  FLAT
```

would have an identical result as the example above. It is suggested that the user adopt a style that is consistent and easy to read. A complete description of the available modeling options that can be specified on the MODELOPT keyword is provided in Section 3.0.

For this example, the average values are calculated for 3-hour and 24-hour and the full period that is modeled. The control file might, therefore, look similar to this after adding two more keywords:

```
CO STARTING
CO TITLEONE A Simple Example Problem for the AERMOD-PRIME Model
CO MODELOPT CONC  FLAT
CO AVERTIME 3  24  PERIOD
CO POLLUTID SO2
```

Note again that the order of the parameters on the AVERTIME keyword is not critical, although the order of the short-term averages given on the AVERTIME keyword will also be the order in which the results are presented in the output file. The order of the keywords within each pathway is also not critical in most cases, although the intent of the input control file may be easier to decipher if a consistent and logical order is followed. It is suggested that users follow the order in which the keywords are presented in Section 3.0, in APPENDIX A, and in the Quick Reference, unless there is a clear advantage to doing otherwise.

The only remaining mandatory keywords for the CO pathway are RUNORNOT and FINISHED. We will set the RUNORNOT switch to RUN for this example. If a user is unsure about the operation of certain options or is setting up a complex control file to run for the first time, it may be desirable to set the model NOT to run, but simply to read and analyze the input file and report any errors or warning messages that are generated. Once the input file has been debugged using these descriptive error/warning messages, then the RUNORNOT switch can be set to RUN, avoiding a possible costly waste of resources generating erroneous results. Even if the model is set NOT to run, all the inputs are summarized in the output file for the user to review.

Our complete control file for the CO pathway may look something like this:

```
CO STARTING
CO TITLEONE A Simple Example Problem for the AERMOD-PRIME Model
CO MODELOPT CONC  FLAT
CO AVERTIME 3  24  PERIOD
CO POLLUTID SO2
CO RUNORNOT RUN
CO FINISHED
```

The following set of control file options has a more structured look, but it is equivalent to the example above:

```
CO STARTING
   TITLEONE A Simple Example Problem for the AERMOD-PRIME Model
   MODELOPT CONC  FLAT
   AVERTIME 3  24  PERIOD
   POLLUTID SO2
   RUNORNOT RUN
CO FINISHED
```

Since the pathway ID is required to begin in column 1 (see Section 2.4.8 for a discussion of this restriction), the model will assume that the previous pathway is in effect if the pathway field is left blank. The model will do the same for blank keyword fields, which will be illustrated in the next section, Section 2.4.3.

In addition to these mandatory keywords on the CO pathway, the user may select optional keywords to allow the use of receptor heights above ground-level for flagpole receptors, to specify a decay coefficient or a half-life for exponential decay, and to generate an input file containing events for EVENT processing. The user also has the option of having the model periodically save the results to a file for later re-starting in the event of a power failure or other interruption of the model's execution. These options are described in more detail in Section 3.0 of this volume.

2.4.3 Specifying source inputs - SO pathway

Besides the STARTING and FINISHED keywords that are mandatory for all pathways, the Source pathway has the following mandatory keywords:

LOCATION - Identifies a particular source ID and specifies the source type and location of that source.

SRCPARAM - Specifies the source parameters for a particular source ID identified by a previous LOCATION card.

SRCGROUP - Specifies how sources will be grouped for calculational purposes. There is always at least one group, even though it may be the group of ALL sources and even if there is only one source.

Since the hypothetical source in this example problem is influenced by a nearby building, we also need to include the optional keywords BUILDHGT and BUILDWID in our input file.

The input file for the SO pathway for this example will similar to the following:

```
STARTING
LOCATION  STACK1    POINT   0.0     0.0     0.0
SRCPARAM  STACK1    500.0   65.00   425.    15.0    5.0
BUILDHGT  STACK1    50.00   50.00   50.00   50.00   50.00   50.00
BUILDHGT  STACK1    50.00   50.00   50.00   50.00   50.00   50.00
BUILDHGT  STACK1    50.00   50.00   50.00   50.00   50.00   50.00
BUILDHGT  STACK1    50.00   50.00   50.00   50.00   50.00   50.00
BUILDHGT  STACK1    50.00   50.00   50.00   50.00   50.00   50.00
BUILDHGT  STACK1    50.00   50.00   50.00   50.00   50.00   50.00
BUILDWID  STACK1    62.26   72.64   80.80   86.51   89.59   89.95
BUILDWID  STACK1    87.58   82.54   75.00   82.54   87.58   89.95
BUILDWID  STACK1    89.59   86.51   80.80   72.64   62.26   50.00
BUILDWID  STACK1    62.26   72.64   80.80   86.51   89.59   89.95
BUILDWID  STACK1    87.58   82.54   75.00   82.54   87.58   89.95
BUILDWID  STACK1    89.59   86.51   80.80   72.64   62.26   50.00
BUILDLEN  STACK1    82.54   87.58   89.95   89.59   86.51   80.80
BUILDLEN  STACK1    72.64   62.26   50.00   62.26   72.64   80.80
BUILDLEN  STACK1    86.51   89.59   89.95   87.58   82.54   75.00
BUILDLEN  STACK1    82.54   87.58   89.95   89.59   86.51   80.80
BUILDLEN  STACK1    72.64   62.26   50.00   62.26   72.64   80.80
BUILDLEN  STACK1    86.51   89.59   89.95   87.58   82.54   75.00
XBADJ     STACK1   -47.35  -55.76  -62.48  -67.29  -70.07  -70.71
XBADJ     STACK1   -69.21  -65.60  -60.00  -65.60  -69.21  -70.71
XBADJ     STACK1   -70.07  -67.29  -62.48  -55.76  -47.35  -37.50
XBADJ     STACK1   -35.19  -31.82  -27.48  -22.30  -16.44  -10.09
XBADJ     STACK1    -3.43    3.34   10.00    3.34   -3.43  -10.09
XBADJ     STACK1   -16.44  -22.30  -27.48  -31.82  -35.19  -37.50
YBADJ     STACK1    34.47   32.89   30.31   26.81   22.50   17.50
YBADJ     STACK1    11.97    6.08    0.00   -6.08  -11.97  -17.50
YBADJ     STACK1   -22.50  -26.81  -30.31  -32.89  -34.47  -35.00
YBADJ     STACK1   -34.47  -32.89  -30.31  -26.81  -22.50  -17.50
YBADJ     STACK1   -11.97   -6.08    0.00    6.08   11.97   17.50
YBADJ     STACK1    22.50   26.81   30.31   32.89   34.47   35.00
SRCGROUP  ALL
FINISHED
```

There are a few things to note about these inputs. First, the source ID (STACK1 in this example) is an alphanumeric parameter (up to 12 characters) that identifies the inputs for different keywords with a particular source. It is crucial that the source be identified with a LOCATION card before any other keyword references the source, since this identifies the source type (POINT in this case), and therefore, which parameters the model will allow. See Section 3.3.1 for a complete list and descriptions of the valid source types. If the effects of elevated terrain were included in this analysis, it would be important to specify the source base elevation above mean sea level (MSL) on the LOCATION card. For this example, the source base elevation is 0.0 meters MSL.

Another thing to note is that since the model uses direction-specific building dimensions for all sources with downwash, there are 36 building heights and 36 building widths entered on the appropriate keywords, one value for each 10-degree sector beginning with the 10-degree flow vector (direction toward which the wind is blowing) and continuing clockwise. Since the user

could not fit all 36 values on a single record, the pathway, keyword, and source ID were repeated as many times as were necessary. In this case there were six values given on each of the six lines for each of the building dimensions. There could have been fewer or more lines if exactly 36 values were entered before starting with a new keyword. Since the building height was the same across the sectors (fairly realistic for the height but not for widths, unless the structure was circular), there is a short cut available for specifying numeric input in the control files for the model. The user can specify "repeat values" by entering a field such as "36*50.0" as a parameter for the BUILDHGT keyword. The model will interpret this as "36 separate entries, each with a value of 50.0," and store the values in the appropriate arrays within the model. Since the model must identify this as a single parameter field, there must not be any spaces between the repeat-value and the value to be repeated.

The final keyword before finishing the SO pathway must be the SRCGROUP keyword (unless the PSDCREDIT keyword is specified on the MODELOPT card, in which case SRCGROUP is replaced with the PSDGROUP keyword). In this example, since there is only one source, we have taken advantage of a short cut provided by the model by specifying a source group ID (which may be up to eight characters) of ALL. Whenever this card appears in an input file, it will generate a source group with a source-group ID of ALL, consisting of all sources defined for that run. The sources do not have to be explicitly identified. In a run involving multiple sources, the user may specify multiple source groups by repeating the SRCGROUP keyword. The use of the SRCGROUP card is explained in more detail in Section 3.0.

Using some of the formatting options discussed above, the SO pathway for this example may look like this, with the same result as above:

```
SO STARTING
LOCATION    STACK1   POINT  0.0 0.0 0.0
** Point Source       QS    HS    TS     VS     DS
** Parameters:       ----  ----  ----   ----   ----
   SRCPARAM STACK1   500.0 65.0  425.0  15.0    5.0
   BUILDHTS STACK1   36*50.
   BUILDWTS STACK1   62.26    72.64    80.80    86.51    89.59     89.95
            STACK1   87.58    82.54    75.00    82.54    87.58     89.95
            STACK1   89.59    86.51    80.80    72.64    62.26     50.00
            STACK1   62.26    72.64    80.80    86.51    89.59     89.95
            STACK1   87.58    82.54    75.00    82.54    87.58     89.95
            STACK1   89.59    86.51    80.80    72.64    62.26     50.00
   XBADJ    STACK1  -47.35   -55.76   -62.48   -67.29   -70.07    -70.71
            STACK1  -69.21   -65.60   -60.00   -65.60   -69.21    -70.71
            STACK1  -70.07   -67.29   -62.48   -55.76   -47.35    -37.50
            STACK1  -35.19   -31.82   -27.48   -22.30   -16.44    -10.09
            STACK1   -3.43     3.34    10.00     3.34    -3.43    -10.09
            STACK1  -16.44   -22.30   -27.48   -31.82   -35.19    -37.50
   YBADJ    STACK1   34.47    32.89    30.31    26.81    22.50     17.50
            STACK1   11.97     6.08     0.00    -6.08   -11.97    -17.50
            STACK1  -22.50    26.81   -30.31   -32.89   -34.47    -35.00
            STACK1  -34.47   -32.89   -30.31   -26.81   -22.50    -17.50
            STACK1  -11.97    -6.08     0.00     6.08    11.97     17.50
            STACK1   22.50    26.81    30.31    32.89    34.47     35.00
   SRCGROUP ALL
SO FINISHED
```

This example of the SO pathway inputs illustrates the use of the comment card to label the stack parameters on the SRCPARAM card, i.e., QS for emission rate (g/s), HS for stack height (m), TS for stack exit temperature (K), VS for exit velocity (m/s), and DS for stack diameter (m). A complete description of the source parameter card, with a list of parameters for each source type, is provided in Section 3.3 and in APPENDIX A.

Other optional inputs that may be entered on the SO pathway include specifying variable emission rate factors for sources whose emissions vary as a function of month, season, hour-of-day, or season and hour-of-day (see Section 3.3.11 for more details). The number of factors entered depends on the option selected, and factors may be input for single sources or for a range of sources.

2.4.4 Specifying a receptor network - RE pathway

As mentioned above, this example illustrates the use of a single polar receptor network centered on the stack location. Other options available on the REceptor pathway include specifying a Cartesian grid receptor network and specifying discrete receptor locations in either a polar or a Cartesian system. These other options are described in more detail in Section 3.4.

The RE pathway for this example will look like this:

```
RE STARTING
   GRIDPOLR POL1 STA
   GRIDPOLR POL1 ORIG STACK1
   GRIDPOLR POL1 DIST 175. 350. 500. 1000.
   GRIDPOLR POL1 GDIR 36 10 10
   GRIDPOLR POL1 END
RE FINISHED
```

Looking at the example for the RE pathway, the first thing to note about these inputs is that there is a new set of keywords, including something that looks like a STArting and ENDing. In fact, the GRIDPOLR keyword can be thought of as a "sub-pathway," in that all the information for a particular polar network must be in contiguous records, and that the start and end of the sub-pathway are identified. Like the main pathways, the order of secondary keywords within the sub-pathway is not critical. Each card must be identified with a network ID (up to eight alphanumeric characters), in this case it is "POL1." Multiple networks may be specified in a single model run. The model waits until the END secondary keyword is encountered to set the variables, which may include terrain heights for receptors on elevated terrain or flagpole receptor heights if those options are being exercised by the user. The use of these optional secondary keywords is described in detail in Section 3.4.

For this example, the ORIG secondary keyword specifies the location of the origin for the polar network being defined as being the location of the source STACK1. The origin can also be specified as X and Y-coordinates. The ORIG keyword is optional, and the model will default to an origin of (0.0, 0.0) if it is omitted. The DIST keyword identifies the distances along each direction radial at which the receptors will be located. In this case there are four distances. More distances could be added by adding values to that input card or by including a continuation card

with the DIST keyword, if needed. The GDIR keyword specifies that the model will Generate DIRection radials for the network, in this case there will be 36 directions, beginning with the 10-degree flow vector and incrementing every 10 degrees clockwise. The user may elect to define Discrete DIRection radials instead by using the DDIR keyword in place of the GDIR keyword.

2.4.5 Specifying the meteorological Input - ME pathway

The MEteorology pathway has the following four mandatory keywords in addition to the common STARTING and FINISHED keywords:

SURFFILE - Specifies the filename and format for the input surface meteorological data file.

PROFFILE - Specifies the filename and format for the input profile meteorological data file.

SURFDATA - Specifies information about the surface meteorological data which will be used in the modeling.

UAIRDATA - Specifies information about the upper air meteorological data which will be used in the modeling.

PROFBASE - Specifies the base elevation above MSL for the potential temperature profile.

For the purposes of this example, it is assumed that the meteorological data files are for Albany, NY and that an on-site location called Hudson has also been used. It is also assumed that the surface and profile data files were generated by the AERMET preprocessor and are in the default format for AERMOD. The filename of the surface file is AERMET2.SFC and it consists of four days of data for Albany/Hudson from March 1988. The filename of the profile file is AERMET2.PFL. The data files used in this example correspond with the on-site example files used for the AERMET preprocessor program. The control file commands for the MEteorology pathway would look like the following:

```
ME STARTING
   SURFFILE  AERMET2.SFC
   PROFFILE  AERMET2.PFL
   SURFDATA  14735  1988  ALBANY,NY
   UAIRDATA  14735  1988  ALBANY,NY
   SITEDATA  99999 1988   HUDSON
   PROFBASE  0.0  METERS
ME FINISHED
```

The first parameters on the SURFFILE and PROFFILE keywords are the filenames for the surface and profile data file, respectively, which can be entered as a full DOS pathname, including the drive specification and subdirectories, up to a total of 200 characters (with the maximum number of characters controlled by the ILEN_FLD PARAMETER located in MODULE MAIN1 - see Section 2.2.1). Since there is no second parameter, the model will assume the default ASCII format for the data files. The format of the surface and profile data files is described in APPENDIX C.

The next two mandatory inputs identify the location and data period of the input meteorological data. A separate keyword is used for the surface meteorological data and for the upper air (mixing height) data. The parameters on these cards are the station number (e.g., WBAN number for NWS stations), the data period (year), and a station name. In order to identify potential errors in the model inputs, the model compares the station number from the control input file with values provided in the first record of the surface meteorology file, and issues warning messages if there are any mismatches. The user may also optionally input the (X,Y) coordinates for the location of the station(s), although these values are not currently used by the model. In this case, we have also included the optional SITEDATA keyword to identify the location for the on-site meteorological data that were preprocessed by AERMET.

The final mandatory keyword is PROFBASE, which is used to specify the base elevation (above MSL) for the potential temperature profile generated by AERMOD for use in the plume rise calculations. This should correspond to the base elevation for the main meteorological tower, which in this example is specified as 0.0 meters and is the same as the source base elevation.

Other optional keywords available on the ME pathway provide the user with options to specify selected days to process from the meteorological data file, and a wind direction rotation correction term. These optional inputs are described in more detail in Section 3.5.

2.4.6 Selecting output options - OU pathway

All the keywords on the Output pathway are optional, although the model will warn the user if no printed outputs are requested and will halt processing if no outputs (printed results or file outputs) are selected. The user has considerable flexibility to select only the outputs that are needed for a particular application. The printed table keywords are:

RECTABLE - Specifies the selection of high value by receptor table output options.

MAXTABLE - Specifies the selection of overall maximum value table output options.

DAYTABLE - Specifies the selection of printed results (by receptor) for each day of data processed (this option can produce very large files and should be used with caution).

The RECTABLE keyword provides the highest, second highest and third highest values, etc., by receptor. The MAXTABLE keyword provides a table of the overall maximum *n* number of values. For both keywords, the user has additional flexibility to specify for which short-term averaging periods the outputs are selected. For the MAXTABLE keyword the user can also specify the number of overall maximum values to summarize for each averaging period selected, up to a maximum number controlled by a parameter in the computer code. In the example below, the highest and second-highest values by receptor and the maximum 50 values for all averaging periods are specified.

```
OU STARTING
   RECTABLE  ALLAVE  FIRST  SECOND
   MAXTABLE  ALLAVE  50
OU FINISHED
```

To simplify the input for users who request the same printed table output options for all averaging periods, these keywords recognize the secondary keyword "ALLAVE" as the first

parameter for that purpose. To obtain the overall maximum 10 values for the 24-hour averages only, the OU pathway input would look like the following example:

```
OU STARTING
   RECTABLE  ALLAVE  FIRST  SECOND
   MAXTABLE  24  10
OU FINISHED
```

It should also be noted that these output table options apply only to the short-term averaging periods, such as the 3-hour and 24-hour averages used in our example. If the user has selected that PERIOD averages be calculated (on the CO AVERTIME keyword), then the output file will automatically include a table of period averages summarized by receptor (the RECTABLE option does not apply since there is only one period value for each receptor). In addition, the printed output file will include tables summarizing the highest values for each averaging period and source group.

Other options on the OU pathway include several keywords to produce output files for specialized purposes, such as generating contour plots of high values, identifying occurrences of violations of a particular threshold value (e.g., a NAAQS), and for postprocessing of the raw concentration data. These options are described in detail in Section 3.7.

The complete input control file for this simple example is shown in Figure 2-2. Note that a consistent style has been used for formatting and structuring the file to improve its readability. This input file is comparable to the version shown earlier in Figure 2-1, which used a somewhat different style.

```
CO STARTING
   TITLEONE A Simple Example Problem for the AERMOD-PRIME Model
   MODELOPT CONC  FLAT
   AVERTIME 3  24  PERIOD
   POLLUTID SO2
   RUNORNOT RUN
CO FINISHED

SO STARTING
   LOCATION  STACK1  POINT 0.0 0.0 0.0
** Point Source       QS     HS    TS    VS   DS
** Parameters:       -----  ----  ----  ----  ---
   SRCPARAM  STACK1  500.0  65.0  425.  15.0  5.0
   BUILDHGT  STACK1  36*50.
SO BUILDWID  STACK1    62.26   72.64   80.80   86.51   89.59   89.95
             STACK1    87.58   82.54   75.00   82.54   87.58   89.95
             STACK1    89.59   86.51   80.80   72.64   62.26   50.00
             STACK1    62.26   72.64   80.80   86.51   89.59   89.95
             STACK1    87.58   82.54   75.00   82.54   87.58   89.95
             STACK1    89.59   86.51   80.80   72.64   62.26   50.00
SO BUILDLEN  STACK1    82.54   87.58   89.95   89.59   86.51   80.80
             STACK1    72.64   62.26   50.00   62.26   72.64   80.80
             STACK1    86.51   89.59   89.95   87.58   82.54   75.00
             STACK1    82.54   87.58   89.95   89.59   86.51   80.80
             STACK1    72.64   62.26   50.00   62.26   72.64   80.80
             STACK1    86.51   89.59   89.95   87.58   82.54   75.00
SO XBADJ     STACK1   -47.35  -55.76  -62.48  -67.29  -70.07  -70.71
             STACK1   -69.21  -65.60  -60.00  -65.60  -69.21  -70.71
             STACK1   -70.07  -67.29  -62.48  -55.76  -47.35  -37.50
             STACK1   -35.19  -31.82  -27.48  -22.30  -16.44  -10.09
             STACK1    -3.43    3.34   10.00    3.34   -3.43  -10.09
             STACK1   -16.44  -22.30  -27.48  -31.82  -35.19  -37.50
SO YBADJ     STACK1    34.47   32.89   30.31   26.81   22.50   17.50
             STACK1    11.97    6.08    0.00   -6.08  -11.97  -17.50
             STACK1   -22.50  -26.81  -30.31  -32.89  -34.47  -35.00
             STACK1   -34.47  -32.89  -30.31  -26.81  -22.50  -17.50
             STACK1   -11.97   -6.08    0.00    6.08   11.97   17.50
             STACK1    22.50   26.81   30.31   32.89   34.47   35.00
   SRCGROUP  ALL
SO FINISHED

RE STARTING
   GRIDPOLR  POL1 STA
   GRIDPOLR  POL1 ORIG STACK1
   GRIDPOLR  POL1 DIST 175. 350. 500. 1000.
   GRIDPOLR  POL1 GDIR 36 10 10
   GRIDPOLR  POL1 END
RE FINISHED

ME STARTING
   SURFFILE AERMET2.SFC
   PROFFILE AERMET2.PFL
   SURFDATA 14735 1988 ALBANY,NY
   UAIRDATA 14735 1988 ALBANY,NY
   SITEDATA 99999 1988 HUDSON
   PROFBASE  0.0 METERS
ME FINISHED

OU STARTING
   RECTABLE ALLAVE FIRST-SECOND
   MAXTABLE ALLAVE 50
OU FINISHED
```

Figure 2-2. Example Input control file for Sample Problem

2.4.7 Using the error message file to debug the input control file

The previous sections in this tutorial have provided a step-by-step construction of a sample control input file for AERMOD. This simple example problem illustrated the usage of the more commonly used options of the AERMOD model. However, many real-time applications of the model will be much more complex than this example, perhaps involving multiple sources and source groups, multiple receptor networks, the addition of discrete receptor locations, and/or elevated terrain heights. To reduce errors in modeling applications, an effort has been made to develop detailed error handling capabilities for the AERMOD model.

The error handling capabilities of the AERMOD model are designed to accomplish two things for the user. First, the model reads through the complete input file and reports all occurrences of errors or suspect entries before stopping, rather than stopping on the first instance (and every instance thereafter) of an error in the input file. Second, the model provides error and warning messages that are detailed and descriptive enough that they will help the user in his/her effort to debug the input file. The remainder of this section provides a brief introduction to the use of the model's error handling capabilities. APPENDIX B of this volume provides more details about the error handling provided by the AERMOD model.

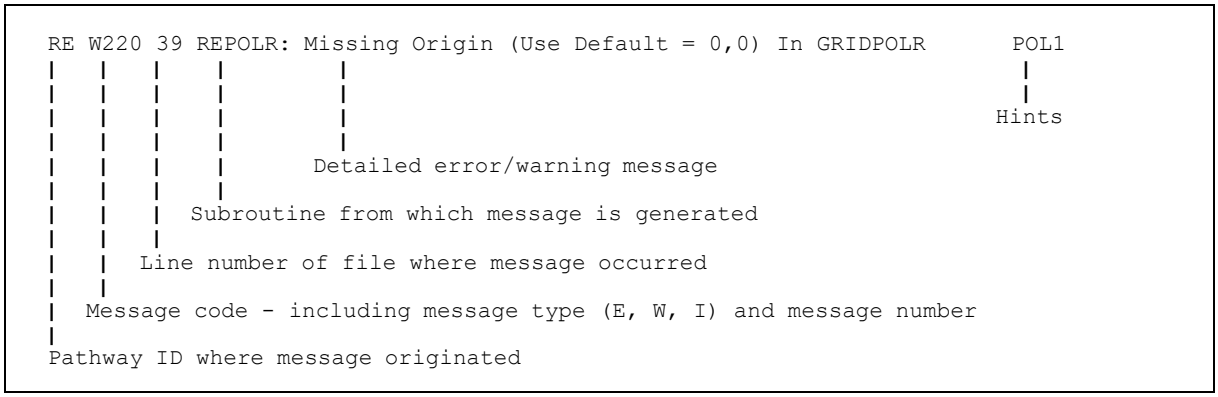
The AERMOD model generates messages during the processing of the input data and during the execution of model calculations. These messages inform the user about a range of possible conditions including:

- Errors that will halt any further processing, except to identify additional error conditions;
- Warnings that do not halt processing but indicate possible errors or suspect conditions; and
- Informational messages that may be of interest to the user but have no direct bearing on the validity of the results.

As the model encounters a condition for which a message is generated, the model writes the message to a temporary storage file. At the completion of the setup processing for a run, and at the completion of the model calculations, the model rereads the message file and generates a

summary of the messages which is included in the main printed output file. If the processing of the model setup information indicates no errors or warnings, and the user has selected the option to RUN the model calculations on the CO RUNORNOT card, then the model will simply write a statement to the print file that the model setup was completed successfully. Otherwise, the model will report a summary of the messages encountered. The summary of model setup messages that would be generated for the example problem if the option NOT to run was chosen is shown in Figure 2-3. This summary table reports the total number of occurrences for each of the message types and lists the detailed message for any fatal errors or warning messages that were generated. In this case, since there were no errors or suspicious conditions in the setup file, there are no error or warning messages listed.

An example of the warning message that would have been generated had we left out the card on the RE pathway that specifies the origin of the polar receptor network is shown below:



Since this is a warning message, it would have appeared at the end of the message summary table in the output file, but it would not have halted processing of the data. The last item on the message line, "Hints," may include such information as the keyword or parameter name causing the error, the source ID, group ID or (as in this case) the network ID involved, or perhaps the date variable identifying when the message occurred during the processing of the meteorological data, such as an informational message identifying the occurrence of a calm wind.

For new users and for particularly complex applications, it is strongly recommended that the model first be run with the RUNORNOT keyword (on the CO pathway) set NOT to run. In

this way, the user can determine if the model is being set up properly by the control file before committing the resources to perform a complete run. The user should make a point of examining any warning messages carefully to be sure that the model is operating as expected for their application, since these messages will not halt processing by the model. The detailed messages should provide enough information for the user to determine the location and nature of any errors in the control file.

In deciphering the error and warning messages, the line number provided as part of the message may be particularly helpful in locating the error within the input file. However, if it is an error of omission that is caught by the error checking performed at the completion of inputs for a pathway, then the line number will correspond to the last record for that pathway. The user may need to examine all the messages carefully before locating the error or errors, especially since a single occurrence of certain types of errors may lead to other error conditions being identified later in the input file which do not really constitute errors in themselves. An example of this is provided in Figure 2-4, which shows some inputs for the SO pathway where the building dimension keywords have been typed incorrectly, and the associated list of error messages. Since continuation cards (cards or records that require multiple entries and the input continues on subsequent lines) were used for the building width inputs, and the keyword was entered incorrectly on the first line, the subsequent records were also taken by the model to be invalid keyword inputs. While the error messages are the same for these records, the message originates from a different part of the model (SUBROUTINE SOCARD) for the records with the blank keyword.

Since the detailed error and warning messages are listed in the output file as part of the message summary table, there will generally not be a need for the user to examine the contents of the detailed message file. For this reason, the default operation of the model is to write the messages that are generated by a particular run to a temporary file that is deleted when the run is completed. If the user wishes to examine the complete list of detailed messages (of all types), there is an optional keyword available on the CO pathway for that purpose. The ERRORFIL keyword, which is described in detail in Section 3.2.19, allows the user to save the complete list of detailed messages to a user-specified filename.

```
*** Message Summary : AERMOD Model Execution ***

  --------- Summary of Total Messages --------

 A Total of            0 Fatal Error Message(s)
 A Total of            1 Warning Message(s)
 A Total of            0 Informational Message(s)

 A Total of           96 Hours Were Processed

 A Total of            0 Calm Hours Identified

 A Total of            0 Missing Hours Identified (  0.00 Percent)


    ******** FATAL ERROR MESSAGES ********
               ***  NONE  ***


    ********   WARNING MESSAGES   ********
 MX W403      57       PFLCNV: Turbulence data is being used w/o ADJ_U* option     SigA & SigW

    ***********************************
    *** AERMOD Finishes Successfully ***
    ***********************************
```

Figure 2-3. Example Message Summary Table for AERMOD Execution

```
SO STARTING
LOCATION    STACK1   POINT  0.0 0.0 0.0
** Point Source       QS    HS    TS     VS     DS
** Parameters:       ----  ----  ----   ----   ----
   SRCPARAM STACK1   500.0 65.0  425.0  15.0    5.0
   BUILDHTS STACK1   36*50.
   BUILDWTS STACK1   62.26    72.64    80.80    86.51    89.59     89.95
            STACK1   87.58    82.54    75.00    82.54    87.58     89.95
            STACK1   89.59    86.51    80.80    72.64    62.26     50.00
            STACK1   62.26    72.64    80.80    86.51    89.59     89.95
            STACK1   87.58    82.54    75.00    82.54    87.58     89.95
            STACK1   89.59    86.51    80.80    72.64    62.26     50.00
   XBADJ    STACK1  -47.35   -55.76   -62.48   -67.29   -70.07    -70.71
            STACK1  -69.21   -65.60   -60.00   -65.60   -69.21    -70.71
            STACK1  -70.07   -67.29   -62.48   -55.76   -47.35    -37.50
            STACK1  -35.19   -31.82   -27.48   -22.30   -16.44    -10.09
            STACK1   -3.43     3.34    10.00     3.34    -3.43    -10.09
            STACK1  -16.44   -22.30   -27.48   -31.82   -35.19    -37.50
   YBADJ    STACK1   34.47    32.89    30.31    26.81    22.50     17.50
            STACK1   11.97     6.08     0.00    -6.08   -11.97    -17.50
            STACK1  -22.50    26.81   -30.31   -32.89   -34.47    -35.00
            STACK1  -34.47   -32.89   -30.31   -26.81   -22.50    -17.50
            STACK1  -11.97    -6.08     0.00     6.08    11.97     17.50
            STACK1   22.50    26.81    30.31    32.89    34.47     35.00
   SRCGROUP    ALL
SO FINISHED
```

```
  *** Message Summary For AERMOD Model Setup ***

  --------- Summary of Total Messages --------

 A Total of            7 Fatal Error Message(s)
 A Total of            1 Warning Message(s)
 A Total of            0 Informational Message(s)


    ******** FATAL ERROR MESSAGES ********
 SO E105      15        SETUP: Invalid Keyword Specified. The Troubled Keyword is     BUILDWTS
 SO E110      16       SOCARD: Keyword is Not Valid for This Pathway.  Keyword is     BUILDWTS
 SO E110      17       SOCARD: Keyword is Not Valid for This Pathway.  Keyword is     BUILDWTS
 SO E110      18       SOCARD: Keyword is Not Valid for This Pathway.  Keyword is     BUILDWTS
 SO E110      19       SOCARD: Keyword is Not Valid for This Pathway.  Keyword is     BUILDWTS
 SO E110      20       SOCARD: Keyword is Not Valid for This Pathway.  Keyword is     BUILDWTS
 SO E237      40        SRCQA: Not Enough BUILDWIDs Specified for SourceID              STACK1

    ********   WARNING MESSAGES   ********
 MX W403      57       PFLCNV: Turbulence data is being used w/o ADJ_U* option     SigA & SigW

    ************************************
    *** SETUP Finishes UN-successfully ***
    ************************************
```

Figure 2-4. Example of Keyword Error and Associated Message Summary Table

2.4.8 Running the model and reviewing the results

Now that we have a complete and error-free control input file, we are ready to run the model and then review the results. The PC-executable file available on the SCRAM website opens the control input and printed output files and the model can be executed from the command prompt three ways as follows:

Path-to-AERMOD.EXE\AERMOD

Path-to-AERMOD.EXE\AERMOD *runstream_input_filename*

Path-to-AERMOD.EXE\AERMOD *runstream_input_filename output_filename*

The first example above is applicable for all versions of AERMOD and assumes that the control input and printed output files are AERMOD.INP and AERMOD.OUT (not case sensitive in DOS and case sensitive on Unix and Linux systems). The other two examples apply to AERMOD versions beginning with 18081 in which the user can specify the control input filename and optionally the output filename as well. The filenames can include a directory pathname if the files reside in a different directory than the working directory. If the output filename is not specified, AERMOD will use the control input filename (including pathname) and replace the input filenames extension (e.g., ".INP") with a ".OUT" extension. Otherwise, if both files are specified, they can be in different locations. The important points are that the AERMOD.EXE file either be in the directory from which you are attempting to run the model or in a directory that is included on the DOS PATH command when the system is "booted-up." The control input file (AERMOD.INP) must also be in the directory which the model is being executed when the control input filename is not specified. When the default control file and main output filenames are used and reside in the working directory with AERMOD.EXE, the model can also be executed by double clicking on the executable file from Windows Explorer.

As mentioned above, the SCRAM PC-executable file for AERMOD opens the input and output files explicitly. One reason for this is to allow for the model to write an update on the status of processing to the PC terminal screen. For the AERMOD model, the model first indicates that setup information is being processed and then gives the Julian day currently being

processed. If no status message is displayed, then the model did not load into memory properly. If the model stops after completing the setup processing, then the RUNORNOT option was set NOT to run. If a fatal error is encountered during the setup processing, then a message to that effect will be written to the screen and model execution will be stopped. Another reason for not sending the printed output to the default output device (i.e., to the screen or redirected to a file), is so that any DOS error messages will be visible on the screen and not be written to the printed file. One such message might be that there is insufficient memory available to run the program. Handling of DOS error messages may require some knowledge of DOS, unless the meaning of the message is obvious.

The order of contents and organization of the main output file for the AERMOD model is presented in Figure 2-5.

Echo of Input Control File Commands

Summary of Control File Messages

Summary of Inputs
- Summary of Modeling Options
- Summary of Source Data Summary
- of Receptor Data Summary of
- Meteorology Data

Model Results

- Daily Results for Each Averaging Period Selected for Each Day Processed (If Applicable)
  - DAYTABLE Keyword
- PERIOD Results for Each Source Group (If Applicable)
  - PERIOD Parameter on AVERTIME Keyword
- Short-Term Average Results (High, Second High, etc.) by Receptor for Each Source Group (If Applicable)
  - RECTABLE Keyword
- Overall Maximum Short-Term Average Results for Each Source Group (If Applicable)
  - MAXTABLE Keyword

Summary Tables of High Values for Each Averaging Period and Source Group (Always provided if PERIOD averages or the RECTABLE keyword are used)

Summary of Complete Model Execution Messages

Figure 2-5. Organization of the AERMOD Model Output File

Each page of the output file, except for the echo of the input file entries, is labeled with the model's name and version number, user-specified title(s), page number, and, for the PC version of the model, the date and time of the particular run. Also included as part of the header information for each page is a one-line summary of the modeling options used for that particular run. The modeling options are listed as the secondary keywords used to control the options, such as DFAULT, CONC, etc.

Since the complete input file is normally echoed back as part of the output file, and since processing of the inputs stops when the OU FINISHED card is reached, the run can be duplicated by simply specifying the output filename as the input control file. Alternatively, the input records could be "cut and pasted" from the output file to a separate file using a text editor.

By default, the model will echo each line of the input control file to the printed output file. This provides a convenient record of the inputs as originally read into the model, without any rounding of numerical values that may appear in the input summary tables. As noted above, it also means that the output file can be used as an input file to the model to reproduce a particular application. However, for some applications, the length of the input control file may be too cumbersome to include the entire set of inputs at the beginning of each output file. This may happen, for example, if a large number of sources are being defined or if a large number of discrete receptor locations are used. For this reason, the user is provided with the option to "turn off" the echoing of the input file at any point within the control file. This is accomplished by entering the keywords "NO ECHO" in the first two fields anywhere within the control file. In other words, place NO in the pathway field, followed by a space and then ECHO. None of the input control file options after the NO ECHO will be echoed to the output file. Thus, a user may choose to place NO ECHO after the Control pathway to keep the control options echoed but suppress echoing the rest of the input file.

The details of the message summary tables were discussed in the previous section. A portion of the summary of modeling option inputs is shown in Figure 2-6 for the simple example described in this section. The summary of source parameter input data includes separate tables for each source type, rather than combining all sources onto a single table. In this way the column headings are specific to the source type.

Figure 2-7 presents an example of the results output for the first highest values by receptor for our sample problem. These values are the first highest 3-hour averages at each receptor location. The number in parentheses following each concentration value is the date corresponding to each value. The date is given as an eight-digit integer variable that includes the year (2-digits), month, day, and hour corresponding to the end of the averaging period.

For each of the different types of model result tables, the controlling keyword is identified in Figure 2-5 at the end of the description. All the outputs of the same type, e.g., high values by receptor, are printed together, and the order of tables loops through all source groups for a particular averaging period and then loops through all averaging periods. The summary tables of high values at the end of the model results follow the same order of loops. An example of the summary tables for our sample problem is shown in Figure 2-8.

```
*** AERMOD - VERSION 22112  ***   *** A Simple Example Problem for the AERMOD-PRIME Model                 ***        06/07/22

*** AERMET - VERSION  22112 ***   ***                                                                   ***        14:18:02
                                                                                                                 PAGE   1
*** MODELOPTs:    NonDFAULT  CONC  FLAT  RURAL  SigA&SigW

                                       ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
** Model Options Selected:
     * Model Allows User-Specified Options
     * Model Is Setup For Calculation of Average CONCentration Values.
     * NO GAS DEPOSITION Data Provided.
     * NO PARTICLE DEPOSITION Data Provided.
     * Model Uses NO DRY DEPLETION. DDPLETE  =  F
     * Model Uses NO WET DEPLETION. WETDPLT  =  F
     * Stack-tip Downwash.
     * Model Assumes Receptors on FLAT Terrain.
     * Use Calms Processing Routine.
     * Use Missing Data Processing Routine.
     * No Exponential Decay.
     * Model Uses RURAL Dispersion Only.
     * CCVR_Sub - Meteorological data includes CCVR substitutions
     * Model Assumes No FLAGPOLE Receptor Heights.
     * The User Specified a Pollutant Type of: SO2

**NOTE: Special processing requirements applicable for the 1-hour SO2 NAAQS have been disabled!!!
        User has specified non-standard averaging periods:    3-HR  24-HR
        High ranked 1-hour values are NOT averaged across the number of years modeled, and
        complete years of data are NOT required.

**Model Calculates  2 Short Term Average(s) of:   3-HR  24-HR
    and Calculates PERIOD Averages

**This Run Includes:      1 Source(s);       1 Source Group(s); and     144 Receptor(s)

               with:      1 POINT(s), including
                          0 POINTCAP(s) and      0 POINTHOR(s)
                and:      0 VOLUME source(s)
                and:      0 AREA type source(s)
                and:      0 LINE source(s)
                and:      0 RLINE/RLINEXT source(s)
                and:      0 OPENPIT source(s)
                and:      0 BUOYANT LINE source(s) with a total of     0 line(s)
                and:      0 SWPOINT source(s)


**Model Set To Continue RUNning After the Setup Testing.

**The AERMET Input Meteorological Data Version Date:  22112

**Output Options Selected:
         Model Outputs Tables of PERIOD Averages by Receptor
         Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
         Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Base Elev. for Pot. Temp. Profile (m MSL) =     0.00 ;  Decay Coef. =    0.000     ;  Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                                 ;  Emission Rate Unit Factor =   0.10000E+07
                 Output Units   = MICROGRAMS/M**3

**Approximate Storage Requirements of Model =      3.5 MB of RAM.
```

Figure 2-6. Sample of Model Option Summary Table from an AERMOD Model Output File

```
*** AERMOD - VERSION 22112  ***   *** A Simple Example Problem for the AERMOD-PRIME Model                  ***        06/07/22
*** AERMET - VERSION  22112 ***   ***                                                                     ***        14:18:02
                                                                                                                    PAGE   9
*** MODELOPTs:    NonDFAULT  CONC  FLAT  RURAL  SigA&SigW

                           *** THE   1ST HIGHEST  3-HR AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP:  ALL      ***
                               INCLUDING SOURCE(S):     STACK1      ,

                                *** NETWORK ID: POL1     ;  NETWORK TYPE: GRIDPOLR ***

                                     ** CONC OF SO2      IN MICROGRAMS/M**3                          **

DIRECTION |                                          DISTANCE (METERS)
(DEGREES) |         175.00                350.00                500.00                1000.00
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

     10.0 |      1.60637 (88030212)      4.32183 (88030215)      9.87871 (88030215)     20.31341 (88030215)
     20.0 |      1.27691 (88030212)      7.75747 (88030215)     19.35471 (88030215)     43.24437 (88030215)
     30.0 |      1.31753 (88030321)      6.80000 (88030215)     16.96932 (88030215)     37.21008 (88030215)
     40.0 |      1.37996 (88030321)      2.78658 (88030215)      6.56111 (88030215)     13.02309 (88030215)
     50.0 |      1.41988 (88030321)      2.62563 (88030115)      4.10823 (88030115)      4.68748 (88030212)
     60.0 |      1.43198 (88030321)      2.82901 (88030115)      4.55254 (88030115)      4.68748 (88030212)
     70.0 |      1.41464 (88030321)      8.49965 (88030115)     11.29511 (88030115)     11.52741 (88030115)
     80.0 |      2.58429 (88030115)     43.19500 (88030115)     48.25320 (88030115)     34.37546 (88030115)
     90.0 |      7.93441 (88030115)    113.82878 (88030115)    143.17280 (88030115)     83.53515 (88030115)
    100.0 |     49.08751 (88030112)    182.84906 (88030115)    220.83958 (88030115)    145.67442 (88030115)
    110.0 |    112.74908 (88030112)    242.27766 (88030112)    278.47896 (88030115)    163.85177 (88030115)
    120.0 |    133.57972 (88030112)    303.36789 (88030112)    329.96015 (88030112)    201.18211 (88030112)
    130.0 |     84.37463 (88030112)    177.43472 (88030112)    193.23411 (88030112)    123.90900 (88030112)
    140.0 |     34.33105 (88030112)     78.48757 (88030115)     90.16431 (88030115)     66.26935 (88030112)
    150.0 |      3.26313 (88030112)     28.20306 (88030115)     35.81299 (88030112)     33.54932 (88030112)
    160.0 |      1.45757 (88030209)      8.53192 (88030112)     13.46873 (88030112)     12.93284 (88030112)
    170.0 |      1.33663 (88030209)      2.92150 (88030112)      4.70642 (88030112)      9.87872 (88030415)
    180.0 |      1.23781 (88030212)      2.59400 (88030115)      4.58665 (88030415)     11.25826 (88030415)
    190.0 |      1.23781 (88030212)      2.62640 (88030115)      4.10607 (88030115)      6.95118 (88030415)
    200.0 |      1.23781 (88030212)      2.63486 (88030115)      4.10609 (88030115)      4.68748 (88030212)
    210.0 |      1.23781 (88030212)      2.63700 (88030115)      4.10609 (88030115)      4.68748 (88030212)
    220.0 |      1.23783 (88030212)      2.63762 (88030115)      4.10609 (88030115)      4.68748 (88030212)
    230.0 |      1.26732 (88030212)      2.63762 (88030115)      4.10609 (88030115)      4.68767 (88030212)
    240.0 |      1.59395 (88030212)      2.63762 (88030115)      4.10609 (88030115)      4.72694 (88030212)
    250.0 |      2.39221 (88030212)      2.63762 (88030115)      4.10609 (88030115)      5.24318 (88030212)
    260.0 |      3.44586 (88030212)      3.11001 (88030212)      4.10609 (88030115)      7.70339 (88030212)
    270.0 |      4.67900 (88030212)      4.53914 (88030212)      4.60912 (88030212)     13.41550 (88030212)
    280.0 |      6.10725 (88030212)      6.15657 (88030212)      6.42897 (88030212)     21.16129 (88030212)
    290.0 |      7.47165 (88030212)      7.75530 (88030212)      8.18188 (88030212)     27.76976 (88030212)
    300.0 |      8.45754 (88030212)      8.93592 (88030212)      9.35713 (88030212)     30.22723 (88030212)
    310.0 |      8.83767 (88030212)      9.29972 (88030212)      9.54143 (88030212)     27.40028 (88030212)
    320.0 |      8.53526 (88030212)      8.67663 (88030212)      8.65382 (88030212)     20.68075 (88030212)
    330.0 |      7.53807 (88030212)      7.17470 (88030212)      6.91694 (88030212)     13.22924 (88030212)
    340.0 |      5.96054 (88030212)      5.15139 (88030212)      4.78244 (88030212)      8.04861 (88030212)
    350.0 |      4.10326 (88030212)      3.16494 (88030212)      4.10609 (88030115)      5.75319 (88030212)
    360.0 |      2.52862 (88030212)      2.63762 (88030115)      4.10609 (88030115)      4.96113 (88030212)
```

Figure 2-7. Example Output Table of High Values by Receptor

```
 *** AERMOD - VERSION 22112  ***   *** A Simple Example Problem for the AERMOD-PRIME Model                 ***        06/07/22
 *** AERMET - VERSION  22112 ***   ***                                                                    ***        14:18:02
                                                                                                                    PAGE  15
 *** MODELOPTs:    NonDFAULT  CONC  FLAT  RURAL  SigA&SigW

                                     *** THE SUMMARY OF MAXIMUM PERIOD (    96 HRS) RESULTS ***


                                   ** CONC OF SO2      IN MICROGRAMS/M**3                        **

                                                                                                        NETWORK
GROUP ID                       AVERAGE CONC              RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)  OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL       1ST HIGHEST VALUE IS      24.85173 AT (     433.01,     -250.00,     0.00,     0.00,    0.00)  GP  POL1
          2ND HIGHEST VALUE IS      23.13772 AT (     469.85,     -171.01,     0.00,     0.00,    0.00)  GP  POL1
          3RD HIGHEST VALUE IS      21.03529 AT (     303.11,     -175.00,     0.00,     0.00,    0.00)  GP  POL1
          4TH HIGHEST VALUE IS      19.33506 AT (     328.89,     -119.71,     0.00,     0.00,    0.00)  GP  POL1
          5TH HIGHEST VALUE IS      17.19044 AT (     383.02,     -321.39,     0.00,     0.00,    0.00)  GP  POL1
          6TH HIGHEST VALUE IS      16.86865 AT (     866.03,     -500.00,     0.00,     0.00,    0.00)  GP  POL1
          7TH HIGHEST VALUE IS      15.01122 AT (     939.69,     -342.02,     0.00,     0.00,    0.00)  GP  POL1
          8TH HIGHEST VALUE IS      14.27336 AT (     268.12,     -224.98,     0.00,     0.00,    0.00)  GP  POL1
          9TH HIGHEST VALUE IS      12.80321 AT (     492.40,      -86.82,     0.00,     0.00,    0.00)  GP  POL1
         10TH HIGHEST VALUE IS      12.38150 AT (     766.04,     -642.79,     0.00,     0.00,    0.00)  GP  POL1


 *** RECEPTOR TYPES:  GC = GRIDCART
                      GP = GRIDPOLR
                      DC = DISCCART
                      DP = DISCPOLR
 *** AERMOD - VERSION 22112  ***   *** A Simple Example Problem for the AERMOD-PRIME Model                 ***        06/07/22
 *** AERMET - VERSION  22112 ***   ***                                                                    ***        14:18:02
                                                                                                                    PAGE  16
 *** MODELOPTs:    NonDFAULT  CONC  FLAT  RURAL  SigA&SigW

                                        *** THE SUMMARY OF HIGHEST  3-HR RESULTS ***


                                   ** CONC OF SO2      IN MICROGRAMS/M**3                        **

                                                 DATE                                                          NETWORK
GROUP ID                       AVERAGE CONC     (YYMMDDHH)             RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)    OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL       HIGH   1ST HIGH VALUE IS     329.96015  ON 88030112: AT (     433.01,     -250.00,     0.00,     0.00,    0.00)  GP  POL1
          HIGH   2ND HIGH VALUE IS     261.07805  ON 88030112: AT (     469.85,     -171.01,     0.00,     0.00,    0.00)  GP  POL1


 *** RECEPTOR TYPES:  GC = GRIDCART
                      GP = GRIDPOLR
                      DC = DISCCART
                      DP = DISCPOLR
 *** AERMOD - VERSION 22112  ***   *** A Simple Example Problem for the AERMOD-PRIME Model                 ***        06/07/22
 *** AERMET - VERSION  22112 ***   ***                                                                    ***        14:18:02
                                                                                                                    PAGE  17
 *** MODELOPTs:    NonDFAULT  CONC  FLAT  RURAL  SigA&SigW
```

```
                                    *** THE SUMMARY OF HIGHEST 24-HR RESULTS ***


                                  ** CONC OF SO2      IN MICROGRAMS/M**3                        **

                                                        DATE                                                                                NETWORK
GROUP ID                          AVERAGE CONC     (YYMMDDHH)             RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)    OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL      HIGH   1ST HIGH VALUE IS      88.89517  ON 88030124: AT (     433.01,     -250.00,     0.00,     0.00,    0.00)  GP  POL1
         HIGH   2ND HIGH VALUE IS      10.09519  ON 88030324: AT (     866.03,     -500.00,     0.00,     0.00,    0.00)  GP  POL1


 *** RECEPTOR TYPES:  GC = GRIDCART
                      GP = GRIDPOLR
                      DC = DISCCART
                      DP = DISCPOLR
```

Figure 2-8. Example of Result Summary Tables for the AERMOD Model

2.5 Modifying an existing control file

As noted earlier, one of the advantages of the keyword/parameter approach and the flexible format adopted for the input control file is that it will be easier for the user to make modifications to the control file and obtain the desired result. This section briefly illustrates some examples of how a control file can be modified. It is assumed that the reader is familiar with the operation of and basic editing commands for a text editor (i.e., a program that edits ASCII files) and is familiar with the previous sections of this tutorial.

2.5.1 Modifying modeling options

Depending on the type of analysis being performed, the user may need to modify the modeling options and run the model again. Because of the descriptive nature of the keywords and the secondary keywords used to control the modeling options, this can easily be done with the new control file, and usually without having to refer to the user's guide each time a modification is attempted.

2.5.2 Adding or modifying a source or source group

Modifying the input file to add a source or a source group, or to add a source to a source group, is as simple as just adding it. There is no need to specify the total number of sources in the run, which would then have to be changed if more sources were added. The same applies to the number of groups, or the number of sources per group. If the user attempts to input more than the total number of sources or groups allowed for a particular run, an error message will be generated to that effect. Also, modifying a source group to delete a source is as easy as just deleting it from the input card, without having to change any other inputs.

Another way of "deleting" a source or a group from an input file is to place a "**" in the pathway field of the card or cards which define the source or group to "comment out" those inputs. This approach, which was discussed above in Section 2.2.2, has the advantage of leaving the input data for the source or group in the input file for possible later use. It doesn't matter whether the "**" is entered with the text editor in "insert" mode, in which case the other inputs of that line are moved over, or if it is in "overtype" mode, which would replace the pathway ID that was already there.

2.5.3 Adding or modifying a receptor network

As with source data, adding to or modifying the receptor information in the AERMOD model is relatively straight forward. The problem of having to make several changes to accomplish one small modification, such as adding a distance to a polar receptor network, has been avoided in the new model. All that the user needs to do is to add the new distance on the appropriate input card, which is easily identifiable because of the use of descriptive keywords. The model checks to ensure that the user does not attempt to specify more than the maximum number of receptors for a particular run and generates an appropriate message if too many are input.

2.5.4 Modifying output options

Modifying the output options involves many of the same principles that are described above. In addition, all the output options are structured in a way that allows the user to select options for specific averaging periods, so that the user may find it useful to copy a record or group of records set up for one averaging period and simply change the averaging period parameter. The other important short cut that is available for the printed table output options is to use the secondary keyword ALLAVE to indicate that the option applies to all averaging periods that are calculated. In this way, there will be no need to change the output options if a new averaging period is added to a run or if one is deleted.

3.0 Detailed keyword reference

This section of the AERMOD user's guide provides a detailed reference for all the input keyword options for the AERMOD model. The information provided in this section is more detailed than the information provided in the Brief Tutorial in Section 2.0. Since this section is intended to meet the needs of experienced modelers who may need to understand completely how particular options are implemented in the model, the information for each keyword should stand on its own. This section assumes that the reader has a basic understanding of the keyword/parameter approach used by the model for specification of input options and data. Novice users should first review the contents of Section 2.0 to obtain that understanding.

3.1 Overview

The information in this section is organized by function, i.e., the keywords are grouped by pathway and are in a logical order based on their function within the model. The order of keywords presented here is the same as the order used in the functional keyword reference in APPENDIX A. The syntax for each keyword is provided, and the keyword type is specified - either mandatory or optional and either repeatable or non-repeatable. Unless noted otherwise, there are no special requirements for the order of keywords within each pathway, although the order in which the keywords are presented here and in APPENDIX A is recommended. Any keyword which has special requirements for its order within the pathway is so noted following the syntax and type description.

The syntax descriptions in the following sections use certain conventions. Parameters that are in all capital letters and underlined in the syntax description are secondary keywords that are to be entered as indicated for that keyword. Other parameters are given descriptive names to convey the meaning of the parameter and are listed with an initial capital letter. Many of the parameter names used correspond to variable names used in the computer code of the model. Parentheses around a parameter indicate that the parameter is optional for that keyword. The default that is taken when an optional parameter is left blank is explained in the discussion for that keyword.

3.2 Control pathway inputs and options

The **CO**ntrol pathway contains the keywords that provide the overall control of the model run. These include the dispersion options, averaging time options, terrain height options, and others that are described below. The CO pathway must be the first pathway in the control input file.

3.2.1 Title information

There are two keywords that allow the user to specify up to two lines of title information that will appear on each page of the main output file from the model. The first keyword, TITLEONE, is mandatory, while the second keyword, TITLETWO, is optional. The syntax and type for the keywords are summarized below:

Syntax:	CO TITLEONE Title1 CO TITLETWO Title2
Type	TITLEONE - Mandatory, Non-repeatable TITLETWO - Optional, Non-repeatable

The parameters Title1 and Title2 are character parameters of length 200, which are read as a single field starting at column 13. The title information is taken as it appears in the control file without any conversion of lower case to upper case letters. If the TITLETWO keyword is not included in the control file, then the second line of the title in the output file will appear blank. Note that in the output files, only the first 68 characters of TITLEONE and TITLETWO are printed.

3.2.2 Dispersion options

The dispersion options are controlled by the MODELOPT keyword on the CO pathway and are specified using secondary keywords that represent each of the different options. The secondary keywords and syntax are shown and described below. Some related options are mutually exclusive, others can be specified in combination with each other, and some are dependent on others and must be specified together.

Syntax:	
CO MODELOPT DFAULT ALPHA BETA CONC AREADPLT FLAT NOSTD NOCHKD NOWARN SCREEN SCIM NOMINO3 RLINEFDH ELEV WARNCHKD NOURBTRAN VECTORWS PSDCREDIT FASTALL FASTAREA GRSM TTRM TTRM2 PVMRM OLM ARM2 DEPOS DDEP WDEP DRYDPLT WETDPLT NODRYDPLT NOWETDPLT AREAMNDR HBP BAREDGE	
Type:	Mandatory, Non-repeatable
Order:	Must precede POLLUTID, HALFLIFE and DCAYCOEF

where the secondary keyword parameters are described below (the order and spacing of these parameters is not critical):

DFAULT - Specifies that the regulatory default options will be used; note that specification of the DFAULT option will override some non-DFAULT options that may be specified in the input file, while other non-DFAULT options will cause fatal errors when DFAULT is specified (see below for details).

ALPHA - Non-regulatory option flag that allows the input control file to include research/experimental options for review and evaluation by the user community; (e.g., LOW_WIND, PSDCREDIT, ORD_DWNW, AWMADWNW, PLATFORM, METHOD 2 particle deposition, gas deposition, RLINEFDH, and RLINEXT with options for modeling barriers and depressed roadways) and cannot be used with DFAULT keyword.

BETA - Non-regulatory option flag that allows the input control file to include options that have been vetted through the scientific community and are waiting to be promulgated as regulatory options. Prior to promulgation, BETA options require alternative model approval for use in regulatory applications and cannot be used with DFAULT keyword.

CONC - Specifies that concentration values will be calculated.

DEPOS - Specifies that total deposition flux values (both dry and wet) will be calculated.

DDEP - Specifies that dry deposition flux values will be calculated.

WDEP - Specifies that wet deposition flux values will be calculated.

AREADPLT - Specifies that a non-regulatory method for optimized plume depletion due to dry removal mechanisms will be included in calculations for area sources (cannot be used simultaneously with the DFAULT keyword).

FLAT - Specifies that the non-regulatory option of assuming flat terrain will be used; Note that FLAT and ELEV may be specified in the same model run to allow specifying the non-regulatory FLAT terrain option on a source-by-source basis; FLAT sources are identified by specifying the keyword

FLAT in the MODELOPT line on the CO pathway and in place of the source elevation field on the SO LOCATION keyword (cannot be used simultaneously with the DFAULT keyword).

ELEV - Specifies that the default option of assuming elevated terrain will be used; Note that FLAT and ELEV may be specified in the same model run to allow specifying the non-regulatory FLAT terrain option on a source-by-source basis (the ELEV option is set as a regulatory option with the DFAULT keyword)

NOSTD - Specifies that the non-regulatory option of no stack-tip downwash will be used (cannot be used with the DFAULT keyword).

NOCHKD - Specifies that the non-regulatory option of suspending date checking will be used for non-sequential meteorological data files (cannot be used with the DFAULT keyword).

WARNCHKD - Specifies that the option of issuing warning messages rather than fatal errors will be used for non-sequential meteorological data files.

NOWARN - Specifies that the option of suppressing the detailed listing of warning messages in the main output file will be used (the number of warning messages is still reported, and warning messages are still included in the error file controlled by the CO ERRORFIL keyword).

SCREEN - Non-regulatory option for running AERMOD in a screening mode for AERSCREEN (cannot be used when the DFAULT keyword is specified).

SCIM - Sampled Chronological Input Model – non-regulatory option used only with the ANNUAL average option to reduce runtime by sampling meteorology at a user-specified regular interval; SCIM sampling parameters must be specified on the ME pathway (cannot be used with the DFAULT keyword).

PVMRM - Specifies that the Plume Volume Molar Ratio Method (PVMRM) for NO_2 conversion will be used (regulatory option, can be used simultaneously with DFAULT); cannot be used with OLM, ARM2, or GRSM; cannot be used with TTRM without TTRM2.

OLM - Specifies that the Ozone Limiting Method (OLM) for NO_2 conversion will be used (regulatory option, can be used simultaneously with DFAULT keyword); cannot be used with PVMRM, ARM2, or GRSM; cannot be used with TTRM without TTRM2.

ARM2 - Specifies that the Ambient Ratio Method - 2 (ARM2) for NO_2 conversion will be used (regulatory option, can be used with DFAULT keyword); cannot be used with PVMRM, OLM, or GRSM; cannot be used with TTRM without TTRM2.

TTRM - Specifies that the non-regulatory Travel Time Reaction Method (TTRM) will be used for NO_2 conversion (non-regulatory ALPHA option, requires

the ALPHA keyword and cannot be used with the DFAULT keyword); cannot be used with PVMRM, OLM, ARM2 without TTRM2; cannot be used with GRSM; cannot be used with TTRM2 without PVMRM, OLM, or ARM2.

TTRM2 - Specifies that the non-regulatory Travel Time Reaction Method (TTRM) will be paired with one of OLM, PVMRM, or ARM2 for NO_2 conversion (non-regulatory ALPHA option, requires the ALPHA keyword and cannot be used with the DFAULT keyword); cannot be used with TTRM alone or GRSM; must be paired with one of PVMRM, OLM, or ARM2 and does not require TTRM keyword when pairing.

GRSM - Specifies that the Generic Reaction Set Method (GRSM) will be used for NO_2 conversion; cannot be used with PVMRM, OLM, TTRM, TTRM2, or ARM2.

PSDCREDIT - Specifies that the non-regulatory ALPHA option will be used to calculate the increment consumption with PSD credits using the PVMRM option (cannot be used with the DFAULT keyword).

FASTALL - Non-regulatory option to optimize model runtime through use of an alternative implementation of horizontal meander for POINT and VOLUME sources; also optimizes model runtime for AREA/AREAPOLY/AREACIRC/LINE, OPENPIT, RLINE, and RLINEXT sources (formerly associated with TOXICS option, now controlled by the FASTAREA and FASTALL option, cannot be used with the DFAULT keyword).

FASTAREA - Non-regulatory option to optimize model runtime through hybrid approach for AREA/ AREAPOLY/AREACIRC and OPENPIT sources (formerly associated with TOXICS option, cannot be used with the DFAULT keyword).

DRYDPLT - Option to incorporate dry depletion (removal) processes associated with dry deposition algorithms; this requires specification of dry deposition source parameters and additional meteorological variables; dry depletion will be used by default if dry deposition algorithms are invoked; cannot be used with NODRYDPLT.

NODRYDPLT - Option to disable dry depletion (removal) processes associated with dry deposition algorithms; cannot be used with DRYDPLT.

WETDPLT - Option to incorporate wet depletion (removal) processes associated with wet deposition algorithms; this requires specification of wet deposition source parameters and additional meteorological variables; wet depletion will be used by default if wet deposition algorithms are invoked; cannot be used with NOWETDPLT.

NOWETDPLT - Option to disable wet depletion (removal) processes associated with wet deposition algorithms; cannot be used with WETDPLT.

NOURBTRAN - Non-regulatory option to ignore the transition from nighttime urban boundary layer to daytime convective boundary layer (i.e., to revert to the urban option as implemented prior to version 11059) (cannot be used with the DFAULT keyword).

VECTORWS - Option to specify that input wind speeds are vector mean (or resultant) wind speeds, rather than scalar means. Under the VECTORWS option, the adjustments to wind speeds based on Equation 112 of the AERMOD Model Formulation document (EPA, 2026a) will be applied (can be used with the DFAULT keyword).

NOMINO3 - Option to remove the minimum ozone used for Tier 3 NO_2 options. Without this option, for nighttime stable conditions AERMOD will use an ozone value based on the minimum of 40 ppb and the maximum from the preceding 24-hours, regardless of the value in an hourly input file (can be used with the DFAULT keyword). See MFD Section 5.8.2 for more details.

RLINEFDH - Option to have wind profile calculations without a displacement height for RLINE and RLINEXT source types. This makes the wind profile closer to other AERMOD source types, which do not use a displacement height in wind profile (requires the ALPHA keyword and cannot be used with the DFAULT keyword).

AREAMNDR - Option to apply plume meander to AREA. AREAPOLY, AREACIRC, and LINE source types. Note that AREAMNDR and FASTAREA or FASTALL can be specified in the same model run, but in that case, meander will not be applied to those source types listed,

HBP - Option for highly buoyant plumes (HBP) when plume penetrates the top of the mixed layer. Limited to point source types (POINT, POINTHOR, POINTCAP). Compares convective mixing height for the current hour and next hour to determine how much of the penetrated plume has been captured by the CBL by the end of the current hour (requires the ALPHA keyword and cannot be used with the DFAULT keyword).

BAREDGE - Option to turn on solid barrier edge effects with RLINEXT source and SBARRIER inputs.

3.2.2.1 DFAULT option

As previously discussed, the regulatory DFAULT option in AERMOD informs the model that certain regulatory options will be invoked including stack-tip downwash, effects of elevated terrain, and calms and missing data processing. The DFAULT option in AERMOD also forces the use of a 4-hour half-life when modeling SO_2 in an urban source and does not allow for exponential

decay for other applications. If exponential decay is requested via the DCAYCOEFF or HALFLIFE keyword, AERMOD will issue a warning that the DFAULT overrides the requested exponential and will run the model without exponential decay. If exponential decay is desired, then the DFAULT keyword cannot be included. The DFAULT option also imposes a restriction on the optional urban roughness length parameter to be 1 meter for regulatory applications. If the urban roughness length parameter is not 1 m with the DFAULT keyword, AERMOD issues a warning and resets it to 1 m.

The missing data processing routines that are included in the AERMOD model allow the model to handle missing meteorological data in the processing of short-term averages. The model treats missing meteorological data in the same way as the calms processing routine, i.e., it sets the concentration values to zero for that hour and calculates the short-term averages according to EPA's calms policy, as set forth in the Guideline. Calms and missing values are tracked separately for the purpose of flagging the short-term averages. An average that includes a calm hour is flagged with a 'c', an average that includes a missing hour is flagged with an 'm', and an average that includes both calm and missing hours is flagged with a 'b'. If the number of hours of missing meteorological data exceeds 10 percent of the total number of hours for a given model run, a cautionary message is written to the main output file, and the user is referred to Section 5.3.2 of "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (EPA, 2004). An hour is considered missing if one or more of the following surface variables have missing value indicators for the hour: wind speed, wind direction, ambient temperature, Monin-Obukhov length, mechanical mixing height, surface friction velocity (u*), convective mixing height (convective hours only), or convective velocity scale (w*; for convective hours only).

The DFAULT keyword cannot be used simultaneously with either the ALPHA or BETA secondary keywords or other secondary keywords that enable a specific ALPHA or BETA option.

3.2.2.2 ALPHA options

Beginning with version 18081, a new secondary keyword, ALPHA, was added to the MODELOPT keyword. When included, ALPHA indicates one or more options are being used that are in a special category of options. These can include but are not limited to:

- Scientific/formulation updates that are in the research phase and have not been fully evaluated and peer reviewed by the scientific community; and
- Non-scientific model options in development that still need rigorous testing and for which EPA is seeking feedback from the user community.

Different ALPHA options are enabled in the control file in different ways. Some ALPHA options, as indicated above, are enabled by specifying the appropriate secondary keyword with the MODELOPT keyword, while others are specified as either a primary keyword on the CO pathway (e.g., LOW_WIND, AWMADWNW) or as source type with the LOCATION keyword (e.g., RLINEXT, SWPOINT) on the SO pathway or as a primary keyword on the SO pathway to enter source-specific inputs (e.g., PLATFORM, RBARRIER). AERMOD version 26135 includes the following ALPHA options:

- Prevention of Significant Deterioration Credit (PSDCREDIT)
- Low Wind Parameters (LOW_WIND)
- A&WMA Downwash Options (AWMADWNW)
- EPA Office of Research and Development Downwash Options (ORD_DWNW)
- Offshore Platform Downwash (PLATFORM, applies to point sources only)
- Extended RLINE Source Type (RLINEXT)
- Depressed Roadway (RDEPRESS, used only with RLINEXT)
- Solid Roadway Barrier (RBARRIER, used only with RLINEXT)
- Solid Continuous Roadway Barrier (SBARRIER, used only with RLINEXT)
- Barrier Edge Effects (BAREDGE, used only with RLINEXT)
- Enable treatment of solid barrier edge effects (BAREDGE, used only with RLINEXT)
- Removal of Displacement Height from RLINE Wind Profile (RLINEFDH)
- Particle Deposition - Method 2 (METHOD_2)
- Gas deposition (GDSEASON, GDLANUSE, GASDEPDF, GASDEPOS, GASDEPVD keywords)
- Travel Time Reaction Method (TTRM, for NO_2 conversion, stand-alone method)
- Travel Time Reaction Method 2 (TTRM2, for NO_2 conversion, applies TTRM to ARM2, OLM, or PVMRM conversion methods)

- Sidewash Point Source (SWPOINT, experimental source type)
- AREA Source Meander (AREAMNDR)
- Highly Buoyant Plume (HBP)
- Aircraft Plume Rise (ARCFTOPT, can be applied to AREA and VOLUME source types only via SO ARCFTSRC grouping and an hourly emission file)

As noted above, METHOD 2 particle deposition and gas deposition are ALPHA options beginning with version 19191 of AERMOD. In previous versions of AERMOD, these two deposition options were non-default and could be used without the ALPHA or BETA keywords. The reason that these two options are now ALPHA options is that they have not been rigorously tested and evaluated since their inclusion in AERMOD's initial promulgation. Thus, it was decided to make the options ALPHA while deposition is further evaluated in AERMOD. Note that METHOD 1 particle deposition is unaffected and can still be used with AERMOD in default mode (i.e., with the DFAULT keyword).

3.2.2.3 BETA options

BETA options refer to scientific updates to the formulation of AERMOD that have been fully vetted through the scientific community with appropriate evaluation and peer review. BETA options are planned for future promulgation as regulatory options. However, until they are promulgated, they require alternative model approval by the EPA Regional Office and concurrence by the Model Clearing House. AERMOD version 26135 does not include any BETA options.

3.2.2.4 Options for capped and horizontal stack releases

Options are included in AERMOD, beginning with version 06341, for modeling releases from capped and horizontal stacks. For sources that are not subject to building downwash influences, the plume rise for these capped and horizontal stacks is simulated based on an EPA Model Clearinghouse Memorandum, dated July 9, 1993. The Model Clearinghouse procedure for these sources entails setting the exit velocity very low (0.001 m/s) to account for suppression of vertical momentum of the plume and using an effective stack diameter that maintains the actual flow rate of the plume. Maintaining the flow rate will also serve to maintain the buoyancy of the

plume to provide a more realistic estimate of plume rise. The Model Clearinghouse procedure also addresses the issue of stack-tip downwash for these cases.

The Model Clearinghouse procedure is not considered to be appropriate for sources subject to building downwash influences with the PRIME downwash algorithm for the following reason. The PRIME algorithm uses the specified stack diameter to define the initial radius of the plume for the numerical plume rise calculation, and the initial radius of the plume can significantly influence plume rise based on the PRIME algorithm. As a result, use of an effective diameter adjusted to maintain the flow rate is not appropriate and could produce unrealistic results. For PRIME downwash sources modeled using the options for capped and horizontal releases, the basic premise of the Model Clearinghouse procedure, i.e., that the vertical momentum is suppressed while the buoyancy of the plume is conserved has been adapted for the PRIME numerical plume rise formulation. For capped stacks the initial radius of the plume is assumed to be 2 times the actual stack diameter to account for the interaction of the exiting plume with the cap. The initial vertical velocity of the plume is set at 0.001 m/s, and the initial lateral velocity of the plume is set at 25% of the initial exit velocity of the plume. For horizontal stacks, the initial vertical velocity of the plume is set at 0.001 m/s, the total exit velocity of the plume is assigned to the initial lateral velocity, and the plume is assumed to be emitted in the downwind direction. Although this adaptation of the Model Clearinghouse procedure to PRIME downwash sources has not been validated by field tracer or wind tunnel data, analyses have shown that simply setting the exit velocity to 0.001 m/s without any further adjustment when downwash is applied, as suggested in Section 6.1 of the AERMOD Implementation Guide (EPA, 2026b), may lead to overly conservative results (EPA, 2007).

The user selects the options for capped and/or horizontal releases by specifying one of the new source types on the SO LOCATION card: POINTCAP for capped stacks, and POINTHOR for horizontal releases. For each of these options, the user specifies the actual stack parameters [release height (m), exit temperature (K), exit velocity (m/s), and stack diameter (m)] using the SO SRCPARAM card as if the release were a non-capped vertical point source. The syntax of the SO LOCATION and SRCPARAM keywords is described in Sections 3.3.1 and 3.3.2 and is also summarized in APPENDIX A. The AERMOD model performs the necessary adjustments internally to account for plume rise and stack-tip downwash. For horizontal releases, the model currently assumes that the release is oriented with the wind direction, and the model does not account for

directional effects that may occur with horizontal releases. The model also does not account for stacks oriented at a non-horizontal angle relative to vertical. For PRIME downwash sources, the user-specified exit velocity for horizontal releases is treated initially as horizontal momentum in the downwind direction.

3.2.2.5 Output types (CONC, DEPOS, DDEP and/or WDEP)

The user may select any or all of the output types (CONC, DEPOS, DDEP and/or WDEP) to be generated in a single model run. The order of these secondary keywords on the MODELOPT card has no effect on the order of results in the output files – the outputs will always be listed in the order of CONC, DEPOS, DDEP, and WDEP. Appropriate deposition parameters must be specified in order to output deposition fluxes using the DEPOS, DDEP, and/or WDEP keywords (see Sections 3.3.3 and 3.3.4 for more details). Deposition has not been implemented for RLINE/RLINEXT, BUOYLINE, or SWPOINT source types, thus the user can only run CONC with these source types.

3.2.2.6 Deposition depletion options

Beginning with version 04300, the dry and wet removal (depletion) mechanisms (the DRYDPLT and WETDPLT options in earlier versions of AERMOD) will automatically be included in the calculated concentrations or deposition flux values if the dry and/or wet deposition processes are considered, unless the user specifies the NODRYDPLT and/or NOWETDPLT options. Note that dry and wet removal effects on calculated concentration values can be included even if deposition flux values are not being calculated. However, the additional data requirements for dry and wet deposition described in Sections 3.3.3 and 3.3.4 must be met in order for dry and wet removal to be included in the concentration calculations. The use of the NODRYDPLT and/or NOWETDPLT options will result in a more conservative estimate of concentrations and/or deposition fluxes for applications involving deposition processes, but the degree of additional conservatism will vary depending on the source characteristics, meteorological conditions, receptor locations and terrain influences. However, the inclusion of particle deposition effects may increase ground-level concentrations for some sources compared to the same source modeled as a gaseous emission due to gravitational settling on the particulate plume. The magnitude of this effect will depend on the source characteristics (elevated or low-level) and particle size distribution. As of

version 19191, deposition has not been implemented for RLINE/RLINEXT, BUOYLINE, or SWPOINT sources, thus the user can only run CONC with these source types.

3.2.2.7 NO_2 conversion options

Beginning with version 16216r, the PVMRM and OLM Tier 3 NO_2 conversion methods, as well as the Tier 2 ARM2 method are regulatory options that can be specified with the DFAULT keyword. PVMRM, OLM, and ARM2 assume the reaction involving NO and available O_3 to form NO_2 occurs instantaneously. Although this chemical reaction is relatively rapid, it is not actually instantaneous and depends on the transport time to the downwind receptor of interest. Beginning with version 21112, TTRM was added as an ALPHA option for NO_2 conversion that considers the distance and the travel time from the emission source to each receptor. In general, much of the conversion of NO to NO_2 occurs within the first minute of travel which limits the effectiveness of this method to the near field receptors.

In version 21112, TTRM, the Travel Time Reaction Method, was implemented as a stand-alone ALPHA option which can determine the initial fraction of NO to NO_2 conversion in the travel time of each source emissions to each receptor. The conversion is capped at an upper limit, which is typically reached after a few tens of seconds of plume travel. Beyond the distance the fraction reaches the upper limit of the equilibrium fraction (generally 0.9), TTRM is no longer effective, and another method is needed for receptors beyond that distance. Beginning with version 22112, TTRM was integrated to be used simultaneously with PVMRM, OLM, or ARM2. This integration was added as the ALPHA option, TTRM2, separate from TTRM which was retained as a stand-alone option. When TTRM2 is specified along with PVMRM, OLM, or ARM2, TTRM will be implemented for near field receptors where the fraction of conversion has not reached the upper limit, and the other specified method will be used for all other receptors.

In addition to TTRM and TTRM2, beginning with version 21112, GRSM, the Generic Reaction Set Method, was added as an ALPHA option, updated as a BETA option beginning with version 22112, and promulgated as a regulatory option in version 24142. GRSM was adapted from the Atmospheric Dispersion Model Method (ADMSM), documented by Carruthers et al., 2017, which accounts for the equilibrium between NO, NO_2, and ozone in the atmosphere. GRSM treats

plume entrainment of ozone similar to PVMRM but provides for treatment of reaction rates based on ozone and solar radiation intensity, NO2 photolysis, and travel time from source to receptor. The reaction rate is based on the generic reaction set (GRS) chemistry scheme, which is a semi-empirical photochemical model developed originally by CSIRO in Australia (Azzi and Johnson, 1992; Venkatram et al., 1994) for multiple step conversions between NO, NO_2, and O_3. The integration of GRSM into AERMOD is documented in EPA's related Technical Support Document (TSD) (2024c).

Only one of ARM2, TTRM, OLM, PVMRM, or GRSM options for NO_2 conversion can be specified for a given model run. Alternatively, the TTRM2 ALPHA option (which invokes TTRM), can be paired with ARM2, OLM, or PVMRM by specifying the TTRM2 keyword along with the ARM2, PVMRM, or OLM with the MODELOPT keyword. Because GRSM accounts for travel time between the emission source and receptor, it cannot be paired with TTRM2. All NO_2 conversion options require that the pollutant ID be specified as 'NO2' on the CO POLLUTID card (see Section 3.2.9.) These options have additional input requirements as described in Section 3.3.6.

3.2.2.8 FASTAREA and FASTALL

The FASTAREA secondary keyword on the MODELOPT keyword is used to select the non-regulatory option to optimize model runtime for AREA sources (including AREA, AREAPOLY, AREACIRC and OPENPIT source types, as well as LINE sources introduced with version 12345 (see Section 3.3.1)). When FASTAREA is specified, the area source integration routine is optimized to reduce model runtime by incorporation of a three-tiered approach using the Romberg numerical integration, a 2-point Gaussian Quadrature routine for numerical integration, or a point source approximation, depending on the location of the receptor relative to the source. In the regulatory default mode, the Romberg numerical integration is utilized for all receptors. The FASTAREA approach does not include meander in the AREA, AREAPOLY, AREACIRC, or LINE source types even if the AREAMNDR keyword has been included. Also beginning with version 09292, a non-regulatory option to optimize model runtime for POINT and VOLUME sources was included, which is selected with the FASTALL secondary keyword on the MODELOPT keyword. Specification of the FASTALL option also activates the FASTAREA option if AREA sources are included in the model inputs. Both FASTALL and FASTAREA skip receptors that are more than 80

kilometers from the source. Beginning with version 22112, the RLINE and RLINEXT sources also include a FAST option activated with the FASTALL keyword.

The FASTALL option for POINT/POINTHOR/POINTCAP and VOLUME sources uses an alternative implementation of the horizontal meander algorithm based on an effective horizontal dispersion coefficient (σ_{yeff}) that replicates the centerline concentration based on the full meander approach. Use of the effective σ_y allows the model runtime to be optimized by skipping receptors that are more than $4\sigma_{yeff}$ off the plume centerline. Based on tests conducted to date, comparisons of concentrations based on the FASTALL option for POINT and VOLUME sources with concentrations using the DFAULT option are similar to comparisons of concentrations for AREA sources using the FASTAREA option. The average ratio of FASTALL concentrations to DFAULT values is about 1.02 for high ranked values, showing a slight bias toward over prediction for the FASTALL option. However, the range of ratios for high ranked values shows both over predictions and under predictions relative to the DFAULT option, and differences at specific receptors may be much larger.

The FASTALL option for RLINE and RLINEXT uses an approximation to estimate the values for the horizontal and vertical dispersion coefficients (σ_y and σ_z, respectively) and the effective plume wind speed. These estimates are made by interpolating between values of these variables computed at three distances from the source (1 m, 10 m, and 500 m). **Note that, as of version 19191, the FASTALL option has not been implemented for the BUOYLINE and SWPOINT source types and is not applicable with the PLATFORM keyword.**

3.2.2.9 Urban transition and NOURBTRAN option

The urban option within AERMOD was modified, beginning with version 11059, to address potential issues associated with the transition from the nighttime urban boundary layer to the daytime convective boundary layer. Prior to version 11059, the enhanced dispersion due to the urban heat island during nighttime stable conditions was ignored once the rural boundary layer became convective. This could result in an unrealistic drop in the mixing height for urban sources during the morning transition to a convective boundary layer, which could contribute to overly conservative concentrations for low-level sources under such conditions. This potentially

anomalous behavior was observed in a few cases during the application of AERMOD for the Risk and Exposure Assessment (REA) conducted in support of a review for the NO_2 National Ambient Air Quality Standard (NAAQS) (EPA, 2008). The potential significance of this issue for AERMOD applications in support of air quality permitting increased with the promulgation of the more recent 1-hour NO_2 and 1-hour SO_2 NAAQS in 2010.

To address this issue, AERMOD was modified to continue applying the urban boundary layer option for urban sources until the daytime (rural) convective boundary exceeds the population-dependent urban boundary layer height. This modification to the urban option within AERMOD has been evaluated using the 1985 Indianapolis SF_6 field study data (Murray and Bowne, 1988) and shows improved model performance during daytime convective conditions compared to the original implementation of the urban option. Model-to-monitor comparisons of 1-hour NO_2 concentrations from the Atlanta NO_2 REA also exhibit improved model performance with this modification to the urban option in AERMOD. A summary of these model evaluation results is provided in the AERMOD Model Formulation document (EPA, 2026a).

The NOURBTRAN non-regulatory option has been included to allow users to revert to the urban option as implemented prior to version 11059, which ignores the transition from the nighttime urban boundary layer to the daytime convective boundary layer.

3.2.2.10 SCREEN mode

The screening mode of AERMOD, which is controlled by the SCREEN keyword on the MODELOPT card, forces the model calculations to represent values for the plume centerline, regardless of the source-receptor-wind direction orientation. This option is included in AERMOD to facilitate the use of the model with the AERSCREEN (EPA, 2021) to estimate worst case impacts. Its use outside of that context is not recommended. Since the screening model is designed to be used with a non-sequential meteorological data file, representing a matrix of conditions, the SCREEN option also forces the use of the NOCHKD option described above, even if NOCHKD is not included on the MODELOPT card. The SCREEN option also restricts the averaging period options to 1-hour averages only on the AVERTIME card (see Section 3.2.2.10). Note that the SCREEN mode is only applicable for point type sources (POINT, POINTCAP, and POINTHOR)

and VOLUME sources. For all other source types, screening is not invoked, and results are unchanged from non-screening mode.

3.2.2.11 SCIM

The AERMOD model includes the non-regulatory Sampled Chronological Input Model (SCIM) option to reduce model runtime for some uses of the model. The SCIM option can only be used with the ANNUAL average option and is primarily applicable to multi-year model simulations. The approach used by the SCIM option is to sample the meteorological data at a user-specified regular interval to approximate the long-term (i.e., ANNUAL) average impacts. Studies have shown that the uncertainty in modeled results introduced by use of the SCIM option is generally lower for area sources than for point sources.

When only the regular sampling is selected, hourly concentrations are calculated in the normal fashion for each sampled hour. The annual average concentration is then simply calculated by dividing the cumulative concentration for the sampled hours by the number of hours sampled (arithmetic average), i.e.,

$$\mathbf{C = \sum C_S / N_S}$$

where:

C = Calculated concentration
$\sum C_S$ = Cumulative impacts for the sampled hours
N_S = Number of sampled hours

To use the SCIM option, the user must include the SCIM keyword on the CO MODELOPT card and the SCIM sampling parameters on the ME SCIMBYHR card. The format and syntax of the ME SCIMBYHR keyword are described in Section 3.5.7.

3.2.2.12 Deposition Options

The AERMOD model includes algorithms for both dry and wet deposition of both particulate and gaseous emissions. The deposition algorithms incorporated into AERMOD are

based on the draft Argonne National Laboratory (ANL) report (Wesely et al., 2002), with modifications based on peer review. Treatment of wet deposition was revised from Wesely et al. (2002) based on recommendations by peer review panel members (Walcek et al., 2001). A full technical description of the deposition algorithms implemented in AERMOD is provided in an EPA report specific to these algorithms (EPA, 2003).

Based on the guidance provided for application of the AERMOD model in the Guideline (EPA, 2024b), and the history of the deposition algorithms in the AERMOD and ISC models, the particle deposition algorithms with a user-specified particle size distribution (referred to below as "Method 1") can be applied simultaneously with the regulatory DFAULT keyword. Method 1 is comparable to the particle deposition algorithm in the ISCST3 model (EPA, 1995a). The gas deposition algorithms and the "Method 2" option for particle deposition based on the ANL draft report (Wesely, et al, 2002) are non-regulatory ALPHA options in AERMOD, and beginning with version 19191, the model will issue a fatal error message and abort processing if the ALPHA keyword is not specified with the gas deposition or Method 2 particle deposition options.

For gaseous dry deposition, the user must define seasonal categories for each of the calendar months, direction-specific land use categories, and several pollutant-specific parameters. An optional keyword is also provided to override default values for three parameters used in the gas deposition algorithm. The input requirements for "Method 1" particle deposition in AERMOD are the same as for the particle deposition algorithm in the ISCST3 model. For "Method 2" particle deposition, the user must define the fraction of the particle mass in the fine particle category (less than 2.5 microns) and a representative mass mean diameter for the particles. Table 3-1 summarizes the required keywords for the various deposition options within AERMOD and whether they are allowed under the DFAULT option. For all keywords associated with METHOD 2 or gas deposition, the ALPHA keyword must be used along with the MODELOPT keyword. The keywords used to define inputs for deposition specified on the CO pathway are described in the sections that follow. The keywords associated with deposition specified on the SO pathway are described in sections 3.3.3 through 3.3.5.

Table 3-1 Summary of Deposition Options

Pollutant Type	Model Output Type	Required Keywords	Allowed under DFAULT?
Gaseous	CONC w/dry depletion DDEP	CO GASDEPVD or CO GDSEASON, CO GDLANUSE, and SO GASDEPOS	No[1]
Gaseous	CONC w/wet depletion WDEP	SO GASDEPOS	No[1]
Gaseous	CONC w/dry & wet depletion DEPOS	CO GDSEASON, CO GDLANUSE, and SO GASDEPOS	No[1]
Particulate ("Method 1")	CONC w/dry and/or wet depletion DEPOS DDEP WDEP	SO PARTDIAM, SO PARTDENS, and SO MASSFRAX	Yes[2]
Particulate ("Method 2")	CONC w/dry and/or wet depletion DEPOS DDEP WDEP	SO METHOD_2	No[1]

The user should be aware that one or more of the following meteorological parameters are needed for deposition: precipitation code, precipitation rate, relative humidity, surface pressure, and cloud cover.

3.2.2.13 Definition of seasons for gaseous dry deposition

The gas deposition algorithms in AERMOD include land use characteristics and gas deposition resistance terms based on five seasonal categories defined in Table 2 of the ANL report as:

[1] The ALPHA option must be included.

[2] While "Method 1" is allowed under the regulatory "DFAULT" option within AERMOD, the use of "Method 1" for particulate emissions in regulatory modeling applications should follow the guidance provided in Section 7.2.1.3 of the Guideline (EPA, 2017).

Seasonal Category 1: Midsummer with lush vegetation

Seasonal Category 2: Autumn with unharvested cropland

Seasonal Category 3: Late autumn after frost and harvest, or winter with no snow

Seasonal Category 4: Winter with snow on ground (with generally continuous snow cover)

Seasonal Category 5: Transitional spring with partial green coverage or short annuals

The user correlates these seasonal definitions to calendar months through the GDSEASON keyword on the CO pathway. The syntax and type of the GDSEASON keyword are:

Syntax:	CO GDSEASON Jan Feb Mar ... Dec
Type:	Optional, Non-repeatable

where a numeric value from 1 to 5 is entered for each of the twelve calendar months to associate it with the seasonal definitions given above. This keyword is optional for the model, but mandatory when applying the gas deposition algorithms, unless the GASDEPVD option for user-specified dry deposition velocity on the CO pathway is used, described below in Section 3.3.3.2. Note that some of the seasonal categories defined above may not apply for certain regions, such as Category 4, winter with continuous snow cover, for moderate climates.

3.2.2.14 Definition of land use categories for gas dry deposition

The gas deposition algorithms also require direction-specific land use categories based on the following land use codes and definitions (from Table 1 of the ANL report):

Land Use Category	Description
1	Urban land, no vegetation
2	Agricultural land
3	Rangeland
4	Forest
5	Suburban areas, grassy
6	Suburban areas, forested
7	Bodies of water
8	Barren land, mostly desert
9	Non-forested wetlands

The user defines the land use categories by direction sector through the GDLANUSE keyword on the CO pathway. The syntax and type of the GDLANUSE keyword are:

Syntax:	CO GDLANUSE Sec1 Sec2 Sec3 ... Sec36
Type:	Optional, Non-repeatable

where a numeric value from 1 to 9 is entered for each of the 36 direction sectors (every 10 degrees) to associate it with the land use definitions given above. This keyword is optional for the model, but mandatory when applying the gas deposition algorithms, unless the GASDEPVD option for user-specified deposition velocity is used. The first value, Sec1, corresponds with the land use category, downwind of the application site, for winds blowing toward 10 degrees, plus or minus 5 degrees. The downwind sectors are defined in clockwise order, with Sec36 corresponding to winds blowing toward 360 degrees (North) and should generally reflect conditions downwind relative to the source location. The user can specify "repeat values" by entering a field such as "36*3" as a parameter for the GDLANUSE keyword. The model will interpret this as "36 separate entries, each with a value of 3." Since the model must identify this as a single parameter field, there must not be any spaces between the repeat-value and the value to be repeated. Option for overriding default parameters for gas dry deposition

An optional keyword is available on the Control (CO) pathway to allow the user to override the default values of the reactivity factor (f_o), and the fraction (F) of maximum green leaf area index (LAI) for seasonal categories 2 (autumn/unharvested cropland) and 5 (transitional spring), for use with the gas dry deposition algorithms.

The syntax and type of the GASDEPDF keyword are summarized below:

Syntax:	CO GASDEPDF React F_Seas2 F_Seas5 (Refpoll)
Type:	Optional, Non-repeatable

where the parameter React is the value for pollutant reactivity factor (f_o), and F_Seas2 and F_Seas5 are the fractions (F) of maximum green LAI for seasonal categories 2 and 5, respectively. The parameter Refpoll is the optional name of the pollutant. If the optional GASDEPDF keyword is

omitted, then the default value of 0 is used for React, and default values of 0.5 and 0.25 are used for F_Seas2 and F_Seas5, respectively. A value of F=1.0 is used for seasonal categories 1, 3, and 4. A reactivity factor value of 1 should be input for ozone (O_3), titanium tetrachloride ($TiCl_4$), and divalent mercury (Hg^{2+}), and a value of 0.1 should be input for nitrogen dioxide (NO_2).

3.2.2.15 Deposition velocity and resistance outputs

In order to facilitate review and testing of the deposition algorithms in the AERMOD model, the model includes an option to output the main resistance terms and deposition velocities for gaseous and particle sources. These optional outputs are generated if the user specifies the 'CO DEBUGOPT MODEL' option described in Section 3.2.18. The gas deposition data are written to a file called GDEP.DAT, which includes the values of R_a, R_b, R_c, and V_{dg} (see Wesely, et al, 2002, for definitions) for each source and for each hour modeled. A header record is included to identify the columns. The particle deposition data are written to a file called PDEP.DAT, which includes the values of R_a, R_p, V_g, and V_d for each source and for each hour modeled. The particle outputs are labeled as being based on either Method 1 or Method 2. For Method 1, results are output for each particle size category. The filename and file units for these data files are hardcoded in the model, and the files are overwritten each time the model is executed. Since these files include data for each source for each hour, file sizes may become large.

3.2.2.16 Remove displacement height from RLINE wind profile

Beginning with version 22112, the ALPHA option RLINEFDH was added to calculate the wind profile for RLINE sources without a displacement height. The displacement height is used in the wind profile to modify the wind profile below five times the surface roughness. When the surface roughness is large, such as in urban environments this displacement height could significantly impact the calculated windspeeds when the mean plume height is below five times the surface roughness length. RLINEFDH removes the displacement height and the wind speed profile is similar to the wind speed profile used in other AERMOD source types. RLINEFDH must be used along with the ALPHA keyword and cannot be used with the DFAULT keyword.

3.2.2.17 Barrier edge effects

The model option, BAREDGE, allows the user to account for edge effects near the ends of a solid barrier. This concept involves the dispersion of pollutants wrapping around the ends of the barrier causing an increase in pollutant concentrations (Venkatram et al., 2021). Thus, receptors near the edges of the barrier (in edge zones) will be modeled as if the barrier is not present. Receptors with barrier influence will experience reduced concentrations due to the increased turbulence caused by the barrier. These edge zones are defined as 6.5*Barrier_Height from the barrier ends and up to 40*Barrier_Height downwind of the barrier, as shown in the figure below.

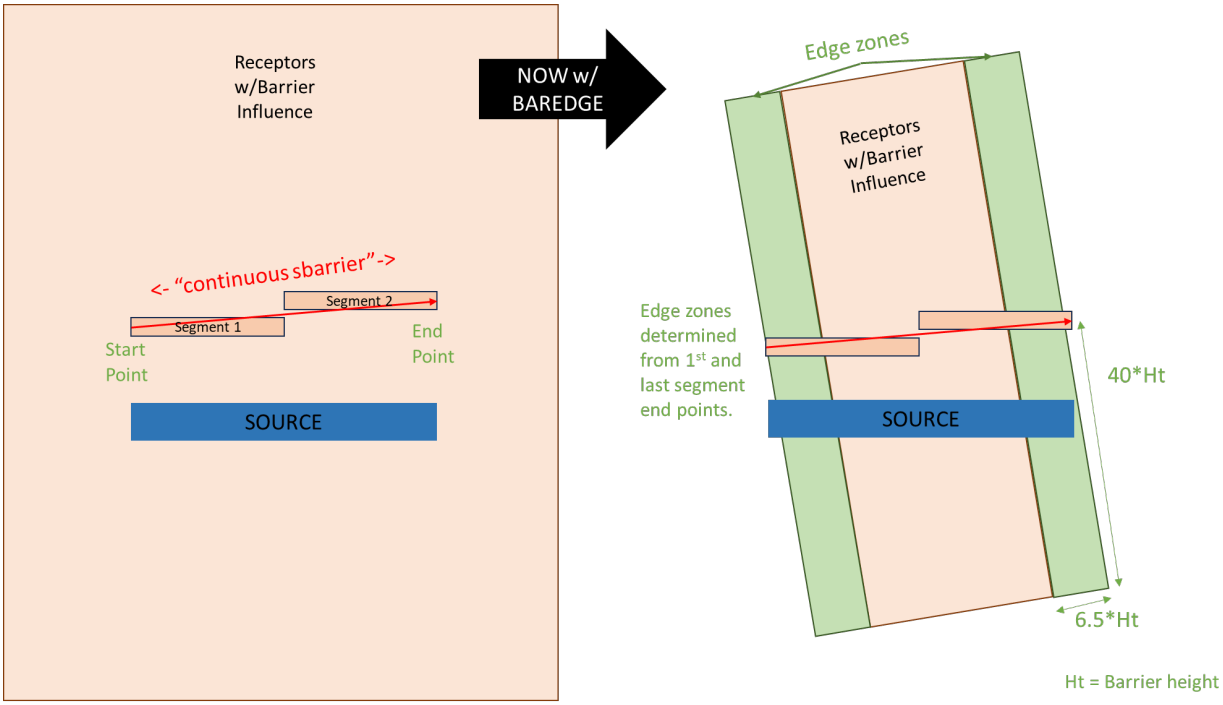


Figure 3-1 Spatial representation of barrier edge effect zones

3.2.3 Low wind parameters

An ALPHA option, LOW_WIND (see Section3.2.3), is included in AERMOD (beginning with the version dated 18081 and updated in versions 21112 and 22112) related to concerns regarding model performance under low wind speed conditions. Inclusion of the LOW_WIND keyword is intended to facilitate further testing and evaluation of AERMOD in low wind conditions to better understand the relationships of certain variables and potentially develop additional regulatory low wind options that will improve AERMOD's performance in low wind conditions.

The LOW_WIND keyword has been added to the CO pathway to allow users to override the default values for seven different parameters that can potentially affect performance under low wind speed conditions with user-defined values. Model default values can be overridden with user-defined values for the following parameters:

- Minimum sigma-v value (SVmin) within a range of 0.01 to 1.0 m/s),
- Minimum wind speed value (WSmin) within a range from 0.01 to 1.0 m/s,
- Maximum value for the meander factor (FRANmax), within a range of 0.0 to 1.0,
- Minimum sigma-w value (SWMin), within a range of 0.0 to 3.0 m/s, and
- Time period (BigT) used to calculate the time scale TRAN, within a range of 0.5 to 48.0 hours.
- Minimum value for the meander factor (FRANmin), within a range of 0.0 to 1.0 but must be less than or equal to FRANmax
- Alternate momentum balance (PBAL) approach to determine plume meander which overrides the default energy balance approach.

Absent user-specified values on the LOW_WIND keyword, a default value of 0.2828 m/s is used for WSmin, consistent with the default applied in previous versions of AERMOD based on SQRT(2*SVmin*SVmin). The default value of SVmin = 0.2 m/s, FRANMax = 1.0, SWMin = 0.02 m/s, BigT = 24.0 hours, and FRANMin = 0.0.

The syntax and type of the LOW_WIND keyword is:

Syntax:	CO LOW_WIND SVmin [WSmin] *or* CO LOW_WIND SVmin WSmin [FRANmax] *or* CO LOW_WIND SVmin WSmin FRANmax [SWmin] *or* CO LOW_WIND SVmin WSmin FRANmax SWmin [BigT] *or* CO LOW_WIND SVmin WSmin FRANmax SWmin BigT [FRANmin] *or* CO LOW_WIND SVmin WSmin FRANmax SWmin BigT FRANmin [PBAL]
Type:	Optional, Non-repeatable

where SVmin is the minimum value of sigma-v, within a range of 0.01 to 1.0 m/s. WSmin is the minimum wind speed and can range from 0.01 to 1.0 m/s. FRANmax is the maximum meander factor, within a range of 0.0 to 1.0. BigT is the time scale used to calculate TRAN and can range

from 0.5 to 48 hours, FRANmin is the minimum meander factor within a range of 0.0 to 1.0 and is required to be less than or equal to FRANmax. PBAL is a secondary keyword to replace the default energy balance approach for determining meander with a momentum balance approach. The syntax allows one of six ways to specify one or more of the LOW_WIND parameter values. For each syntax option, the parameter listed in square brackets, [], is optional, but the preceding parameters are required. For example, to override the default value for SWMin, you must also provide values for SVMin, WSMin, and FRANmax preceding the value for SWMin, in the order listed above.

Note: The LOW_WIND keyword was previously implemented as a BETA option to supplement the former LOWWIND1, LOWWIND2, and LOWWIND3 BETA options. These options have since been removed from AERMOD, and the LOW_WIND keyword was retained and changed to an ALPHA option.

In addition to the LOW_WIND ALPHA option, an option has been incorporated in the AERMET meteorological processor (first as a BETA option beginning with version 12345 and a regulatory option in version 16216) to address concerns regarding model performance under low wind conditions. The ADJ_U* option in AERMET adjusts the surface friction velocity (U*) under low wind/stable conditions based on Qian and Venkatram (2011). The ADJ_U* option may be used as a regulatory option in AERMET with NWS data or with site-specific data that does not include turbulence (i.e., sigma-w and/or sigma-theta). When the ADJ_U* option is used in the absence of turbulence data, AERMOD can accept the data with the regulatory DFAULT option enabled. Beginning with version 16216 of AERMET, an adjustment to U* under the ADJ_U* option is also available as a regulatory option for applications utilizing the Bulk Richardson Number (BULKRN) method, based on Luhar and Raynor (2009) (see also AECOM (2010)) when used with site-specific data that does not include turbulence parameters. The ADJ_U* option, when used with site-specific data that does include turbulence parameters, is currently considered a non-regulatory option and is therefore, subject to the alternative model provisions in Section 3.2 of Appendix W (40 CFR Part 51). During processing, AERMET includes a flag in the header of the surface meteorological data file (.SFC) to inform AERMOD that the data were processed using the ADJ_U* option. If AERMOD then encounters turbulence data in the profile file (PFL) generated by AERMET and the DFAULT flag is set, AERMOD will record the error and abort processing. Refer to the AERMET user's guide for additional details regarding the ADJ_U* option in AERMET.

3.2.4 Building downwash options

Beginning with version 19191, two distinct sets of ALPHA building downwash options are included in AERMOD and are enabled using the ORD_DWNW and AWMADWNW keywords. These are research grade options that have been identified as having potential to refine and improve the performance of the PRIME downwash algorithm in AERMOD in certain situations. They have been made available to users for testing and evaluation and require that the secondary keyword, ALPHA, be included with the MODELOPT keyword. The options associated with ORD_DWNW were developed by the EPA's Office of Research and Development (ORD) and the AWMADWNW options were developed by a research subcommittee of the Air and Waste Management Association (AWMA) formed for the purpose of conducting research that will lead to the improvement of the treatment of building downwash in AERMOD.

In addition to the ALPHA building downwash options implemented in AERMOD by ORD and AWMA, the research and development performed by both groups of researchers used an alternative method for determining the equivalent building dimensions for a rectangular building that is oblique to the wind from the method used by the building preprocessor, BPIPPRM. The alternative method uses the along wind building length and actual building width, for a given wind direction, as the equivalent building length and width, whereas BPIPPRM, for the same wind direction, uses the maximum projected length and maximum projected width. The alternate method reduces the footprint of the building which is reflected in the building parameters that are input into AERMOD.

The alternate method for determining equivalent building dimensions for a rectangular building used by ORD and AWMA has been implemented by ORD in a draft version of BPIPPRM (19191_DRFT) which can be downloaded from the EPA SCRAM website at: https://www.epa.gov/scram/air-quality-dispersion-modeling-related-model-support-programs#bpipprm. It is important to note that this draft version of BPIPPRM (19191_DRFT) is a research grade version that has been provided to the modeling community for testing, evaluation, and feedback and may not be used in a regulatory context. The changes implemented in this draft version affect only the building parameters generated for rectangular buildings or tiers. It is also important to note that this draft version of BPIPPRM (19191_DRFT) is completely independent of

the ALPHA downwash options implemented by ORD and AWMA. Any of the ALPHA downwash options can be tested and evaluated with and without the use of this draft version of BPIPPM.

The remainder of this section describes the usage of these keywords (ORD_DWNW and AWMADWNW), the ALPHA building downwash options associated with each, and the corresponding secondary keywords used to enable them for testing and evaluation. While, for the most part, the different downwash options are independent of one another and can be used in various combinations with one another, any conflicts and dependencies between options are noted in the sections below.

3.2.4.1 ORD building downwash options

The first is an initiative led by the EPA's Office of Research and Development (ORD). ORD has performed wind tunnel experiments and embedded large eddy simulations (LES) to better understand how to parameterize buildings that are elongated and angled relative to the wind flow and the parameterization of the plume in the cavity and far wake regions. The ORD studies are concentrated on single rectangular buildings, specifically investigating changes in plume parameters at discrete downwind distances from the building and source, longitudinal and lateral plume profiles, the lateral plume shift on the lee side of rotated buildings, and building characterization in BPIPPRM (Heist et al., 2016). To date, this research has led to recommended changes to the building preprocessor, BPIPPRM, as well as changes to the building downwash algorithm in the AERMOD program.

ORD has performed wind tunnel experiments and embedded large eddy simulations (LES) to better understand how to parameterize buildings that are elongated and angled relative to the wind flow and the parameterization of the plume in the cavity and far wake regions. The ORD studies focused on single rectangular buildings and investigated changes in plume parameters at discrete downwind distances from the building and source and building characterization.

As previously stated, the ORD building options associated with the ORD_DWNW keyword are research grade ALPHA options and require the ALPHA secondary keyword included with the MODELOPT keyword. There are three distinct ORD options that can be enabled individually or in

combination with one another. For detailed information on ORD's research and the options implemented in AERMOD, refer to Heist et al., 2016; Monbureau et al., 2018; and Perry et al., 2018. The usage of the ORD_DWNW keyword and associated secondary keywords is as follows:

Syntax:	CO ORD_DWNW	ORDUEFF ORDTURB ORDCAV	and/or and/or
Type:	Optional, Non-repeatable		

where:

ORDUEFF - Redefines the height at which the wind speed is taken from the profile wind speed used in the calculation of concentrations from the primary plume. The PRIME algorithm currently uses the wind speed at the stack height. ORDUEFF uses the average of the profiled wind speed between the height of the receptor and the plume centerline, allowing the wind speed of the plume to change with a changing environment.

NOTE: ORDUEFF cannot be used in combination with the AWMADWNW option AWMAUEFF.

ORDTURB - Redefines the maximum value of the non-dimensional vertical turbulence intensity in the wake, reduced from 0.07, the current value in PRIME, to 0.06 based on Wiel (1996).

ORDCAV- Redefines point downwind at which the vertical and lateral dispersion coefficients begin to grow with downwind distance from the lee edge of the building to the end of the cavity. PRIME considers a cavity plume and a re-emitted plume to simulate two distinct regions with a weighted distribution of mass between the two plumes. The cavity and re-emitted plumes initially have the same lateral and vertical dispersion on the leeward side of the building. The re-emitted plume grows with downwind distance while the dispersion of the cavity plume remains unchanged throughout the cavity

which creates a discontinuity of the two plumes at the near-wake boundary and results in a reduction in ground level concentrations. This option sets the dispersion coefficients for the two plumes equal to each other at the cavity edge eliminating the discontinuity between the two plumes.

NOTE: Each of the three ORD_DWNW options listed are optional, but at least one must be included if the ORD_ DWNW keyword is specified in the control file.

3.2.4.2 AWMA building downwash options

AWMA's research focused on the reanalysis of existing wind tunnel data, as well as the completion of new wind tunnel experiments to investigate the decay of the building wake above the top of the building, appropriate height at which approach turbulence and wind speed are calculated, the reduction of wake effects for streamlined structures, and the effect of approach roughness on the wake.

Five ALPHA building downwash options developed by the AWMA have been implemented in AERMOD and require the ALPHA secondary keyword included with the MODELOPT keyword. For detailed information on AWMA's research and the development of these ALPHA building downwash options, refer to Petersen et al., 2017 and Petersen et al., 2018. The usage of the AWMADWNW keyword and the associated secondary keywords to enable the AWMA building downwash ALPHA options is as follows:

Syntax:	CO AWMADWNW AWMAUEFF and/or AWMAENTRAIN and/or ((AWMAUTURB or AWMAUTURBHX) w/wo STREAMLINE(D))
Type:	Optional, Non-repeatable

where:

AWMAUEFF - Redefines the height at which the wind speed is taken from the profile wind speed used in the calculation of concentrations from the primary

plume. The PRIME algorithm currently uses wind speed at the stack height. AWMAUEFF uses the wind speed at the height of the plume centerline.

NOTE: AWMAUEFF cannot be used in combination with the ORD_DWNW option ORDUEFF.

AWMAENTRAIN - AWMAENTRAIN changes beta (B) entrainment coefficient for PRIME downwash from default value of 0.60 to 0.35.

AWMAUTURB - Enables enhanced calculations of turbulence and wind speed using the minimum of the final momentum plume rise or a representative PRIME plume rise height for all calculations. It also uses the final momentum plume rise height used to compute effective wind speed (UEFF), effective σ_w (SWEFF), effective σ_v (SVEFF), effective potential temperature gradient (TGEFF), and initial turbulence intensities (ambiy and ambiz) and computes mean wind speed, σ_w, and σ_v at 30 meters (U30, SW30 and SV30, respectively).

AWMAUTURBHX - Enables enhanced calculations of turbulence and wind speed using the PRIME plume rise at the downwind distance X, for all calculations. Uses the final momentum plume rise height to initially compute effective wind speed (UEFF), effective σ_w (SWEFF), effective σ_v (SVEFF), effective potential temperature gradient (TGEFF), and initial turbulence intensities (ambiy and ambiz) and then uses the PRIME computed plume rise at each downwind distance. Also, computes mean wind speed, σ_w, and σ_v at 30 meters (U30, SW30 and SV30, respectively).

NOTE: If AWMAUTURB and AWMAUTURBHX are both specified, AERMOD will issue a warning and continue processing using the AWMAUTURBHX option.

STREAMLINE(D) - Reduces dispersion in the wake of streamlined structures such as storage tanks and cooling towers. Uses alternate formulations for turbulence enhancement and velocity deficit associated with the AWMUTURB and AWMATURBHX options with modifications for streamlined structures. When specified, all structures will be treated as streamlined structures.

NOTE: The STREAMLINE option can only be specified in conjunction with the AWMAUTURB and AWMAUTURBHX options. When specified, AERMOD assumes all buildings defined in the input control file are streamlined structures.

NOTE: Each of the AWMADWNW options listed are optional, but at least one must be included if the AWMADWNW is used.

Refer to Section 3.2.18 for debug output options associated with the ALPHA building downwash options.

3.2.5 Input parameters for NO_2 conversion options

This section provides a description of the AERMOD inputs related to the PVMRM, OLM, GRSM (Tier 3), and ARM2 (Tier 2) regulatory screening options for modeling the conversion of NO to NO_2, as well as the ALPHA options, TTRM and TTRM2. TTRM and GRSM (Tier 3) were both added as ALPHA options beginning with version 21112. Beginning with version 22112, GRSM was updated to a BETA option, and TTRM2 was added as an ALPHA option to invoke TTRM simultaneously with ARM2, PVMRM, or OLM. GRSM was updated to a regulatory screening option beginning in version 24142. As a stand-alone option, TTRM is only effective for near field receptors. TTRM2 paired with ARM2, PVMRM, or OLM, will invoke TTRM for near field receptors and use the other method specified for all other receptors. While TTRM as a method has now been integrated to be paired with these other options using the TTRM2 keyword, the TTRM keyword has been retained as a stand-alone option for testing and diagnostic purposes. Note that the TTRM2 option cannot be paired with GRSM. Also note that beginning with version

16216r, ARM2 replaced the original Ambient Ratio Method (ARM) Tier 2 option for NO conversion to NO_2. ARM is no longer an option in AERMOD.

All Tier 2 and Tier 3 NO_2 screening options are coded such that NO_X chemistry calculations are applied to all sources and associated combined NO_X emissions in a single AERMOD model run. This ensures that the NO_X chemistry schemes for each NO_2 screening option correctly reflect the incremental, non-linear contribution of influencing factors to conversion of NO_X to NO_2 for each hour and at each receptor. In general, the influencing factors informing the formulation and application of each NO_2 screening option on a source-by-source basis include in-stack NO_2/NO_X ratio, NO_X emissions reaction with ambient ozone, plume entrainment of ambient ozone, and dominant and ensemble plume assumptions. As such, AERMOD Tier 2 and Tier 3 NO_2 model outputs are a function of all sources and NO_2 input parameters included in the model run, and thus, the non-linear contributions from each source are mathematically tied to all sources in a single model run. This effectively means that Tier 2 and Tier 3 NO_2 model outputs are limited to representing one operating emissions scenario per model run.

A technical description of the PVMRM algorithm as incorporated within AERMOD is provided in the AERMOD Model Formulation document (EPA, 2026a). Additional information regarding the regulatory options for NO_2 modeling are provided in Technical Support Document (TSD) for NO_2-related AERMOD Modifications (EPA, 2015). Background on the original development of the PVMRM option is provided by Hanrahan (1999a and 1999b).

The ARM2 option is based on work sponsored by API (API, 2013) to develop a method to adjust the modeled NO_x concentrations based on an empirical relationship between ambient NO_x and ambient NO_2 concentrations. A key difference between the PVMRM and OLM methods, as compared to the ARM2 method, is that ARM2 does not require the user to input background ozone (O_3) concentrations or in-stack NO_2/NO_x ratios, as required by PVMRM and OLM; however, the default minimum ratio utilized in the ARM2 method may not be appropriate in cases where the sources being modeled are known to have relatively high in-stack NO_2/NO_x ratios. ARM2 sums all NOX impacts from all sources modeled in a single model run to determine the NO2/NOX ratio that's applied for each source group (SRCGROUP) specified. While the SRCGROUP keyword is required with at least one source group defined, if source group 'ALL' is omitted, AERMOD will

automatically assume a source group 'ALL' internally and apply ARM2 to that assumed source group. In this case, AERMOD will generate a warning message to indicate that source group 'ALL' is missing but not required. Thus, ARM2 will not be calculated based on separate source groups NOX impacts. For example, if NOX emissions from five stacks are modeled with the ARM2 option, and only one source group is specified for one stack, ARM2 will first determine the total NOX impact from all five stacks, calculate the empirically derived NO2/NOX ratio from the total NOX impact (using a 6^{th} order polynomial equation discussed in API, 2013), and the final NO2 impact concentration for the single stack source group would be calculated as the product of the NO2/NOX ratio and the discreet NOX impact for the single stack source group.

ARM2 has been implemented as a regulatory Tier 2 screening option while the PVMRM, OLM, and GRSM algorithms have been implemented as regulatory Tier 3 screening options. Therefore, any one of the four options can be used with the DFAULT keyword. TTRM/TTRM2 have been added as non-regulatory ALPHA options and cannot be used with the DFAULT keyword. As with all other ALPHA options, they require the use of the ALPHA keyword. With exception to daytime GRSM NO_2 calculations, it is important to note that the OLM, PVMRM, ARM2, and TTRM/TTRM2 options are NOT applied to the background NO_2 concentrations input through the SO BACKGRND option (described in Section 0). The background NO_2 concentrations, if provided, will be added to the modeled NO_2 concentrations after the NO-NO_2 conversion has been calculated.

GRSM daytime NO_2 model concentrations are calculated based on the net production of NO_2 from the following: NO_2 in-stack ratio, ambient ozone and ambient NO_X entrainment, conversion of source and ambient NO_X to NO_2, photolysis conversion of source and ambient NO_2 to NO, and time-of-travel of the NO_X plume from source to receptor. **Note: GRSM NO_2 daytime concentrations are calculated differently depending on whether the user assigns background (as specified through the SO BACKGRND pathway) to source group ALL (i.e., SO SRCGROUP ALL BACKGROUND). If background is assigned to source group ALL, GRSM will calculate the NO_X-to-NO_2 conversion based on the post-chemistry total NO_2 and NO from both source impacts and entrained ambient concentrations. If background is not assigned to source group ALL, GRSM calculates the NO_X-to-NO_2 conversion based on the post-chemistry source NO_2 and NO minus a minimum entrained ambient NO_2 and NO concentration (see**

***Post-chemistry Concentrations*, pg. 37, CERC, 2023). In terms of NO_2 NAAQS demonstrations, the former GRSM calculation would be appropriate for the cumulative impact analysis whereas the latter GRSM calculation would be more appropriate for the single source impact analysis as discussed in the *Guideline* Section 9.2.3.**

GRSM nighttime NO_2 model concentrations are calculated similar to OLM and PVMRM, i.e., limited by ozone conversion of NO to NO_2 with background NO_2 concentrations (as specified through the SO BACKGRND pathway) simply added to the post-chemistry total NO_2 concentration when background is assigned to the ALL source group.

It should be noted that not all NO_2 conversion options have been implemented for all source types in AERMOD. Table 3-2 summarizes which NO_2 conversion options have been implemented for each of the AERMOD source types and which options have not.

Table 3-2. Implemented NO2 Conversion Options by AERMOD Source Type

AERMOD Source Type	Implemented NO2 Options	Not Implemented Warning Issued
POINT (inc. POINTCAP and POINTHOR)	ALL	NONE
AREA (inc. AREAPOLY, AREACIRC, and LINE)	ALL	NONE
VOLUME	ALL	NONE
OPENPIT	ARM2, PVMRM, OLM, TTRM, GRSM	TTRM2 (unpaired or paired with ARM2, OLM, or PVMRM), TTRM2 by itself produces zero-values!
RLINE/RLINEXT	ARM2	PVMRM, OLM, TTRM, TTRM2, GRSM

BUOYLINE	ARM2	PVMRM, OLM, TTRM, TTRM2, GRSM
SWPOINT	NONE	ARM2, PVMRM, OLM, TTRM, TTRM2, GRSM

As described in Section 3.3.7, the ALPHA model option, PSDCREDIT, has been included for testing and evaluation for increment consumption with PSD credits using PVMRM. The special source grouping required for the PSDCREDIT option is also described below in Section 3.3.7.

3.2.5.1 Specifying ozone concentrations for PVMRM, OLM, TTRM/TTRM2, and GRSM options

The background ozone concentrations for the PVMRM, OLM, TTRM/TTRM2, and GRSM options can be input as a single annual value using the OZONEVAL keyword on the CO pathway, as temporally varying values using the O3VALUES keyword on the CO pathway, or as hourly values in a separate data file specified with the OZONEFIL keyword on the CO pathway. The user **must** specify background ozone concentrations with the OZONEVAL, O3VALUES, or OZONEFIL keyword to use any one of the PVMRM, OLM, TTRM/TTRM2, or GRSM options. The OZONEVAL or O3VALUES keyword may also be used simultaneously with the OZONEFIL keyword, in which case the value(s) entered on the OZONEVAL or O3VALUES keyword will be used to substitute for hours with missing ozone data in the hourly ozone data file. Users are strongly encouraged to utilize the OZONEVAL or O3VALUES keyword with the OZONEFIL keyword to substitute for missing ozone concentrations in the hourly data file. If there are no substitution values supplied via the OZONEVAL or O3VALUES keywords for an hour with missing ozone value, all AERMOD Tier 3 NO_2 screening options will skip chemistry calculations and assume 100% conversion of NO_X emissions to NO_2 for that hour.

Beginning with version 13350, users can vary background ozone concentrations by wind sector. For applications that include sector-varying background ozone concentrations, the sectors are defined based on the CO O3SECTOR keyword, as follows:

Syntax:	CO O3SECTOR StartSect1 StartSect2 . . . StartSect*N*, where $N \leq 6$
Type:	Optional, Non-Repeatable

where StartSect1, StartSect2 … StartSect*N* are the starting directions of each downwind sector. For applications that include sector-varying background ozone concentrations, the minimum sector width allowed is 30 degrees and warning messages will be issued for sector widths less than 60 degrees. A maximum of six sectors can be defined. **Sector-varying background ozone concentrations will be selected based on the flow vector, i.e., the downwind direction based on the wind direction specified in the surface meteorological data file.**

The syntax of the OZONEVAL keyword is as follows:

Syntax:	CO OZONEVAL O3Value (O3Units) (w/o sectors) or CO OZONEVAL SECT*x* O3Value (O3Units), where $x \leq 6$ (w/ sectors)
Type:	Optional, Repeatable

where the O3Value parameter is the background ozone concentration in the units specified by the optional O3Units parameter (PPM, PPB, or UG/M3), and SECT*x* refers to the user-specified sector defined on the optional O3SECTOR keyword for which the O3Value inputs are applied. Implement as SECT1 or SECT2 …or SECT*x* where $x \leq 6$, and *x* is an integer and corresponds to the *N*th sector defined with the O3SECTOR keyword. If the optional O3Units parameter is missing, then the model will assume units of micrograms/cubic-meter (UG/M3) for the background ozone values. If units of PPM or PPB are used, then the model will convert the concentrations to micrograms/cubic-meter based on reference temperature (25 C) and pressure (1013.25 mb) (i.e., 1.96 UG/M3 per 1 PPB ozone, or 1.96×10^3 UG/M3 per 1 PPM ozone).

The syntax of the O3VALUES keyword is as follows and is similar to the EMISFACT keyword on the SO pathway (Section 3.3.11) for specifying temporally varying emission rates:

Syntax:	CO O3VALUES O3Flag O3values(i), i=1, *n* (w/o sectors) or CO O3VALUES SECT*x* O3Flag O3values(i), i=1, *n* where $x \leq 6$ (w/ sectors) and *n* is based on O3Flag
Type:	Optional, Repeatable

where the SECT*x* parameter specifies the applicable sector as defined on the optional O3SECTOR keyword. Implemented as SECT1 or SECT2 …or SECT*x* where $x \leq 6$, and *x* is an integer and corresponds to the *N*th sector defined with the O3SECTOR keyword. The parameter O3Flag is the variable ozone concentration flag and must be specified as one of the following secondary keywords (the number in parentheses indicates the number of values required for each option):

ANNUAL - annual ozone value (*n* = 1); equivalent to OZONEVAL keyword in PPB,

SEASON - ozone values vary seasonally (*n* = 4),

MONTH - ozone values vary monthly (*n* = 12),

HROFDY - ozone values vary by hour-of-day (*n* = 24),

WSPEED - ozone values vary by wind speed (*n* = 6),

SEASHR - ozone values vary by season and hour-of-day (*n* = 96),

HRDOW - ozone values vary by hour-of-day, and day-of-week [M-F, Sat, Sun] (*n* = 72),

HRDOW7 - ozone values vary by hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (*n* = 168),

SHRDOW - ozone values vary by season, hour-of-day, and day-of-week [M-F, Sat, Sun] (*n* = 288),

SHRDOW7 - ozone values vary by season, hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (*n* = 672),

MHRDOW - ozone values vary by month, hour-of-day, and day-of-week [M-F, Sat, Sun] (*n* = 864), and

MHRDOW7 - ozone values vary by month, hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (*n* = 2,016).

The O3Values array is the array of ozone values, where the number of values required is shown as the value of *n* in parentheses above for each O3Flag option. The seasons are defined in the following order: Winter (Dec., Jan., Feb.), Spring (Mar., Apr., May), Summer (Jun., Jul., Aug.), and Fall (Sep., Oct., Nov.). The wind speed categories used with the WSPEED option may be defined

using the ME WINDCATS keyword (Section 3.5.6). If the WINDCATS keyword is not used, the default wind speed categories are defined by the upper bound of the first five categories as follows (the sixth category is assumed to have no upper bound): 1.54, 3.09, 5.14, 8.23, and 10.8 m/s. The O3VALUES keyword may be repeated as many times as necessary to input all of the ozone values and repeat values may be used for the numerical inputs.

The order of inputs specified for the hour-of-day/day-of-week options (HRDOW, SHRDOW, SHRDOW7, etc.) are by hour-of-day, then season or month, if applicable, and then by day-of-week. For the HRDOW/SHRDOW/MHRDOW options, the days of the week are specified in the order of Weekdays (M-F), Saturdays, and Sundays. For the HRDOW7/SHRDOW7/ MHRDOW7 options, the days of the week are specified in the order of Mondays, Tuesdays, etc., through Sundays. Section 3.3.11 below includes an example illustrating the order of inputs for these options for the EMISFACT keyword.

Ozone concentrations specified on the O3VALUES keyword are assumed to be in units of PPB unless the OZONUNIT keyword is specified.

The syntax of the OZONUNIT keyword is as follows:

Syntax:	CO OZONUNIT OzoneUnits
Type:	Optional, Non-repeatable

where the OzoneUnits parameter specifies the units as parts-per-billion (PPB), parts-per-million (PPM), or micrograms/cubic-meter (UG/M3). Units specified on the CONCUNIT keyword are only applied to ozone concentrations input through the O3VALUES keyword, which assumes default units of PPB if the OZONUNIT keyword is not specified. Model input ozone concentrations specified in units of PPB or PPM are converted to UG/M3 based on reference temperature (25 C) and pressure (1013.25 mb) (i.e., 1.96 UG/M3 per 1 PPB ozone, or 1.96×10^3 UG/M3 per 1 PPM ozone).

Hourly ozone concentrations can be input through the optional OZONEFIL keyword. The syntax of the OZONEFIL keyword is as follows:

Syntax:	CO OZONEFIL O3FileName (O3Units) (O3Format) (w/o sectors) or CO OZONEFIL SECT*x* O3FileName (O3Units) (O3Format), where $x \leq 6$ (w/ sectors)
Type:	Optional, Repeatable

where the O3FileName parameter is the filename for the hourly ozone concentration file, the optional O3Units parameter specifies the units of the ozone data (PPM, PPB, or UG/M3, with UG/M3 as the default), and the optional O3Format parameter specifies the Fortran format to read the ozone data. If sector-varying ozone concentrations are being used, based on the CO O3SECTOR keyword, then the applicable sector ID needs to be specified, e.g., 'SECT1' indicates that values are specified for the first downwind sector. The O3FileName can be up to 200 characters in length based on the default parameters in AERMOD. Double quotes (") at the beginning and end of the filename can also be used as field delimiters to allow filenames with embedded spaces.

The hourly ozone file must include the year, month, day, and hour, followed by the ozone concentration, in that order (unless specified differently through the O3Format parameter). The year can be specified as either a 2-digit or 4-digit year. If an optional Fortran format is specified using the O3Format parameter, the year, month, day, and hour variables must be read as integers using the Fortran 'I' format specifier, and the ozone concentration must be read as a real variable, using the Fortran 'F,' 'E,' or 'D' format specifiers, e.g., (4I2, F8.3). Note that ozone values that do not include decimal places can be read as F*x*.0, where *x* is the length of the data field. However, ozone values that do not include decimal places may be read incorrectly if the O3Format specified for reading the data includes decimal places. For example, a value of '1234' would be interpreted as '123.4' if a format of F4.1 was used. The O3Format parameter must include the open and close parentheses as shown in the example and may also include embedded spaces if double quotes (") are used to delimit the field. A warning message will be generated if the specified format does not meet these requirements, and AERMOD may also issue a fatal error message when reading the file in cases where real variables are read with an integer format, or vice versa.

If the optional O3Format parameter is missing, then the model will read the ozone data using a Fortran 'free' format, i.e., assuming commas or spaces separate the data fields, and that the

fields are in the order given above. The date sequence in the ozone data file must match the date sequence in the hourly meteorological data files. As with the OZONEVAL keyword, if units of PPM or PPB are used, then the model will convert the concentrations to micrograms/cubic-meter based on reference temperature (25 C) and pressure (1013.25 mb) (i.e., 1.96 UG/M3 per 1 PPB ozone, or $1.96x10^3$ UG/M3 per 1 PPM ozone).

Values of ozone concentrations in the ozone data file that are less than zero or greater than or equal to 900.0 will be regarded as missing. If background ozone values have been specified using the OZONEVAL and/or O3VALUES keyword, then the appropriate value will be used to substitute for missing ozone data from the ozone file. If no OZONEVAL or O3VALUES keywords are used, then the model will assume full conversion of NO to NO_2 for hours with missing ozone data.

AERMOD will apply a minimum ozone value for NO conversion during stable hours, based on the minimum of 40 ppb and the maximum hourly ozone from the previous 24-hours of ozone data. This minimum ozone restriction can be turned off with the NOMINO3 keyword. As with all NO_2 options, this option should be used in consultation with the appropriate reviewing authority. See the Model Formulation Document (MFD) Section 5.8.2 for further details.

NOTE: The OLM method for estimating NO_2 concentrations, outlined by Cole and Summerhays (1979), assumes NO conversion to NO_2 by first dividing total NO_x into a thermal NO_2 component directly emitted from a stack, with the remaining NO_x assumed as NO and available for reaction with O_3. If ambient O_3 is greater than the portion of NO_x assumed as NO, all NO is converted to NO_2, otherwise, the amount of NO converted to NO_2 is limited to available O_3. AERMOD, for OLM processing, only incorporates user-defined, background ozone values in concentration calculations for hours that are “ozone-limited”, when sufficient atmospheric ozone is not present for NO_x chemistry reactions. Determination of ozone-limited hours is dependent on the relative values of background ozone concentrations to NO_2 emissions multiplied by the in-stack NO_2/NOx ratio, described in Section 3.2.5.4, defined by the user. It is possible, therefore, to define scenarios that will result in an absence of ozone-limited hours. Users interested in evaluating concentrations sensitivities to background ozone should consider the potential that modification of the background ozone concentration may not appear to impact output concentrations if relatively

low in-stack NO_2/NO_x and/or emissions rates are defined. This behavior does not apply to the AERMOD PVMRM method.

3.2.5.2 Specifying NO_X background concentrations for the GRSM option

The background NO_X concentrations for the GRSM option is input similarly to the ozone background concentrations. The background NO_X concentrations can be input as a single annual value with the NOXVALUE keyword on the CO pathway, as temporally varying values through the NOX_VALS keyword on the CO pathway, or as hourly values from a separate data file specified through the NOX_FILE keyword on the CO pathway. The user may specify background NO_X concentrations with the NOXVALUE, NOX_VALS, or NOX_FILE keyword in order to use the GRSM option. The NOXVALUE or NOX_VALS keyword may also be specified with the NOX_FILE keyword, in which case the value(s) entered on the NOXVALUE or NOX_VALS keyword will be used to substitute for hours with missing NO_X background data in the hourly NO_X data file. Users are strongly encouraged to utilize the NOXVALUE or NOX_VALS keyword with the NOX_FILE keyword to substitute for missing NO_X concentrations in the hourly data file. If no NO_X input is supplied, GRSM calculates ambient NO_X based on adjustment of background NO_2 and ozone assuming photo-stationary state (PSS) equilibrium and conservation of oxidants (see pg. 35, CERC, 2023). As with background ozone, users can vary background NO_X concentrations by wind sector. For applications that include sector-varying background NO_X concentrations, the sectors are defined based on the CO NOXSECTR keyword, as follows:

Syntax:	CO NOXSECTR StartSect1 StartSect2 . . . StartSect*N*, where $N \leq 6$
Type:	Optional, Non-Repeatable

For applications that include sector-varying background concentration the minimum sector width allowed is 30 degrees and warning messages will be issued for sector widths less than 60 degrees. **Sector-varying background concentrations will be selected based on the flow vector, i.e., the downwind direction, based on the wind direction specified in the surface meteorological data file.**

The syntax of the NOXVALUE keyword is as follows:

Syntax:	CO NOXVALUE NOXValue (NOXUnits) (w/o sectors) or CO NOXVALUE SECT*x* NOXValue (NOXUnits), where $x \leq 6$ (w/ sectors)
Type:	Optional, Repeatable

where the NOXValue parameter is the background NO_X concentration in the units specified by the optional NOXUnits parameter (PPM, PPB, or UG/M3), and SECT*x* refers to the user-specified sector defined on the optional NOXSECTR keyword for which the NOXValue inputs are applied. Implement as SECT1 or SECT2 …or SECT*x* where $x \leq 6$, and *x* is an integer and corresponds to the *N*th sector defined by NOXSECTR. If the optional NOXUnits parameter is missing, then the model will assume units of micrograms/cubic-meter (UG/M3) for the background NO_X values. If units of PPM or PPB are used, then the model will convert the concentrations to micrograms/cubic-meter based on reference temperature (25 C) and pressure (1013.25 mb) and assuming a molecular weight of NO_2 (i.e., NO_X as NO_2).

The syntax of the NOX_VALS keyword is as follows and is similar to the O3VALUES keyword described above in Section 3.2.5.1 for specifying temporally varying ozone background concentrations:

Syntax:	CO NOX_VALS NOXFlag NOXvalues(i), i=1, *n* (w/o sectors) or CO NOX_VALS SECT*x* NOXFlag NOXvalues(i), i=1, *n* and $x \leq 6$ (w/ sectors)
Type:	Optional, Repeatable

where the SECT*x* parameter specifies the applicable downwind sector as defined on the optional NOXSECTR keyword and the parameter NOXFlag is the variable NO_X concentration flag and must be specified as one of the following secondary keywords (the number in parentheses indicates the number of values required for each option):

ANNUAL - annual NO_X value ($n = 1$); equivalent to NOXVALUE keyword in PPB,

SEASON - NO_X values vary seasonally ($n = 4$),

MONTH - NO_X values vary monthly (n = 12),

HROFDY - NO_X values vary by hour-of-day (n = 24),

WSPEED - NO_X values vary by wind speed (n = 6),

SEASHR - NO_X values vary by season and hour-of-day (n = 96),

HRDOW - NO_X values vary by hour-of-day, and day-of-week [M-F, Sat, Sun] (n = 72),

HRDOW7 - NO_X values vary by hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n = 168),

SHRDOW - NO_X values vary by season, hour-of-day, and day-of-week [M-F, Sat, Sun] (n = 288),

SHRDOW7 - NO_X values vary by season, hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n = 672),

MHRDOW - NO_X values vary by month, hour-of-day, and day-of-week [M-F, Sat, Sun] (n = 864), and

MHRDOW7 - NO_X values vary by month, hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n = 2,016).

The NOX values array is the array of NO_X values, where the number of values is shown above for each NOXFlag option. The seasons are defined in the following order: Winter (Dec., Jan., Feb.), Spring (Mar., Apr., May), Summer (Jun., Jul., Aug.), and Fall (Sep., Oct., Nov.). The wind speed categories used with the WSPEED option may be defined using the ME WINDCATS keyword (Section 3.5.6). If the WINDCATS keyword is not used, the default wind speed categories are defined by the upper bound of the first five categories as follows (the sixth category is assumed to have no upper bound): 1.54, 3.09, 5.14, 8.23, and 10.8 m/s. The NOX_VALS keyword may be repeated as many times as necessary to input all the NO_X values and repeat values may be used for the numerical inputs.

The order of inputs specified for the hour-of-day/day-of-week options (HRDOW, SHRDOW, SHRDOW7, etc.) are by hour-of-day, then season or month, if applicable, and then by day-of-week. For the HRDOW/SHRDOW/MHRDOW options, the days of the week are specified in the order of Weekdays (M-F), Saturdays, and Sundays. For the HRDOW7/SHRDOW7/ MHRDOW7 options, the days of the week are specified in the order of Mondays, Tuesdays, etc., through Sundays. Section 3.3.11 below includes an example illustrating the order of inputs for these options for the EMISFACT keyword.

NO_X concentrations specified on the NOX_VALS keyword are assumed to be in units of PPB unless the NOX_UNIT keyword is specified.

The syntax of the NOX_UNIT keyword is as follows:

Syntax:	CO NOX_UNIT NOXUnits
Type:	Optional, Non-repeatable

where the NOXUnits parameter specifies the units as parts-per-billion (PPB), parts-per-million (PPM), or micrograms/cubic-meter (UG/M3). Units specified on the CONCUNIT keyword are only applied to NO_X concentrations input with the NOX_VALS keyword, which assumes default units of PPB if the NOX_UNIT keyword is not specified. NO_X concentrations specified in units of PPB or PPM are converted to UG/M3 based on reference temperature (25 C) and pressure (1013.25 mb).

Hourly NO_X concentrations can be input through the optional NOX_FILE keyword. The syntax of the NOX_FILE keyword is as follows:

Syntax:	CO NOX_FILE NOXFileName (NOXUnits) (NOXFormat) (w/o sectors) or CO NOX_FILE SECT*x* NOXFileName (NOXUnits) (NOXFormat), where $x \leq 6$ (w/ sectors)
Type:	Optional, Repeatable

where the NOXFileName parameter is the filename for the hourly ozone concentration file, the optional NOXUnits parameter specifies the units of the ozone data (PPM, PPB, or UG/M3, with UG/M3 as the default), and the optional NOXFormat parameter specifies the Fortran format to read the NO_X data. If sector-varying NO_X concentrations are being used, based on the CO NOXSECTR keyword, then the applicable sector ID needs to be specified, e.g., 'SECT1' indicates that values are specified for the first downwind sector. The NOXFileName can be up to 200 characters in length based on the default parameters in AERMOD. Double quotes (") at the beginning and end of the filename can also be used as field delimiters to allow filenames with embedded spaces.

The hourly NO_X file must include the year, month, day, and hour, followed by the NO_X concentration, in that order (unless specified differently through the NOXFormat parameter). The year can be specified as either a 2-digit or 4-digit year. If an optional Fortran format is specified using the NOXFormat parameter, the year, month, day, and hour variables must be read as integers using the Fortran 'I' format specifier, and the NO_X concentration must be read as a real variable, using the Fortran 'F,' 'E,' or 'D' format specifiers, e.g., (4I2, F8.3). Note that NO_X values that do not include decimal places can be read as F*x*.0, where *x* is the length of the data field. However, NO_X values that do not include decimal places may be read incorrectly if the NOXFormat specified for reading the data includes decimal places. For example, a value of '1234' would be interpreted as '123.4' if a format of F4.1 was used. The NOXFormat parameter must include the open and close parentheses as shown in the example and may also include embedded spaces if double quotes (") are used to delimit the field. A warning message will be generated if the specified format does not meet these requirements, and AERMOD may also issue a fatal error message when reading the file in cases where real variables are read with an integer format, or vice versa.

If the optional NOXFormat parameter is missing, then the model will read the NO_X data using a Fortran 'free' format, i.e., assuming commas or spaces separate the data fields, and that the fields are in the order given above. The date sequence in the NO_X data file must match the date sequence in the hourly meteorological data files. As with the NOXVALUE keyword, if units of PPM or PPB are used, then the model will convert the concentrations to micrograms/cubic-meter based on reference temperature (25 C) and pressure (1013.25 mb).

Values of NO_X concentrations in the NO_X data file that are less than zero will be regarded as missing. If background NO_X values have been specified using the NOXVALUE and/or NOX_VALS keyword, then the appropriate value will be used to substitute for missing NO_X data from the NO_X file. If no NOXVALUE or NOX_VALS keywords are used, then the model will assume equilibrium of NOx with NO_2 predicted from GRSM based on NO_X emissions and hourly ozone for hours with missing NO_X data.

3.2.5.3 Specifying the ambient equilibrium NO_2/NO_x ratio (PVMRM, OLM, TTRM/TTRM2)

The PVMRM option for modeling conversion of NO to NO_2 incorporates a default NO_2/NO_x ambient equilibrium ratio of 0.90. Beginning with version 11059 of AERMOD, a default equilibrium ratio of 0.90 has also been incorporated in the OLM option, as well as the TTRM option beginning with version 21112. A NO_2/NO_x equilibrium ratio other than 0.90 can be specified for the PVMRM, OLM, or TTRM/TTRM2 option through the optional NO2EQUIL keyword on the CO pathway. The syntax of the NO2EQUIL keyword is as follows:

Syntax:	CO NO2EQUIL NO2Equil
Type:	Optional, Non-repeatable

where the NO2Equil parameter is the NO_2/NO_x equilibrium ratio and must be between 0.10 and 1.0, inclusive. Note the NO2EQUIL option is invalid for GRSM simulations given that GRSM calculates the NO_2/NO_x conversion equilibrium ratio explicitly.

3.2.5.4 Specifying the default in-stack NO_2/NO_x ratio (PVMRM, OLM, TTRM/TTRM2, GRSM)

The PVMRM, OLM, TTRM/TTRM2, and GRSM options for modeling conversion of NO to NO_2 require that an in-stack NO_2/NO_x ratio be specified. Based on guidance issued June 28, 2010 (EPA, 2010b), regarding the 1-hour NO_2 NAAQS, AERMOD has been modified to require the user to specify in-stack NO_2/NO_x ratios for each source under the OLM and PVMRM options, i.e., AERMOD no longer assumes a default in-stack ratio of 0.10 for the OLM or PVMRM option. This requirement has been carried forward with the addition of the TTRM/TTRM2 and GRSM options.

The in-stack NO_2/NO_x ratio can be specified for the PVMRM, OLM, TTRM/TTRM2, or GRSM option by using either the CO NO2STACK keyword to specify a default value to be used for all sources, or by using the SO NO2RATIO keyword to specify a value on a source-by-source basis. The SO NO2RATIO keyword can also be used to override the default value for specific sources if the CO NO2STACK keyword has been specified. The syntax of the NO2STACK keyword is as follows:

Syntax:	CO NO2STACK NO2Ratio
Type:	Optional, Non-repeatable

where the NO2Ratio parameter is the default in-stack NO_2/NO_x ratio that will be used, unless overridden on a source-by-source basis by the SO NO2RATIO keyword (described below). The value of NO2Ratio must be between 0.0 and 1.0, inclusive. Users should note that while CO NO2STACK is an optional keyword, the OLM, PVMRM, TTRM/TTRM2, and GRSM options require the user to specify an in-stack NO_2/NO_x ratio for each source, using either the CO NO2STACK or SO NO2RATIO keyword (described in Section 3.3.6.1), or both.

3.2.6 Averaging time options

The averaging periods for AERMOD are selected using the AVERTIME keyword on the CO (Control) pathway. The syntax and type of the AVERTIME keyword are summarized below:

Syntax:	CO AVERTIME Time1 Time2 . . . Time*N* MONTH PERIOD or ANNUAL
Type:	Mandatory, Non-repeatable

where the parameters Time1 . . . Time*N* refer to the user-specified short-term averaging periods of 1, 2, 3, 4, 6, 8, 12, and/or 24 hours, the secondary keyword MONTH refers to monthly averages (for calendar months), the secondary keyword PERIOD refers to the average for the entire data period, and the secondary keyword ANNUAL refers to an annual average. Any of the short-term averaging periods listed above may be selected for a given run. Since the monthly averages are treated as short-term averages, the user can select appropriate output options, such as the second highest values by receptor, on the OU pathway. The location of the PERIOD or ANNUAL keyword in the parameter list is not critical. The order of the short-term averaging periods (including MONTH) is also not critical, although it does control the order of the averaging period result tables in the main output file. Generally, it is recommended that the short-term averaging periods be input in increasing order, unless there is a clear advantage in doing otherwise.

The user may specify either the PERIOD keyword or the ANNUAL keyword, but not both. For concentration calculations for a single year data file, the PERIOD and ANNUAL keywords produce the same results. **However, the ANNUAL average option applies only to complete years of data, and for multi-year data files, the ANNUAL average output is based on the average of the ANNUAL values across the years of data processed.**

For deposition calculations, the PERIOD keyword will provide a total deposition flux for the full period of meteorological data that is modeled, including multi-year data files, with default units of g/m^2, whereas the ANNUAL keyword will provide an annualized rate of the deposition flux with default units of $g/m^2/yr$.

Use of the ANNUAL average option for meteorological data periods of less than a year will result in a fatal error. For meteorological data periods of longer than a year, if the meteorological data file does not contain complete years of data, any data remaining after the last complete year will be ignored for the ANNUAL average, and a warning message will be generated. The treatment of short-term averages with multiple-year data files is comparable to their treatment when the CO MULTYEAR option is used.

3.2.7 Performing multiple year analyses with MULTYEAR option

The MULTYEAR keyword on the CO pathway provides an option for the user to perform a multiple year analysis such as would be needed to determine the "high-sixth-high in five years" design value for determining PM-10 impacts without the need for postprocessing of multiple concentration files, and for multiple year analyses associated with the 24-hour PM2.5 NAAQS and 1-hour NO_2 and SO_2 NAAQS which are based on concentrations averaged across the number of years processed. More information regarding the 24-hour PM2.5 and 1-hour NO_2 and SO_2 NAAQS is provided in Sections 3.2.16 and 3.2.17. Since the multiple year option makes use of the model re-start capabilities described in the Section 3.2.15, the MULTYEAR keyword is not compatible with the SAVEFILE or INITFILE keywords. The model will generate a fatal error message if the user attempts to exercise both options in a single run. The syntax and type of the MULTYEAR keyword is summarized below:

Syntax:	CO MULTYEAR (H6H) Savfil (Inifil)
Type:	Optional, Non-repeatable

where the optional H6H field, formerly used to highlight the use of the MULTYEAR option for determining the High-6th-High (H6H) 24-hour average for the "pre-1997" PM-10 NAAQS, is no longer required since the "post-1997" PM-10 NAAQS was vacated. A warning message will be generated if the H6H field is included on the MULTYEAR keyword indicating that it is not required. The Savfil parameter specifies the filename for saving the results arrays at the end of each year of processing, and the Inifil parameter specifies the filename to use for initializing the results arrays at the beginning of the current year. The Inifil parameter is optional and should be left blank for the first year in the multi-year series of runs. The MULTYEAR option works by accumulating the high short-term average results from year to year through the mechanism of the re-start save file. The model may be set up to run in a batch file with several years of meteorological data, and at the end of each year of processing, the short-term average results reflect the cumulative high values for the years that have been processed. The PERIOD average results are given for only the current year, but the model carries the highest PERIOD values from year to year and includes the cumulative highest PERIOD averages in the summary table at the end of the run.

When setting up a batch file to perform a multiple year analysis, the user would first create an input control file for the first year with all the applicable modeling options, the source inventory data, the receptor locations, the meteorology options for the first year and the output file options. To obtain the PM-10 design value, be sure to include the SIXTH highest value on the OU RECTABLE card (see Section 3.7.1). For the CO MULTYEAR card for the first year, the user would only specify the Savfil parameter, and may use a card such as:

```
CO MULTYEAR YEAR1.SAV
```

For the subsequent years, the user could copy the input file created for Year-1 and edit the files to change the year parameters and meteorology filename on the ME pathway (and possibly in the title information) and edit the MULTYEAR cards. For the subsequent years, both the Savfil and Inifil parameters must be specified, with the Savfil for Year-1 becoming the Inifil for Year-2, and so on. The MULTYEAR cards (one for each AERMOD run) might look like this:

```
CO MULTYEAR YEAR1.SAV (First year)
CO MULTYEAR YEAR2.SAV YEAR1.SAV (Second year)
CO MULTYEAR YEAR3.SAV YEAR2.SAV (Third year)
CO MULTYEAR YEAR4.SAV YEAR3.SAV (Fourth year)
CO MULTYEAR YEAR5.SAV YEAR4.SAV (Fifth year)
```

The MULTYEAR keyword option is separate from the ability of the AERMOD model to process a multiple-year meteorological data file in a single model run. The latter capability can be used for applications of the model to long term risk assessments where the average impacts over a long time period are of concern rather than the maximum annual average determined from five individual years. The MULTYEAR option can only be used when PM10, PM-10, PM25, PM2.5, PM-2.5, PM-25, LEAD, NO2, SO2, or OTHER is specified as the pollutant ID.

3.2.8 Urban modeling option

The AERMOD model allows the user to incorporate the effects of increased surface heating from an urban area on pollutant dispersion under stable atmospheric conditions. Beginning with version 06341, multiple urban areas can be specified within the same model run. Multiple areas may be applicable for large domains that encompass more than one identifiable urban area where the separation is large enough to warrant separate treatment of the urban boundary layer effects. Use of the option for multiple urban areas eliminates the need for post-processing for such applications. The urban area(s) are defined using one or more instances of the URBANOPT keyword on the CO pathway. The sources that are to be modeled with urban effects and the urban area that will be applied to each source are identified using the URBANSRC keyword on the SO pathway (see Section 3.3.10). The syntax and type of the URBANOPT keyword are summarized below:

Syntax:	**For Multiple Urban Areas:** CO URBANOPT UrbanID UrbPop (UrbName) (UrbRoughness) **For Single Urban Areas:** CO URBANOPT UrbPop (UrbName) (UrbRoughness)
Type:	Optional, Repeatable for multiple urban areas

where the UrbanID parameter is the alphanumeric urban ID defined by the user (up to eight characters) when multiple urban areas are defined, the UrbPop parameter specifies the population of the urban area, the optional UrbName parameter may be used to identify the name of the urban area, and the optional UrbRoughness parameter may be used to specify the urban surface roughness length. Note the UrbName must be specified if the user wants to specify the urban roughness length. A default value of 1.0 meter will be used for the urban roughness length if the UrbRoughness parameter is omitted. Beginning with version 09292, any value for the urban roughness length other than 1.0 meter will be treated as a non-regulatory option. Caution should be used when specifying a non-default urban roughness length and use of a non-default value should be clearly documented and justified. Note that the syntax of the URBANOPT keyword for single urban areas has not changed from previous versions of AERMOD, so that existing input files will not require modification.

3.2.9 Specifying the pollutant type

The POLLUTID keyword is used to identify the type of pollutant being modeled for a particular run. The syntax, type, and order of the POLLUTID keyword are summarized below:

Syntax:	CO POLLUTID Pollut (H1H or H2H or INC)
Type:	Mandatory, Non-repeatable

where the Pollut parameter may be a pollutant name of up to eight characters. Examples include SO2, NOX, CO, PM10, TSP, and OTHER. Some pollutant names, by themselves or in combination with other model options, have special meaning and will affect how AERMOD computes the final results based on the current NAAQS. The parameters H1H, H2H, and INC disable the special processing requirements associated with the 1-hr NO_2 and SO_2 NAAQS and the 24-hr PM2.5 NAAQS. Specifying one of these keywords will allow for modeling PM2.5 24-hr increments which are based on the H2H value and also allow evaluating NO_2 options in AERMOD based on incomplete years of field measurements. The pollutants names with special meaning that will affect how AERMOD computes the results include:

- PM10 (or PM-10) with the multi-year option for generating the high-sixth-high in five years (see Section 3.2.16.2),
- PM25 (or PM-2.5, PM2.5, or PM-25) (see Section 3.2.16.1),
- NO2 when computing 1-hour averages (See Sections 3.2.7 and 3.2.17),
- NO2 is required when using the OLM, PVMRM, TTRM/TTRM2, or GRSM option for simulating the conversion of NO to NO_2 (see Section 3.2.2.7),
- SO2 when computing 1-hour averages (see Sections 3.2.7 and 3.2.17),
- SO2 triggers the use of a 4-hour half-life for SO2 decay for urban applications under both the regulatory default options and non-default options(see Sections 3.2.2.1 and 3.2.10), and
- The MULTYEAR option can only be used when PM10, PM-10, PM25, PM2.5, PM-2.5, PM-25, LEAD, NO2, SO2, or OTHER is specified as the pollutant ID.

3.2.10 Modeling with exponential decay

The model provides the option to use exponential decay of the pollutant being modeled. Two keywords are available for this purpose, HALFLIFE and DCAYCOEF. The syntax, type, and order of these keywords are summarized below:

Syntax:	CO HALFLIFE Haflif CO DCAYCOEF Decay
Type:	Optional, Non-repeatable

where the Haflif parameter is used to specify the half-life for exponential decay in seconds, and the parameter Decay is used to specify the decay coefficient in units of s^{-1}. The relationship between these parameters is DECAY = 0.693/HAFLIF.

Only one of these keywords may be specified in each run. If more than one is encountered, a non-fatal warning message is generated, and the first specification is used in the modeling.

3.2.11 Flagpole receptor height option

The FLAGPOLE keyword specifies that receptor heights above local ground level (i.e., flagpole receptors) are allowed on the REceptor pathway. The FLAGPOLE keyword may also be

used to specify a default flagpole receptor height other than 0.0 meters. The syntax and type of the FLAGPOLE keyword are summarized below:

Syntax:	CO FLAGPOLE (Flagdf)
Type:	Optional, Non-repeatable

where Flagdf is an optional parameter to specify a default flagpole receptor height. If no parameter is provided, then a default flagpole receptor height of 0.0 meters is used. Any flagpole receptor heights that are entered on the Receptor pathway will override the default value but are ignored if the FLAGPOLE keyword is not present on the Control pathway, and a non-fatal warning message is generated.

3.2.12 Plume Rise from Aircraft Emissions

An ALPHA option to simulate aircraft emissions was added to AERMOD beginning with version 23132. Aircraft emissions from jet engines experience plume rise from both momentum and buoyancy but are commonly modeled as AREA and VOLUME source types in AERMOD which do not account for either momentum or buoyancy. The aircraft plume rise ALPHA option extends the formulation of AREA (including AREAPOLY, AREACIRC, and LINE) and VOLUME source types with additional input parameters based on the work of Pandey, et. al. (2023). The option can be applied to AREA (including AREAPOLY, AREACIRC, and LINE) and VOLUME source types identified as aircraft sources by specifying the primary keyword ARCFTOPT in the CO pathway. Aircraft sources are identified on the SO pathway with the primary keyword ARCFTSRC followed by a list of source IDs and/or a range of source IDs (see Section 3.3.18). The syntax for ARCFTOPT is summarized below:

Syntax:	CO ARCFTOPT (AirportID)
Type:	Optional, Non-Repeatable

Where AirportID is an optional alphanumeric character string that can be included to identify the airport at which the sources are located. The current implementation of aircraft plume rise requires that an additional seven aircraft parameters be supplied to AERMOD using an hourly varying

emissions input file. The additional aircraft parameter variables are read from the hourly emissions file by AERMOD in the following order:

- MFUEL: Fuel burn rate (g/s)
- THRUST: Aircraft thrust (newtons)
- VAA: Aircraft speed (m/s)
- AFR: Air-fuel ratio
- BYPR: Bypass ratio (> 0 for turbofan and -999 for shaft-based engines)
- RPWR: Rated power (kW) (-99999 for turbofan and > 0 for shaft-based)
- SRCANGLE: Landing/takeoff angle with the ground (degrees) (airborne sources)

Note that AERMOD will issue a fatal error if ARCFTOPT and ARCFTSRC are specified and the aircraft parameters are missing from the hourly emissions file, or if the hourly emissions file is missing altogether.

3.2.13 To run or not to run

Because of the improved error handling and the "defensive programming" that has been employed in the design of the AERMOD model, the model will read through all of the inputs in the control file regardless of any errors or warnings that may be encountered. If a fatal error occurs in processing of the control file information, then further model calculations will be aborted. Otherwise, the model will attempt to run. Because of the great many options available in the AERMOD model, and the potential for wasted resources if a large run is performed with some incorrect input data, the RUNORNOT keyword has been included on the Control pathway to allow the user to specify whether to RUN the model and perform all of the calculations, or NOT to run and only process the input control file commands and summarize the setup information. The NOT option allows the user to check the syntax of the model keywords without performing possible time-consuming model calculations. The syntax and type of the RUNORNOT keyword are summarized below:

Syntax:	CO RUNORNOT RUN or NOT
Type:	Mandatory, Non-repeatable

3.2.14 Generating an input file for EVENT processing

The EVENTFIL keyword can be included on the CO pathway to generate an input file for EVENT processing. The syntax and type of the EVENTFIL keyword are summarized below:

Syntax:	CO EVENTFIL (Evfile) (Evopt)
Type:	Optional, Non-repeatable

where the optional Evfile parameter specifies the name of the EVENT input file to be generated (the maximum length of the file name is set by the ILEN_FLD parameter in MODULE MAIN1), and the optional parameter, Evopt, specifies the level of detail to be used in the EVENT output file. Valid inputs for the Evopt parameter are the secondary keywords of SOCONT and DETAIL (see the EVENTOUT keyword on the OUtput pathway, Section 3.7.2). The default filename used if no parameters are specified is EVENTS.INP, and the default for the level of detail is DETAIL. If only one parameter is present, then it is taken to be the Evfile, and the default will be used for Evopt.

The primary difference between routine AERMOD and EVENT processing is in the treatment of source group contributions. The AERMOD model treats the source groups independently. EVENT processing is designed to provide source contributions to specific events such as the design concentrations determined from AERMOD or user specified events. The user may specify the "events" to process using the EVent pathway, which lists specific combinations of receptor location, source group, and averaging period. By specifying the EVENTFIL keyword, an input control file will be generated that can be used directly for EVENT processing. The events included in the generated EVENT processing input file are the design concentrations defined by the RECTABLE keyword and the threshold violations identified by the MAXIFILE keyword on the OU pathway.

3.2.15 The model re-start capability

The AERMOD model has an optional capability to store intermediate results into an unformatted file, so that the model run can be continued later in case of a power failure or a user interrupt. This re-start option is controlled by the SAVEFILE and INITFILE keywords on the CO pathway. The syntax and type of these keywords are summarized below:

Syntax:	CO SAVEFILE (Savfil) (Dayinc) (Savfl2) CO INITFILE (Inifil)
Type:	Optional, Non-repeatable

The SAVEFILE keyword instructs the model to save the intermediate results to a file and controls the save options. All three parameters for this keyword are optional. If the user specifies only the Savfil parameter, then the intermediate results are saved to the same file (and overwritten) each time. If the user specifies both the Savfil and the Savfl2 parameters, then the model alternates between the two files for storing intermediate results. The latter approach requires additional disk space to handle two storage files. However, selecting two files avoids potential problems like a power failure or interrupt that might occur while the temporary file is open, and the intermediate results are being copied to it. In such a case, the temporary results file would be lost.

The optional Dayinc parameter allows the user to specify the number of days between successive dumps. The default is to dump values at the end of each day, i.e., Dayinc = 1. For larger modeling runs, where the SAVEFILE option is most useful, the additional execution time required to implement this option is very small compared to the total runtime. To be most effective, it is recommended that results be saved at least every 5 days.

If no parameters are specified for the SAVEFILE keyword, then the model will store intermediate results at the end of each day using a default filename of TMP.FIL.

The INITFILE keyword works in conjunction with the SAVEFILE keyword and instructs the model to initialize the results arrays from a previously saved file. The optional parameter, Inifil, identifies the unformatted file of intermediate results to use for initializing the model. If no Inifil

parameter is specified, then the model assumes the default filename of TMP.FIL. If the file doesn't exist or if there are any errors encountered in opening the file, then a fatal error message is generated, and processing is halted.

Note: It is important to note that if both the SAVEFILE and INITFILE keywords are used in the same model run, then different filenames must be specified for the Savfil and Inifil parameters. Otherwise, the model will encounter an error in opening the files, and further processing will be halted.

3.2.16 Processing for particulate matter (PM) NAAQS

3.2.16.1 Processing for fine particulate matter (PM-2.5)

A NAAQS for fine particulate matter, with aerodynamic particle diameters of 2.5 microns or less (PM-2.5), was promulgated in 1997, and the 24-hour standard was revised in December 2006. For attainment demonstrations, the PM-2.5 standard is based on a 3-year average of the 98th percentile 24-hour average and a 3-year average of the annual mean concentration at each ambient monitor. EPA issued new recommendations in May 2014 (EPA, 2014b) regarding appropriate modeling procedures for use in modeling demonstrations of compliance with the PM2.5 NAAQS that is intended to supersede the earlier guidance issued in March 2010 (EPA, 2010a). The May 2014 guidance, which addresses the issue of secondary formation of PM2.5 due to precursor emissions, has modified the earlier guidance regarding use of the average of the first-highest 24-hour average concentrations across the number of years modeled to represent the modeled contribution for a cumulative impact assessment and recommends using the average of the eighth-highest (98th percentile) of 24-hour concentrations to represent the modeled contribution for a cumulative impact assessment. Use of the first-highest 24-hour average is still appropriate for significant contribution determinations. Note that the use of a 3-year average for monitored design values to determine attainment of the NAAQS does not preempt the requirement in Section 8.3.1.2 of the Guideline (EPA, 2024b) for use of 5 years of National Weather Service (NWS) data, and the 5-year average of modeled impacts serves as an unbiased estimate of the 3-year average for purposes of modeling demonstrations of compliance with the NAAQS.

Based on EPA's May 2014 draft recommendations, the 24-hour modeled contribution to the design value for purposes of modeling demonstrations of compliance with the PM-2.5 NAAQS is based on the highest of the eighth-highest (H8H) concentrations at each receptor, if one year of site-specific meteorological data is input to the model, or the highest of the multi-year average of the eighth-highest (H8H) concentrations at each receptor, if more than one year of meteorological data is input to the model. In other words, the model calculates the eighth-highest 24-hour concentration at each receptor for each year modeled, averages those eighth-highest concentrations at each receptor across the number of years of meteorological data, and then selects the highest, across all receptors, of the N-year averaged eighth-highest values.

Similar to the 24-hour averages, an unbiased estimate of the 3-year average annual mean is simply the annual mean, if only one year of site-specific meteorological data is input to the model, or the multi-year average of the annual means if multiple years of meteorological data are used. The annual design value for PM-2.5 is then based on the highest annual average across the receptor domain for single-year meteorological data input, or the highest of the multi-year averaged annual means across the receptor domain for multi-year meteorological data input.

The special processing of the 24-hour and annual averages for the PM-2.5 NAAQS is triggered by specifying a pollutant ID of 'PM25', 'PM-2.5', 'PM2.5' or 'PM-25' on the CO POLLUTID card. In this case, the model will compute the 24-hour and annual average design values as described in the previous paragraphs. For the PM-2.5 processing to work correctly for multiple year periods, the yearly meteorological data files can be concatenated into a single multi-year file for input into the model, or the MULTYEAR option (Section 3.2.7) can be used with separate model runs for each year. There is no requirement to remove the header records between concatenated surface meteorological data files prior to running the model, and multi-year meteorological data files can also be generated by processing multi-year inputs in AERMET. (NOTE: While the MULTYEAR option with separate yearly meteorological data files can be used to determine the modeled design values for PM2.5, the OU MAXDCONT option (see Section 3.7.2.8) to determine contributions from other source groups to the cumulative modeled design value will not work with the MULTYEAR option or with separate meteorological data files for each year.) Processing the average of the individual annual mean values across multiple years for PM-2.5 also requires use of the ANNUAL average option on the AVERTIME keyword, rather than

PERIOD average. The PERIOD option computes a single multi-year average concentration for each receptor, which may give slightly different results than the multi-year average of individual ANNUAL mean concentrations due to differences in the number of calms and/or missing data from year to year.

To comply with these processing requirements, the following restrictions are applied to the PM-2.5 NAAQS processing whenever a pollutant ID of 'PM25', 'PM2.5', 'PM-2.5' or 'PM-25' is specified on the CO POLLUTID keyword:

1. The averaging periods on the AVERTIME keyword are limited to the 24-hour and ANNUAL averages. Use of the PERIOD average or use of a short-term average other than 24-hour will result in a fatal error message being generated.

2. The FIRST (or 1ST) highest value should be requested on the RECTABLE keyword for 24-hour averages for estimating modeled PM2.5 contributions for compliance with the NAAQS. However, the model places no restriction on the ranks requested on the RECTABLE keyword since selection of ranks lower than the FIRST highest may be needed to determine whether a source or group of sources is contributing significantly to modeled violations of the NAAQS.

3. The model will only process meteorological data for periods of record that span complete years, although the meteorological data period does not need to follow calendar years (i.e., the data period does not need to start on January 1, hour 1). If the period of record spans less than one complete year of data, a fatal error message will be generated, and the model run will be unsuccessful. If additional meteorological data remains after the end of the last complete year of data, the remaining data will be ignored, and a non-fatal warning message will be generated specifying the number of hours ignored.

4. The MULTYEAR keyword on the CO pathway can be used to calculate multi-year averages for the PM-2.5 NAAQS; however, the MAXDCONT option will not work

with the MULTYEAR. Multiple year analyses are best accomplished by including the multiple years of meteorology in a single data file.

5. Since the 24-hour average design values for PM-2.5 analyses, based on the H1H averaged over N years, may consist of averages over a multi-year period, they are not compatible with the EVENT processor, and the high ranked values generated based on the RECTABLE keyword will not be included in the EVENTFIL. However, if the MAXIFILE option is used to output 24-hour averages exceeding a user-defined threshold, these individual exceedances may be used with the EVENT processor. Therefore, if the EVENTFIL option is used without the MAXIFILE option for PM-2.5 analyses, a non-fatal warning message will be generated, and the EVENTFIL option will be ignored.

3.2.16.2 Processing for particulate matter of 10 microns or less (PM-10)

The 24-hour NAAQS for particulate matter with aerodynamic particle diameters of 10 microns or less (PM-10) is in the form of an expected exceedance value, which cannot be exceeded more than once per year on average over a three-year period for purposes of monitored attainment demonstrations. Modeling demonstrations of compliance with the PM-10 NAAQS are based on the High-*N*+*1*-High value over *N* years, or in the case of five years of NWS meteorological data, the High-6th-High (H6H) value over five years. In the AERMOD model, the H6H 24-hour average over five years can be modeled in one of two ways: 1) running five individual years and combining the results using the CO MULTYEAR option, as described above in Section 3.2.7) using a single five-year meteorological data file and specifying the SIXTH (or 6TH) highest value on the OU RECTABLE card. If applied properly, the 24-hour average results of these two approaches will be equivalent. The special processing consisting of the 99th percentile 24-hour value averaged over *N* years for PM-10 in versions of AERMOD prior to 09292, referred to as the "Post-1997" PM-10 option, has been removed since that standard was vacated.

3.2.17 Processing for 1-hour NO_2 and SO_2 NAAQS

New 1-hour NAAQS for NO_2 and SO_2 were promulgated in February 2010 and June 2010, respectively. EPA has issued guidance related to dispersion modeling in support of these 1-hour

standards (EPA, 2010b; EPA, 2010c; EPA, 2011; EPA, 2014a; and EPA, 2017). The form of these 1-hour standards is similar, based on a percentile rank from the annual distribution of daily maximum 1-hour values, averaged across the number of years processed. For the 1-hour NO_2 standard, the modeled design value is based on the 98^{th}-percentile of the daily maximum 1-hour values, which is represented by the eighth highest of the daily maximum 1-hour values across the year. The 1-hour SO_2 modeled design value is based on the 99^{th}-percentile, or fourth highest, of the daily maximum 1-hour values across the year. For typical multi-year modeling analysis based on 5 years of NWS meteorological data, the modeled design value is the 5-year average of the eighth-highest values daily maximum 1-hour values for NO_2, or fourth-highest values for SO_2.

The form of these 1-hour standards complicates the process of determining the modeled design value as well as the analyses that may be required to determine whether a particular source or group of sources contributes significantly to any modeled violations of the standards, paired in time and space. Several enhancements have been incorporated into AERMOD, beginning with version 11059, to facilitate the modeling analyses required to demonstrate compliance with these new standards. These enhancements are described in Section 3.7.2. The ability of the model to exercise these options is facilitated by specifying 'NO2' or 'SO2' as the pollutant ID on the CO POLLUTID keyword, with the following restrictions. Whenever a pollutant ID of 'NO2' or 'SO2' is specified and 1-hour averages are selected, the options to calculate 1-hour NO_2 or SO_2 design values based on the distribution of daily maximum 1-hour values will be allowed, unless short-term averaging periods other than 1-hour are also specified on the AVERTIME keyword. If other short-term averages are specified, non-fatal warning messages will be generated and the options for processing 1-hour NO_2 or SO_2 design values will be disabled. In that case, the 1-hour modeled design values will be processed the same as other short-term averages, based on the overall distribution of hourly values. Also, if ANNUAL or PERIOD averages are specified on the AVERTIME keyword along with 1-hour averages, a non-fatal warning message will be generated unless the CO MULTYEAR keyword is specified, since the annual NAAQS for NO_2 and SO_2 is based on the highest PERIOD or ANNUAL average from an individual year, rather than an average across the years modeled. However, the special processing based on daily maximum1-hour values will be still applied for the 1-hour averages in these cases since the ANNUAL or PERIOD averages may be appropriate if only 1 year of site-specific meteorological data is modeled.

Modeling 1-hour ‘SO2’ or ‘NO2’ for less than a full year without specifying additional short-term averaging periods will result in an error during processing since AERMOD attempts to generate a 1-hour value based on the form of the SO_2 or NO_2 1-hour standard. When modeling with a dataset that contains less than a full year of data or by restricting the days or hours that are modeled using the STARTEND or DAYRANGE keywords on the ME pathway, the NOCHKD option should be specified on the CO pathway along with the MODELOPT keyword to avoid an error during the processing phase (Refer to sections 3.2.2 and 3.5.4 for information on the use of the NOCHKD option and the STARTEND and DAYRANGE keywords).

3.2.18 Debugging output options

The DEBUGOPT keyword on the CO pathway allows the user to request detailed files of intermediate calculation results for debugging purposes. There are several types of debug information that AERMOD can generate. For each type specified, the user can also specify a filename of the file to which the debug output should be written. Filenames are optional except for DEPOS debug. If omitted, AERMOD will use a default filename. The syntax and type of the DEBUGOPT keyword are summarized below. Listed are the debug types and filename pairs. While multiple types of debugging information can be specified, note that there are some related types in which case only one type within the group can be specified:

Syntax:	CO DEBUGOPT MODEL (Dbgfil)	and/or
	METEOR (Dbmfil)	and/or
	PRIME (Prmfil)	and/or
	AWMADW (AwmaDwfil)	and/or
	PLATFORM (PlatfmDbgfil)	and/or
	DEPOS	and/or
	[AREA (AreaDbFil) or LINE (LineDbFil)**]**	and/or
	RLINE (RlineDbgFil)	and/or
	BLPDBUG (BLPDbFil)	and/or
	URBANDB (UrbanDbFil)	and/or
	[PVMRM (Dbpvfil) (and TTRM2)	or
	OLM (OLMfil) (and TTRM2)	or
	ARM2 (ARM2fil) (and TTRM2)	or
	TTRM (TTRMfil)	or
	GRSM (GRSMfil)**]**	and/or
	SWPOINT (SWfil)	and/or
	HBPDBG (HBPfil)	and/or
	AIRCRAFT (DbARCFTfil)	and/or
	SBARRIER (SBARDbgFil)	and/or
	BAREDGE (BarEdgDbgFil)	and/or
	VBARRIER (VBARDbgFil)	
Type:	Optional, Non-repeatable	

where the types of debug information and optional filename references include:

- MODEL (Dbgfil): Model type debug data. Default filename: MODEL.DBG.
- METEOR (Dbmfile): Meteorological profile data. Default filename: METEOR.DBG.
- PRIME (Prmfil): PRIME downwash debug data. Default filename: PRIME.DBG.
- AWMADW (Awmafil): AWMA downwash debug data. Default filename: AWMADW.DBG
- PLATFORM (PlatfmDbgfil): Platform downwash debug file. Default filename: PLATFORM.DBG
- DEPOS: Deposition debug information. Only default filenames will be used: GDEP.DAT for gas deposition and PDEP.DAT for particle deposition. If the MODEL debug option is not chosen, a debug file containing wet deposition debug information is also created called DEPOS.DBG. If the MODEL debug option is chosen with the DEPOS debug option, the wet deposition debug information is included in the model debug file.
- AREA (AreaDbFil) **or** LINE (LineDbFil): Area or Line source debugging data (including OPENPIT). May only specify one. Default filename: AREA.DBG (same default filename used for AREA, LINE, and OPENPIT sources)

- RLINE (RlineDbgFil): RLINE and RLINEXT source type debug file. Default filename: RLINE.DBG
- BLPDBUG (BLPDbFil): Debug information for the BUOYLINE source. Default filename: BLPDBUG.DBG
- URBANDB (UrbanDbFil): Debug information for the urban option (URBANOPT, see Section 3.2.8). This will produce three output files, one for the surface meteorology, two for the profile meteorology. If the filename is specified by the user, then the filename will be used for the surface meteorology debug file. The same name will be assigned for the two profile debug files with a "1" and "2" appended to the filename, respectively. Default filenames: URBDBUG.DBG, URBDBUG1.DBG, and URBDBUG2.DBG.
- PVMRM (Dbpvfil) (and TTRM2) **or** OLM (OLMfil) (and TTRM2) **or** ARM2 (ARM2fil) (and TTRM2) **or** TTRM (TTRMfil) **or** GRSM (GRSMfil): NO to NO_2 conversion debug data. Default filenames: PVMRM.DBG, OLM.DBG, ARM2.DBG, TTRM.DBG, GRSM.DBG, respectively. May only specify one of PVMRM, OLM, ARM2, TTRM, or GRSM debug options, consistent with the NO_2 conversion option specified with the MODELOPT keyword. The TTRM2 debug option can be paired with PVMRM, OLM, or ARM2 debug options when both options are specified with the MODELOPT keyword. A user-defined filename cannot be specified for the TTRM2 debug option. The TTRM2 debug option will generate three separate debug files named AFTER_TTRM.DBG, AFTER_*option*.DBG, and TTRM2_MERGE.DBG, where *option* is the NO_2 conversion option with which TTRM2 is paired. (e.g., AFTER_PVMRM.DBG).
- SWPOINT (SWfil): Sidewash point source type debug information and optional debug filename. Default filename: SWPOINT.DBG
- HBPDBG (HBPfil): Debug information for HBP option and optional debug filename. Default filename: HBP_DEBUG.DBG.
- AIRCRAFT (DbARCFTfil): Debug information for the aircraft plume rise option (ARCFTOPT) and optional debug filename. Default filename: AIRCRAFT.DBG.
- SBARRIER (SBARDbgFil): SBARRIER RLINE barrier processing debug output. Default filename: SBARRIER.DBG.
- BAREDGE (BarEdgDbgFil): BAREDGE RLINE barrier processing debug output. Default filename: BAREDGE.DBG.
- VBARRIER (VBARDbgFil): VBARRIER RLINE barrier processing debug output. Default filename: VBARRIER.DBG.

CAUTION!! Use the DEBUGOPT keyword with extreme CAUTION: it can produce very large files! Note that the model will overwrite the debug files, without warning, if they already exist.

3.2.19 Detailed error listing file

The ERRORFIL keyword on the CO pathway allows the user to request a detailed listing file of all the messages generated by the model. This includes the error and warning messages that are listed as part of the message summaries provided in the main output file and any informational messages (such as occurrences of calm winds) and quality assurance messages that are generated. The syntax and type of the ERRORFIL keyword are summarized below:

Syntax:	CO ERRORFIL (Errfil)
Type:	Optional, Non-repeatable

where the Errfil parameter is the name of the detailed message file. If the optional Errfil parameter is left blank, then the model will use a default filename of ERRORS.LST. A complete description of the error and other types of messages generated by the model is provided in APPENDIX B.

3.3 Source pathway inputs and options

The **SO**urce pathway contains the keywords that define the source information for a particular model run. The model currently handles six source types identified as point, volume, area sources (including non-buoyant line and open pit sources), non-buoyant line (e.g., roadway sources), buoyant line sources, and a newly added source type to research the sidewash effect from building downwash when the winds are oblique to the face of a building. The input parameters vary depending on the source type. For point sources, the user can also identify building dimensions for nearby structure that cause aerodynamic downwash influences on the source. The user can also identify groups of sources for which the model will combine the results.

The LOCATION keyword, which identifies the source type and location, must be the first keyword entered for each source. In general, the order of keywords is not important. However, there are some exceptions such as, the SRCGROUP keyword must be the last keyword before the SO FINISHED keyword unless the PSDCREDIT keyword is specified on the MODELOPT card, in which case SRCGROUP is replaced with the PSDGROUP keyword. Additional exceptions are discussed in the sections specific to applicable keywords. The user may group all the LOCATION cards together, then group the source parameter cards together, or they may want to group all input

cards for a particular source together. All sources are given a source ID by the user, which is used to link the source parameter inputs to the correct source or sources. The source ID can be any alphanumeric string of up to 12 characters.

The number of sources is allocated dynamically at the time AERMOD is run. This value, in concert with the other dynamically allocated arrays and input requirements, is limited only by the amount of available memory.

3.3.1 Identifying source types and locations

The LOCATION keyword is used to identify the source type and the location of each source to be modeled. The LOCATION card must be the first card entered for each source since it identifies the source type and dictates which parameters are needed and/or accepted. The syntax, type and order of the LOCATION keyword are summarized below:

Syntax:	**When Srctyp = POINT, POINTHOR, POINTCAP, VOLUME, AREA, AREAPOLY, AREACIRC, OPENPIT, or SWPOINT** SO LOCATION Srcid Srctyp Xs Ys (Zs) **When Srctyp = LINE, RLINE, or BUOYLINE** SO LOCATION Srcid Srctyp Xs1 Ys1 Xs2 Ys2 (Zs) **When Srctyp = RLINEXT** SO LOCATION Srcid Srctyp Xs1 Ys1 Zs1 Xs2 Ys2 Zs2 (Zs)
Type:	Mandatory, Repeatable
Order:	Must be first card for each source input

where the Srcid parameter is the alphanumeric source ID defined by the user (up to 12 characters), Srctyp is the source type, which is identified by one of the secondary keywords - POINT, POINTHOR, POINTCAP, VOLUME, AREA, AREAPOLY, AREACIRC, OPENPIT, LINE, RLINE, RLINEXT, BUOYLINE, or SWPOINT. Xs and Ys, are the x and y coordinates of the source location in meters for POINT, POINTHOR, POINTCAP, VOLUME, AREA, AREAPOLY, AREACIRC, OPENPIT, and SWPOINT source types. For the LINE and RLINE source type, Xs1 and Ys1 are the x and y coordinates for the midpoint of one end of the LINE or RLINE source while Xs2 and Ys2 are the x and y coordinates for the midpoint of the other end of the LINE or RLINE source. For the RLINEXT source type, Zs1 and Zs2 are the release heights for the

endpoints of the source. For the OPENPIT source type, Zs is the elevation at the top of the pit, and the effective depth is calculated based on the lateral dimensions and volume of the pit.

Beginning with version 19191, the RLINE and RLINEXT source types were added to the SO pathway for roadway sources. Beginning with AERMOD version 24142, the RLINE source type was updated to a regulatory option while the RLINEXT source type is an ALPHA option and requires the ALPHA keyword with the MODELOPT keyword. The original implementation of RLINE and RLINEXT was based on the numerical integration and algorithms in the Research LINE-source model, version 1.2, for near-surface releases (Snyder et al., 2013). The implementation has since been updated to better harmonize the RLINE and RLINEXT source types with AERMOD similar to the POINT, AREA, and VOLUME source types as described in EPA's related TSD (EPA, 2023). The R-LINE model was formulated for flat terrain, and the original implementation in AERMOD required terrain to be specified as FLAT. Beginning in AERMOD version 23132, RLINE/RLINEXT can account for elevated terrain; however, when modeling for project level transportation conformity and hot-spot analyses, refer to the EPA's Office of Transportation and Air Quality (OTAQ) for the most up-to-date guidance on how to model roadway sources (https://www.epa.gov/state-and-local-transportation/project-level-conformity-and-hot-spot-analyses).

RLINEXT sources require the user to input the offset distance from road centerline, number of lanes, width per lane and initial vertical dispersion for each specified road link. These parameters are discussed in more detail in Section 3.3.2.10. Also, refer to the user's guide for R-LINE Model Version 1.2 (Snyder and Heist, 2013) and EPA's 2023 TSD (EPA, 2023) for detailed information about the original formulation of the RLINE source algorithms as well as the reformulation beginning in AERMOD version 23132.

Beginning with version 15181, the BUOYLINE source type was added to the SO pathway for buoyant line sources. The current implementation is based on the buoyant line source algorithm in the Buoyant Line and Point Source (BLP) dispersion model (Schulman and Scire, 1980) with very little modification and similar limitations. A buoyant line source is, comprised of one or multiple lines. Multiple lines are assumed to be parallel, though each line can have a different length, height, and base elevation. AERMOD will check to see if the lines in a single source are

parallel, within a 5° tolerance, to the first line in the source. If an individual buoyant line exceeds the tolerance, AERMOD will issue a warning message, but will continue the model run. The BUOYLINE source type also requires the user to input average values of length, width, height, and separation distance for the set of lines that comprise the buoyant line source. These parameters are discussed in more detail in Section 3.3.2.11. Refer to the BLP user's guide (Schulman and Scire, 1980) for detailed information about the formulation of the buoyant line source algorithm.

Beginning with version 22112, the SWPOINT source type was added to the SO pathway as a research tool to study the sidewash effects of the recirculation cavity that forms on the lee side a building and shifts laterally when the wind is oblique to the face of the building. The SWPOINT source has been added for continued research and development and requires the ALPHA secondary keyword as a model option using the MODELOPT keyword on the CO pathway.

For the BUOYLINE source, the definitions of Xs1, Ys1, Xs2, and Ys2 are similar to the definitions for the LINE source, but there is a subtle difference due to the current implementation of the buoyant line source algorithm in AERMOD. When specifying a buoyant line source, the LOCATION keyword and parameters should be repeated for each individual line that comprises the buoyant line source. BUOYLINE should be specified as the source type (Srctyp), and each line should be given a unique source ID (Srcid). **Note that the order that the individual lines are entered using the LOCATION keyword in the control file is important.** Again, as in BLP, AERMOD assumes all of the buoyant lines are parallel. As noted above, AERMOD performs a check to see if the lines are within an allowable tolerance, currently 5°, and issues a warning message if a line exceeds this tolerance. For lines that are not oriented exactly north-south but are angled either southeast-to-northwest or southwest-to-northeast, the individual lines should be entered in the order of there location from south to north. In other words, the southernmost line should be defined first in the control file, followed by the adjacent line to the north and so on, ending with the northernmost line. For an individual line, the most westerly endpoint should be entered first followed by the easterly endpoint where Xs1 and Ys1 are the x and y coordinates of the most westerly endpoint of the line, and Xs2 and Ys2 are the x and y coordinates of the most easterly endpoint of the line. Zs is the optional elevation of the source above sea-level and is applicable for all source types.

In the case where the buoyant lines are parallel to the Y axis, the order that the lines should be entered depends on which endpoint is entered first, the southern or northern endpoint of the lines. **If the southern endpoint is entered first, the lines should be entered in the order of the eastern most line to the western most line. If the northern endpoint is entered first, lines should be ordered west to east.** The convention used for the first line should be used for all subsequent lines.

The three area source types (AREA, AREACIRC, and AREAPOLY), as well as the LINE source type use the same numerical integration algorithm for estimating impacts from area sources and are merely different options for specifying the shape of the area source. The AREA source keyword may be used to specify a rectangular-shaped area source with arbitrary orientation; the AREAPOLY source keyword may be used to specify an area source as an irregularly shaped polygon of up to 20 sides; and the AREACIRC source keyword may be used to specify a circular-shaped area source (modeled as an equal-area polygon of 20 sides). The LINE source type option allows users to specify line-type sources based on a start point and end point of the line and the width of the line, as an alternative to the current AREA source type for rectangular sources. The LINE source type utilizes the same routines as the AREA source type and will give identical results for equivalent source inputs. The LINE source type also includes an optional initial sigma-z parameter on the SRCPARAM keyword to account for initial dilution of the emissions. AREA, AREAPOLY, AREACIRC, LINE, and OPENPIT source types do not, by default, include the horizontal meander component in AERMOD. AREAMNDR was added in 23132 as an ALPHA option on the CO pathway which incorporates meander into the AREA, AREAPOLY, AREACIRC, and LINE sources if specified. Since the LINE source type utilizes the AREA source algorithms, the runtime optimizations associated with the FASTAREA option will also apply to LINE sources if included. The AREAMNDR option will not add meander to the AREA, AREAPOLY, AREACIRC, or LINE sources if the FASTAREA option has been included.

RLINE and RLINEXT source types use the numerical integration algorithms described in Snyder et. al. 2013, intended mainly for roadway sources. Beginning with version 19191, the RLINE and RLINEXT source types were added as an option to the SO pathway. Initial sigma-z (vertical dispersion/dilution) and width are specified using the SRCPARAM keyword on the SO pathway for an RLINE and RLINEXT source. The RLINEXT source requires an additional

distance from the centerline parameter on the SRCPARAM keyword, used in the barrier and depressed roadway algorithms. The RLINE and RLINEXT source types contain a horizontal meander component for roadway sources.

The OPENPIT source algorithm can be used to model particulate or gaseous emissions from open pits, such as surface coal mines and rock quarries. The OPENPIT algorithm uses an effective area for modeling pit emissions, based on meteorological conditions, and then utilizes the numerical integration area source algorithm to model the impact of emissions from the effective area sources. A complete technical description of the OPENPIT source algorithm is provided in the ISC3 Model User's Guide - Volume II (EPA, 1995b).

Note that the source elevation, Zs, is an optional parameter. If the default option to include elevated terrain effects is used and the source elevation is omitted, a warning message will be generated, and the source elevation will be given a value of 0.0. The source elevation is not used by the model if the non-default FLAT terrain option is used. While the default units of Zs are meters, the user may also specify source elevations to be in feet by adding the SO ELEVUNIT FEET card immediately following the SO STARTING card. The x (east-west) and y (north-south) coordinates are for the center of the source for POINT, POINTHOR, POINTCAP, VOLUME, AREACIRC, SWPOINT sources, for one of the vertices of the source for AREA, AREAPOLY, and OPENPIT sources, and the endpoints for RLINE, RLINEXT, and BUOYLINE sources. The source coordinates may be input as Universal Transverse Mercator (UTM) coordinates or may be referenced to a user-defined origin.

Certain types of non-buoyant line sources can be handled in AERMOD using a string of volume sources, an elongated area source, or a roadway source. The volume source algorithms are most applicable to line sources with some initial plume depth, such as conveyor belts and rail lines. Section 1.2.2 of the ISC Model User's Guide - Volume II (EPA, 1995b) provides technical information on how to model a line source with multiple volume sources. The use of the AERMOD area source algorithm for elongated rectangles would be most applicable to near ground level line sources, such as a viaduct. The area source algorithm is applied identically to both AREA and LINE source types and AERMOD should produce the same results for an elongated area source defined as either an AREA or LINE source type.

The source ID entered on the LOCATION card identifies that source for the remainder of the SO pathway inputs. Since the model accepts alphanumeric strings of up to 12 characters for the source ID, the sources can be identified with descriptive names, such as STACK1, STACK2, BOILER3, SLAGPILE, etc. This may also be useful if line sources are modeled as multiple volume or areas, as discussed above. Since they are part of the same physical source, they can be given names that will identify them as being related, such as LINE1A, LINE1B, LINE1C, etc.

It should be noted that not all NO_2 conversion options have been implemented for all source types in AERMOD. Table 3-2 summarizes which NO_2 conversion options have been implemented for each of the AERMOD source types and which options have not.

3.3.2 Specifying source release parameters

The main source parameters are input on the SRCPARAM card, which is a mandatory keyword for each source being modeled. Since the input parameters vary depending on the source type, the different source types handled by the AERMOD model are discussed separately.

3.3.2.1 POINT, POINTHOR, and POINTCAP source inputs

The AERMOD POINT source algorithms are used to model releases from stacks and isolated vents, as well as other kinds of sources. The syntax, type and order for the SRCPARAM card for POINT, POINTHOR, and POINTCAP sources are summarized below:

Syntax:	SO SRCPARAM Srcid Ptemis Stkhgt Stktmp Stkvel Stkdia
Type:	Mandatory, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Ptemis - point emission rate in g/s,
Stkhgt - release height above ground in meters,
Stktmp - stack gas exit temperature in degrees K,
Stkvel - stack gas exit velocity in m/s, and

Stkdia - stack inside diameter in meters.

An example of a valid SRCPARAM input card for a point source is given below:

```
SO SRCPARAM     STACK1     16.71   35.0    444.0   22.7    2.74
```

where the source ID is STACK1, the emission rate is 16.71 g/s, the release height is 35.0 m, the exit temperature is 444.0 K, the exit velocity is 22.7 m/s, and the inside stack diameter is 2.74 m. All the parameters must be present on the input card.

If a value of 0.0 is input for the exit temperature, AERMOD will adjust the exit temperature for each hour to match the ambient temperature. This option allows the user to model a plume that is released at ambient temperature. The user may also model a plume with an exit temperature that exceeds the ambient temperature by a fixed amount by entering a negative value for exit temperature equal in magnitude to the temperature difference. The model will add the absolute value of a negative exit temperature to the ambient temperature for each hour to obtain the exit temperature used in computing the buoyancy flux of the plume. The AERMOD model does not include algorithms to model plumes that are released at temperatures below ambient temperature. Such releases should be modeled with a dense gas model.

AERMOD model uses direction-specific building dimensions for POINT, POINTHOR, and POINTCAP sources subject to building downwash. Building dimensions for these source types are entered on the BUILDHGT, BUILDWID, BUILDLEN, XBADJ, and YBADJ cards described below in Section 3.3.9. Offshore platform dimensions for these source types are entered for each source ID using the PLATFORM keyword as described below in Section 3.3.16.

3.3.2.2 VOLUME source inputs

The AERMOD VOLUME source algorithms are used to model releases from a variety of industrial sources, such as building roof monitors, multiple vents, and conveyor belts. Beginning with AERMOD version 23132, the input parameters for VOLUME (and AREA) source types were expanded to characterize aircraft emissions to account for the effects of buoyancy and momentum (see Section 3.2.12). The additional parameters are required to be input as hourly data in the hourly

emissions file (see Section 3.3.12). Thus, aircraft sources can only be modeled as a VOLUME source using an hourly emissions file that includes the non-aircraft VOLUME source parameters described in Section 3.3.12, as well as the extended set of parameters required to characterize the aircraft source as a VOLUME source as described in Section 3.3.12. The syntax, type, and order for the SRCPARAM card for VOLUME sources are summarized below:

Syntax:	SO SRCPARAM Srcid Vlemis Relhgt Syinit Szinit
Type:	Mandatory, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Vlemis - volume emission rate in g/s,
Relhgt - release height (center of volume) above ground, in meters,
Syinit - initial lateral dimension of the volume in meters, and
Szinit - initial vertical dimension of the volume in meters.

Table 3-3, which is explained in more detail in Section 1.2.2 of the ISC Model User's Guide - Volume II, summarizes the suggested procedures to be used for estimating the initial lateral and vertical dimensions for various types of volume and line sources.

Table 3-3. Summary of Suggested Procedures for Estimating Initial Lateral Dimensions σyo and Initial Vertical Dimensions σzo for Volume and Line Sources

Type of Source		Procedure for Obtaining Initial Dimension
(a) Initial Lateral Dimension (σ_{yo})		
Single Volume Source	σ_{yo} =	length of side divided by 4.3
Line Source Represented by Adjacent Volume Sources (see Figure 1-8 (a) in EPA, 1995a)	σ_{yo} =	length of side divided by 2.15
Line Source Represented by Separated Volume Sources (see Figure 1-8(b) in EPA, 1995a)	σ_{yo} =	center to center distance divided by 2.15

(b) Initial Vertical Dimension (σ_{zo})		
Surface-Based Source ($h_e \sim 0$)	σ_{zo} =	vertical dimension of source divided by 2.15
Elevated Source ($h_e > 0$) on or Adjacent to a Building	σ_{zo} =	building height divided by 2.15
Elevated Source ($h_e > 0$) not on or Adjacent to a Building	σ_{zo} =	vertical dimension of source divided by 4.3

3.3.2.3 AREA source type

The AERMOD area source algorithm is used to model low level or ground level releases with no plume rise (e.g., storage piles, slag dumps, and lagoons). The AERMOD model uses a numerical integration approach for modeling impacts from area sources. When the FASTAREA or FASTALL option is specified, the area source integration routine is optimized to reduce model runtime. This is accomplished by incorporation of a three-tiered approach using the Romberg numerical integration, a 2-point Gaussian Quadrature routine for numerical integration, or a point source approximation based on the location of the receptor relative to the source. In the regulatory default mode, the Romberg numerical integration is utilized for all receptors.

The AERMOD model includes various options for specifying the shape of an area source: the AREA source type may be used to specify rectangular areas that may also have a rotation angle specified relative to a north-south orientation; the LINE source type is a simplified representation of an elongated area source and does not utilize a rotation angle; the AREAPOLY source type may be used to specify an area source as an irregularly-shaped polygon; the AREACIRC source keyword may be used to specify a circular-shaped area source (modeled as an equal-area polygon); and the OPENPIT source type can be used to model open rectangular pits such as surface coal mines and rock quarries. The OPENPIT source type also includes an optional rotation angle. The source parameter inputs for each of the area source types is described below.

3.3.2.4 AREA source inputs

The rotation angle for rectangular AREA sources is specified relative to the vertex used to define the source location on the SO LOCATION card (e.g., the southwest corner). The syntax, type and order for the SRCPARAM card for AREA sources are summarized below:

Syntax:	SO SRCPARAM Srcid Aremis Relhgt Xinit (Yinit) (Angle) (Szinit)
Type:	Mandatory, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Aremis - area emission rate in g/(s-m^2),

Relhgt - release height above ground in meters,

Xinit - length of X side of the area (in the east-west direction if Angle is 0 degrees) in meters,

Yinit - length of Y side of the area (in the north-south direction if Angle is 0 degrees) in meters (optional),

Angle - orientation angle for the rectangular area in degrees from North, measured positive in the clockwise direction (optional), and

Szinit - initial vertical dimension of the area source plume in meters (optional).

It should be noted that the emission rate for the AREA source is an emission rate per unit area, which is different from the point and volume source emission rates, which are total emissions for the source.

If the optional Yinit parameter is omitted, then the model assumes that the area is a square, i.e., Yinit = Xinit. If the optional Angle parameter is omitted, then the model assumes that the area is oriented in the north-south and east-west directions, i.e., Angle = 0.0. If the Angle parameter is input, and the value does not equal 0.0, then the model will rotate the area clockwise around the

vertex defined on the SO LOCATION card for this source. Figure 3-2 illustrates the relationship between the Xinit, Yinit, and Angle parameters and the source location, (Xs,Ys), for a rotated rectangle. The Xinit dimension is measured from the side of the area that is counterclockwise along the perimeter from the vertex defined by (Xs,Ys), while the Yinit dimension is measured from the side of the area that is clockwise from (Xs,Ys). The Angle parameter is measured as the orientation relative to North of the side that is clockwise from (Xs,Ys), i.e., the side with length Yinit. The Angle parameter may be positive (for clockwise rotation) or negative (for counterclockwise rotation), and a warning message is generated if the absolute value of Angle is greater than 180 degrees. The selection of the vertex to use for the source location is not critical, as long as the relationship described above for the Xinit, Yinit, and Angle parameters is maintained.

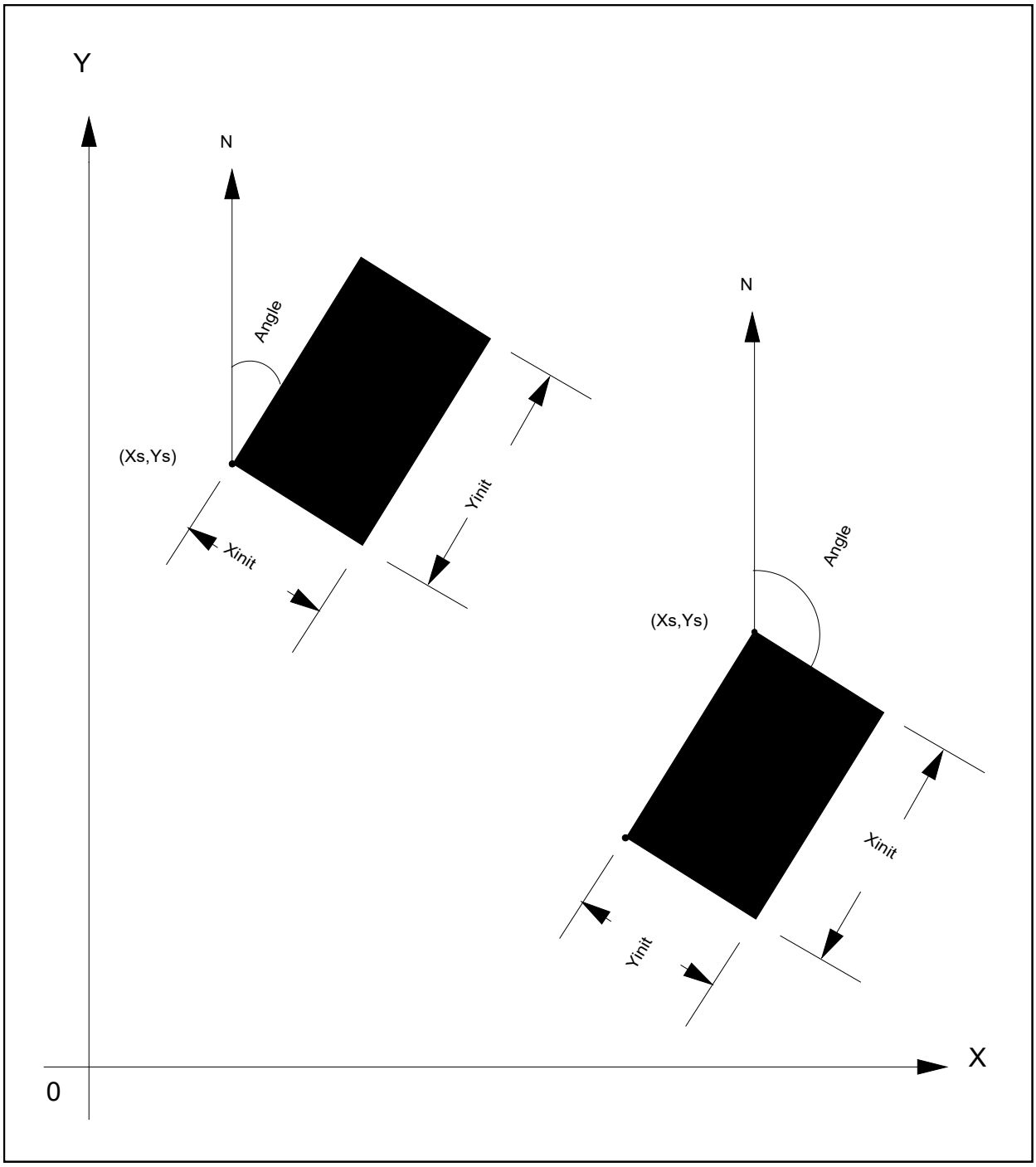


Figure 3-2. Relationship of Area Source Parameters for Rotated Rectangle

By making the Yinit and Angle parameters optional, the area source input data for the previous versions of the ISC model can be used with the AERMOD model. The aspect ratio (i.e., length/width) for area sources should generally be less than about 100 to 1. If this is exceeded, then the model will generate a non-fatal warning message, and the user should consider subdividing the area to achieve a 100 to 1 aspect ratio (or less) for all subareas.

The optional Szinit parameter may be used to specify an initial vertical dimension to the area source plume, similar to the use of the Szinit parameter for volume sources. This parameter may be important when the area source algorithm is used to model mechanically generated emission sources, such as mobile sources. In these cases, the emissions may be turbulently mixed near the source by the process that is generating the emissions and therefore occupy some initial depth. For more passive area source emissions, such as evaporation or wind erosion, the Szinit parameter may be omitted, which is equivalent to using an initial sigma-z of zero.

An example of a valid SRCPARAM input card for a rectangular area source is given as

SO SRCPARAM	SLAGPILE	0.0015	5.0	50.0	100.0	30.0

where the source ID is SLAGPILE, the emission rate is 0.0015 g/(s-m^2), the release height is 5.0 m, the X-dimension is 50.0 m, the Y-dimension is 100.0 m, and the orientation angle is 30.0 degrees clockwise from North.

Since the numerical integration algorithm can handle elongated areas with aspect ratios of up to 100 to 1, the AERMOD area source algorithm may be useful for modeling certain types of line sources. Users now have the option of specifying a line-type source as either AREA or LINE. There are no restrictions on the placement of receptors relative to area sources for the AERMOD model. Receptors may be placed within the area and at the edge of an area. The AERMOD model will integrate over the portion of the area that is upwind of the receptor. However, since the numerical integration is not performed for portions of the area that are closer than 1.0 meter upwind of the receptor, caution should be used when placing receptors within or adjacent to areas that are less than a few meters wide. More technical information about the application of the AERMOD

area source algorithm is provided in Sections 1.2.3 and 2.2.3 of the ISC Model User's Guide - Volume II (EPA, 1995b).

Beginning with AERMOD version 23132, the input parameters for AREA (and VOLUME) source types were expanded to characterize aircraft emissions to account for the effects of buoyancy and momentum (see Section 3.2.12). The additional parameters are required to be input as hourly values in the hourly emission rate file (see Section 3.3.12). Thus, aircraft sources can only be modeled using an hourly emissions file that that includes the standard non-aircraft AREA source parameters described in Section 3.3.12, as well as the extended set of parameters required to characterize the aircraft source as an AREA source as described in Section 3.3.12.

3.3.2.5 AREAPOLY source inputs

The AREAPOLY source type may be used to specify an area source as an arbitrarily- shaped polygon. This source type option provides the user with considerable flexibility for specifying the shape of an area source. The syntax, type and order for the SRCPARAM card for AREAPOLY sources are summarized below:

Syntax:	SO SRCPARAM Srcid Aremis Relhgt Nverts (Szinit)
Type:	Mandatory, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Aremis - area emission rate in g/(s-m^2),

Relhgt - release height above ground in meters,

Nverts - number of vertices (or sides) of the area source polygon,

Szinit - initial vertical dimension of the area source plume in meters (optional).

As with AREA sources, the emission rate for the source is an emission rate per unit area, which is different from the point and volume source emission rates, which are total emissions for the source. The locations of the vertices are specified by use of the AREAVERT keyword, which applies only to AREAPOLY sources. The syntax, type and order for the AREAVERT keyword used for AREAPOLY sources are summarized below:

Syntax:	SO AREAVERT Srcid Xv(1) Yv(1) Xv(2) Yv(2) ... Xv(i) Yv(i)
Type:	Mandatory for AREAPOLY sources, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Xv(i) and Yv(i) are the x-coordinate and y-coordinate values of the vertices of the area source polygon. There must be Nverts pairs of coordinates for the area source, where Nverts is the number of vertices specified for that source on the SRCPARAM card. The first vertex, Xv(1) and Yv(1), must also match the coordinates given for the source location on the LOCATION card, Xs and Ys. The remaining vertices should be defined in either a clockwise or counter-clockwise order from the point used for defining the source location.

Receptors may be placed within the area and at the edge of an area. The AERMOD model will integrate over the portion of the area that is upwind of the receptor. However, since the numerical integration is not performed for portions of the area that are closer than 1.0 meter upwind of the receptor, caution should be used when placing receptors within or adjacent to areas that are less than a few meters wide.

3.3.2.6 AREACIRC source inputs

The AREACIRC source type may be used to specify an area source as a circular shape. The model will automatically generate a regular polygon to approximate the circular area source. The polygon will have the same area as that specified for the circle. The syntax, type and order for the SRCPARAM card for AREACIRC sources are summarized below:

Syntax:	SO SRCPARAM Srcid Aremis Relhgt Radius (Nverts) (Szinit)
Type:	Mandatory, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Aremis - area emission rate in g/(s-m^2),
Relhgt - release height above ground in meters,
Radius - radius of the circular area in meters,
Nverts - number of vertices (or sides) of the area source polygon to approximate a circle (optional, 20 sides will be used if omitted),
Szinit - initial vertical dimension of the area source plume in meters (optional).

As with AREA sources, the emission rate for the source is an emission rate per unit area, which is different from the point and volume source emission rates, which are total emissions for the source.

3.3.2.7 OPENPIT source inputs

The AERMOD model accepts rectangular pits with an optional rotation angle specified relative to a north-south orientation and the vertex used to define the source location on the SO LOCATION card (e.g., the southwest corner). The syntax, type and order for the SRCPARAM card for OPENPIT sources are summarized below:

Syntax:	SO SRCPARAM Srcid Opemis Relhgt Xinit Yinit Pitvol (Angle)
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Opemis - open pit emission rate in g/(s-m^2),

Relhgt - average release height above the base of the pit in meters,

Xinit - length of X side of the open pit (in the east-west direction if Angle is 0 degrees) in meters,

Yinit - length of Y side of the open pit (in the north-south direction if Angle is 0 degrees) in meters,

Pitvol - volume of open pit in cubic meters, and

Angle - orientation angle for the rectangular open pit in degrees from North, measured positive in the clockwise direction (optional).

The same emission rate is used for both concentration and deposition calculations in the AERMOD model. It should also be noted that the emission rate for the open pit source is an emission rate per unit area as with the other area source types. This is different from the point and volume source emission rates, which are total emissions for the source. The Relhgt parameter cannot exceed the effective depth of the pit, which is calculated by the model based on the length, width, and volume of the pit. A Relhgt of 0.0 indicates emissions that are released from the base of the pit.

If the optional Angle parameter is input, and the value does not equal 0.0, then the model will rotate the open pit clockwise around the vertex defined on the SO LOCATION card for this source. The relationship between the Xinit, Yinit, and Angle parameters and the source location, (Xs,Ys), for a rotated pit is the same as for rectangular area sources. The Xinit dimension is measured from the side of the area that is counterclockwise along the perimeter from the vertex defined by (Xs,Ys), while the Yinit dimension is measured from the side of the open pit that is clockwise along the perimeter from (Xs,Ys). Unlike the area source inputs, the Yinit parameter is not optional for open pit sources. The Angle parameter is measured as the orientation relative to North of the side that is clockwise from (Xs,Ys), i.e., the side with length Yinit. The Angle parameter may be positive (for clockwise rotation) or negative (for counterclockwise rotation), and a warning message is generated if the absolute value of Angle is greater than 180 degrees. The selection of the vertex to use for the source location is not critical, as long as the relationship described above for the Xinit, Yinit, and Angle parameters is maintained.

The aspect ratio (i.e., length/width) of open pit sources should be less than 10 to 1. However, since the pit algorithm generates an effective area for modeling emissions from the pit, and the size, shape and location of the effective area is a function of wind direction, an open pit cannot be subdivided into a series of smaller sources. Aspect ratios of greater than 10 to 1 will be flagged by a warning message in the output file, and processing will continue. Since open pit sources cannot be subdivided, the user should characterize irregularly-shaped pit areas by a rectangular shape of equal area. **Receptors should not be located within the boundaries of the pit; concentration and/or deposition at such receptors will be set to zero.** Such receptors will be identified during model setup and will be flagged in the summary of inputs.

An example of a valid SRCPARAM input card for an open pit source is given below:

```
SO SRCPARAM  NORTHPIT  1.15E-4  0.0  150.0  500.0  3.75E+6
30.0
```

where the source ID is NORTHPIT, the emission rate is 1.15E-4 g/(s-m^2), the release height is 0.0 m, the X-dimension is 150.0 m, the Y-dimension is 500.0 m, the pit volume is 3.75E+6 cubic meters (corresponding to an effective pit depth of about 50 meters) and the orientation angle is 30.0 degrees clockwise from North. Note, that unlike the ISC model formulation for OPENPIT sources, particle information (diameter, mass fraction, and density) are not needed by AERMOD except when modeling with particle deposition or depletion.

3.3.2.8 LINE source inputs

The syntax, type and order for the SRCPARAM card for LINE sources are summarized below:

Syntax:	SO SRCPARAM Srcid Lnemis Relhgt Width (Szinit)
Type:	Mandatory, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Lnemis - line source emission rate in g/(s-m^2),
Relhgt - average release height above ground in meters,
Width - width of the source in meters (with a minimum width of 1m),
Szinit - initial vertical dimension of the line source in meters (optional).

As noted above, the LINE source type option in AERMOD uses the same algorithms as used for the AREA source type for rectangular sources and will give identical results for equivalent source definitions. The LINE source emission rate is in g/(s-m^2) and the model assumes that emissions are uniformly distributed across the dimensions of the LINE source. As with the AREA source type, the LINE source type does not include the horizontal meander component that is incorporated for POINT and VOLUME sources unless the AREAMNDR and ALPHA keywords have been specified. Also, as with the AREA source type, the LINE source type will estimate concentrations (and/or deposition) at receptors located within the dimensions of the source.

3.3.2.9 RLINE source inputs

The AERMOD RLINE source algorithm is used to model near-surface releases from mobile sources and can be used to represent a travelled roadway with either single or multiple lanes of traffic. The AERMOD model simulates mobile source emissions using Romberg numerical integration of point sources, with the number of points included in the integration determined by error analysis. Beginning with version 24142, the RLINE source type has been updated to a regulatory option and can be used with the DFAULT option.

RLINE was originally formulated as a flat terrain model, and in the original implementation, AERMOD required that the FLAT MODELOPT flag was specified. If FLAT and ELEV were both used, Zs for all RLINE sources needed to be = 0.0 or = 'FLAT'. Beginning with version 23132, the RLINE source type can account for terrain elevations. **However, when modeling for project level transportation conformity and hot-spot analyses, refer to the EPA's Office of Transportation and Air Quality (OTAQ) for current guidance on how to model and configure roadway**

sources (https://www.epa.gov/state-and-local-transportation/project-level-conformity-and-hot-spot-analyses).

The syntax, type, and order for the SRCPARAM card for RLINE sources are summarized below:

Syntax:	SO SRCPARAM Srcid Lnemis Relhgt Width (Szinit)
Type:	Mandatory, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Lnemis[3] - line source emission rate in g/s/m^2,
Relhgt - average release height above ground in meters,
Width - width of the source in meters (with a minimum width of 1m),
Szinit - initial vertical dimension of the line source in meters (optional).

Notice these are identical to the LINE source type above, thus allowing the user to use the RLINE dispersion calculations by simply changing the source type from LINE to RLINE. The RLINE source emission rate is in grams/second/meter^2, and the model assumes that emissions are uniformly distributed. If the keyword RLEMCONV is used on the SO pathway, then the emission units for all RLINE sources should be in g/hr/link (see Section 3.3.13).

3.3.2.10 RLINEXT source inputs

Like the RLINE source type, the RLINEXT source type is used to model near-surface releases from mobile sources and can be used to represent a travelled roadway with either single or multiple lanes of traffic. Unlike RLINE, RLINEXT source type is a non-regulatory ALPHA option. The RLINEXT source type cannot be used with the DFAULT option and requires use of the non-

3 Alternatively, the user may specify emissions units of grams per link per hour for the RLINE and RLINEXT source types using the RLEMCONV keyword on the SO pathway (See Section 3.3.13.)

regulatory ALPHA flag with the Control pathway MODELOPT keyword. RLINE and RLINEXT sources use the same dispersion calculations, but the parameter requirements to characterize each of the source types are different. Prior to version 23132, AERMOD also required that the FLAT MODELOPT flag was specified when using the RLINEXT source. If FLAT and ELEV were both used, Zs for all RLINEXT sources needed to be = 0.0 or = 'FLAT'. Beginning with version 23132, the RLINEXT source type can process terrain elevations as does the RLINE source type. **However, when modeling for project level transportation conformity and hot-spot analyses, refer to the EPA's Office of Transportation and Air Quality (OTAQ) for current guidance on how to model and configure roadway sources (https://www.epa.gov/state-and-local-transportation/project-level-conformity-and-hot-spot-analyses).**

The syntax, type, and order for the SRCPARAM card for RLINEXT sources are summarized below:

Syntax:	SO SRCPARAM Srcid Rlemis DCL Width Szinit
Type:	Mandatory, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Rlemis[3] - roadway source emission rate in g/s/m,

DCL - distance from the roadway centerline to the center of the source (e.g., the center of the lane of traffic for a one-lane source) in meters,

Width - width for each source in meters (e.g., for a one lane source, Width would be the width of the lane),

Szinit - initial vertical dimension of the line source in meters.

All parameters are required for an RLINEXT source type, however, the user may enter "0" for any unused parameters. The RLINEXT source emission rate is in grams/second/meter and the model assumes that emissions are uniformly distributed across the dimensions of the RLINEXT

source. If the keyword RLEMCONV is used on the SO pathway, then the emission units for all RLINEXT sources should be in g/hr/link (see Section 3.3.13).

The distance from the centerline (DCL) parameter determines the offset from the roadway centerline for a source representing a single lane of traffic, as shown in Figure 3-3. For example, in the case of a multi-lane, divided highway with traffic travelling in the northbound and southbound directions, the centerline would be defined as the midpoint of the highway median. The DCL would be the perpendicular distance from the midpoint of the median to the midpoint of each source, i.e., middle distance between source end points. If a source is one lane, the DCL would be the distance from the midpoint of the median to the center of the lane. A positive DCL value indicates the source is to the east of the median for a north-south oriented source, or to the north of the median for an east-west oriented source. A negative DCL value means the source is to the west of the median for a north-south oriented source, or to the south of the median for an east-west oriented source.

Most Orientations	(+DCL) Source **East** of median	(–DCL) Source **West** of median
Exception: East-West Orientation	(+DCL) Source **North** of median	(–DCL) Source **South** of median

DCL can be 0 for lanes of traffic with defined source coordinates, unless the user includes the RDEPRESS keyword, explained below, in which case DCL must represent the distance from the roadway centerline for each individual source. In the multi-lane, divided highway example where each lane is a unique source, each source would have a DCL reflecting the distance from the midpoint of the median to the middle of the individual lane of traffic, with the easternmost-lane having the largest-magnitude positive DCL value and the westernmost-lane having the largest-magnitude negative DCL value.

It should be noted that use of the RDEPRESS keyword requires that all RLINEXT sources have coordinates reflecting the roadway centerline coordinates and not coordinates representing the individual lane of traffic. DCL with the RDEPRESS keyword must, therefore, define the distance of

each source to a common location. The user may apply similar source characterization to RLINEXT sources without the use of RDEPRESS, so that DCL defines the location of each lane from a common set of coordinates.

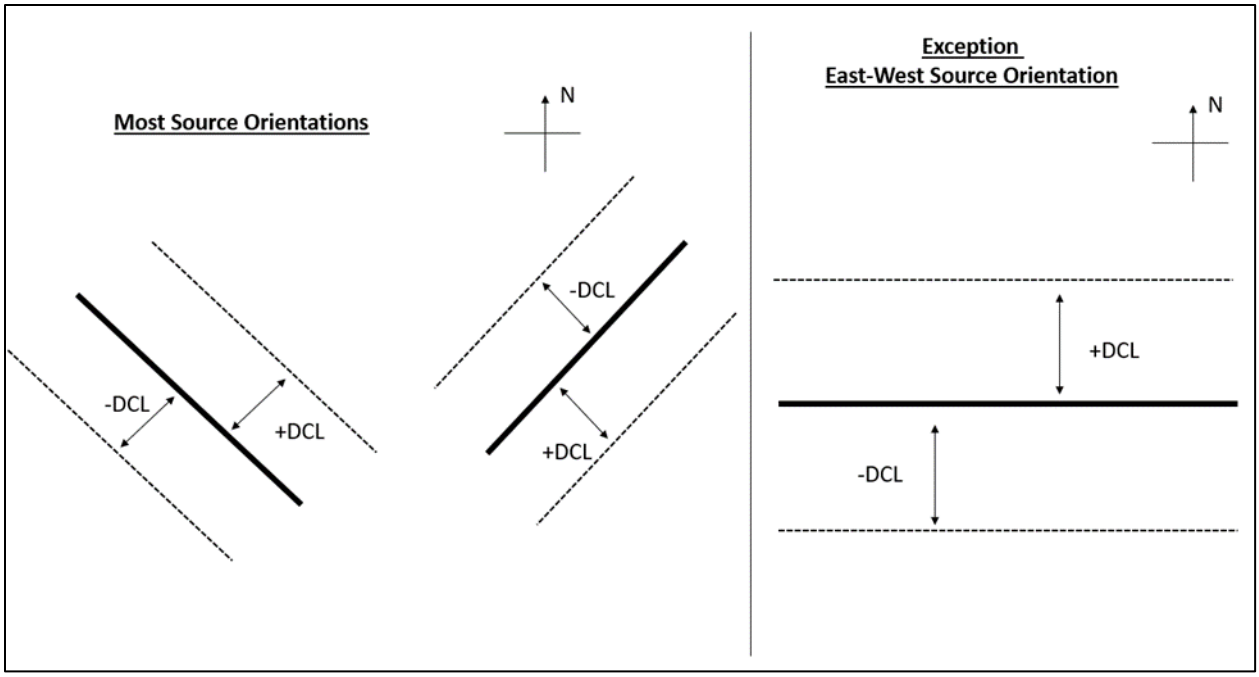


Figure 3-3. Definition of DCL for RLINEXT sources. Dashed lines represent lanes of a roadway with an offset (DCL) from the median (solid line).

The Width parameter specifies the width of the RLINEXT source (e.g., the width of a lane or multiple lanes, depending on how the source is defined). A warning message is issued if Width is less than zero.

Optionally, RLINEXT sources can also contain source configurations to represent solid barriers or a depressed location. A roadside barrier is specified with the RBARRIER keyword. The syntax, type, and order for the RBARRIER card for RLINEXT sources are summarized below:

Syntax:	SO RBARRIER Srcid Htwall DCLwall (Htwall2 DCLwall2)
Type:	Optional, Repeatable
Order:	Must follow the SRCPARAM card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Htwall - height of the solid barrier (wall) in meters,

DCLwall - the distance from the centerline of the source to the barrier (wall) in meters,

Htwall2 - height of a second solid barrier (wall) in meters, if present,

DCLwall2 - the distance from the centerline of the source to the second barrier (wall) in meters.

RBARRIER inputs should be on opposite sides of the RLINEXT source (DCLwall and DCLwall2). If two RBARRIERs are input that are on the same side of the source, a warning will be issued, the closest of the two barriers will be kept and the other will be ignored.

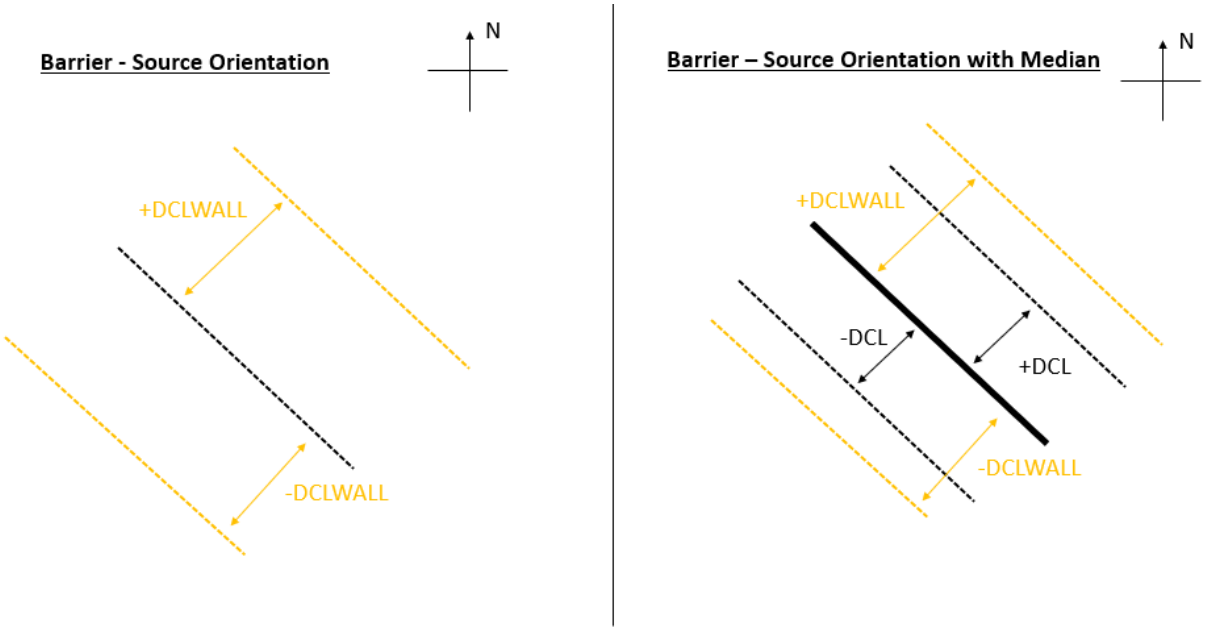


Figure 3-4. Definition of DCLWALL for RLINEXT sources. Dashed black lines represent roadway sources and dashed orange lines represent barriers with an offset (DCLWALL). The solid line in the right-hand panel represents the median

From Figure 3-2, the DCL is defined and the DCLWALL is defined when there is a median. This median DCL is subtracted from the DCLWALL within the RLINE barrier processing, so only the relative distance between each source and wall (barrier) is used when estimating concentrations.

A roadside located in a depression is specified with the RDEPRESS keyword. The syntax, type and order for the RDEPRESS card for RLINEXT sources are summarized below

Syntax:	SO RDEPRESS Srcid Depth Wtop Wbottom
Type:	Optional, Repeatable
Order:	Must follow the SRCPARAM card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Depth: depth of the depression in meters (should be negative),

Wtop: width of the top of the depression containing the RLINE source in meters,

Wbottom: width of the bottom of the depression containing the RLINE source in meters (must be less than, or equal to, Wtop).

The barrier and depressed roadway source configurations can only be used if the ALPHA flag is present with the MODELOPT keyword in the CO pathway.

Roadside barrier configurations are specified by the height of the barrier (Htwall) and the distance from the centerline to the wall (DCLwall). Currently, there is no limit to the Htwall parameter, but a fatal error message is issued if the height of the barrier is less than zero. If a second barrier is specified with Htwall2 and DCLwall2, this barrier should be on the opposite side of the roadway from barrier 1. Positive values of DCLwall (and DCLwall2) indicate barriers east of the roadway centerline (or north if the roadway runs directly east-west). Negative values indicate barriers west of the roadway centerline (or south if the roadway runs directly east-west).

Depressed roadway dimensions are specified by the Depth parameter, defining the depth of the roadway relative to surrounding terrain, in meters, and the Wtop and Wbottom parameters, defining the widths of the depression top and depression bottom, respectively. The Depth parameter must be a negative value, reflecting a lower elevation than the surrounding terrain. A fatal error is issued if the Depth parameter is greater than zero. A fatal error is issued if either the Wtop or Wbottom parameters are less than zero, or if the specified Wbottom parameter is greater than the

Wtop parameter for the source. Wbottom can, however, have a greater value than the width of the roadway, if the inclusion of shoulders or other areas are considered within the depression.

As an alternative to using the RBARRIER keyword, beginning with AERMOD version 26135 solid roadside barriers can also be input using barrier end points with the SBARRIER keyword. Barriers can be broken into segments (optional) with varying lengths, heights, and elevations. SBARRIER provides AERMOD with the needed inputs to calculate the barrier Htwall and DCL as used in RBARRIER. The input barrier segment groups (Barid) will be treated as a continuous barrier. Thus, there should be minimal separation between segments in any direction, and end points should be in order from starting point to end point to represent the full extent of the desired barrier. The syntax, type, and order of the SBARRIER keyword for RLINEXT sources are summarized below:

Syntax:	SO SBARRIER Barid STA Numseg SO SBARRIER Barid $X1_1$ $Y1_1$ $X2_1$ $Y2_1$ HT_1 Z_1 … SO SBARRIER Barid X1n Y1n X2n Y2n HTn Zn SO SBARRIER Barid END
Type:	Optional, Repeatable
Order:	Must follow the SRCPARAM card for each source input

where the parameters are defined as follows:

Barid:	Barrier identification code (up to 12 alphanumeric characters)
STA:	STArt of SBARRIER inputs for specific BARID, repeated for each unique Barid
Numseg:	Number of segments associated with BARID (integer, 50 segment limit) (n)
$X1_1$, $Y1_1$:	Starting coordinate point of first segment (meters)
$X2_1$, $Y2_1$:	Ending coordinate point of first segment (meters)
HT_1:	Height of first barrier segment (meters) (>0)
Z_1:	Elevation of first segment (meters) – Elevation currently ignored, Flat required (0m)

$X1_n$, $Y1_n$:	Starting coordinate point of nth segment (meters)
$X2_n$, $Y2_n$:	Ending coordinate point of nth segment (meters)
HT_n:	Height of nth barrier segment (meters) (>0)
Z_n:	Elevation of nth segment (meters) – Elevation currently ignored, Flat required (0m)
END:	Indicates the END of SBARRIER inputs for specific BARID, repeated for each unique Barid

RLINEXT barrier algorithm computations occur for each RLINEXT source, as the barrier algorithm was developed for a barrier parallel to the source. This processing was left unchanged. However, the SBARRIER allows the user to input the barrier segments separate from the source. Individual barrier segments do not have to be parallel or continuous, but the final barrier and source are assumed by AERMOD to be parallel and continuous for the source when the RLINE algorithm is applied.

For cases with multiple barriers (multiple BARID segment groups), a total of two barriers will be kept: one upwind and one downwind of the source (opposite DCL sign). For barriers on the same side of the source, the closest barrier to the source (smallest DCL) will be kept and the other barrier disregarded. Each Barid is checked against each input RLINEXT source.

The final combined DCL and HT found from the segment inputs is the average of each segment DCL or HT, weighted by the segments overlap with the source.

- Requirements of the solid barrier algorithm:
- Requires an RLINEXT source; with ALPHA and FLAT as model options (MODELOPT).
- RLINEXT algorithms assume barrier is continuous and fully covers the source (single DCL and height).
- Barriers can exist on either side or both sides of the roadway/source.
- The height (HT) of the barrier (or segments) should be between 2 – 12 m.
- Barrier must be within 10*HT distance from the source.

Requirements to be treated as a <u>continuous</u> solid barrier (SBARRIER):

- The order of the starting and ending points for each segment should be entered from West-to-East or North-to-South. For the barrier group (Barid), the "most westerly" segment's starting point should be entered as the first point and the "most easterly" segment's endpoint is the last endpoint entered for the barrier group.
- Input segments cannot be separated by more than 1m in any direction. Gap check performed between consecutive segments within a single barrier group (Barid).
- Barrier must overlap at least 90% of the source. The overlap is determined from the overlap of input segments (Barid) relative to the source. If less than 90% overlap, the barrier is assumed to have no influence on source and Barid is skipped for this source.
- Barrier segment(s) should be near parallel with the source (within 50-degrees).
- If the segment(s) are near parallel, have sufficient overlap, and are within 10*HT of the source, then they will be retained and considered to have influence on the dispersion from the source.
- Note: individual barrier segments may not be parallel or continuous, but the final barrier and source are assumed to be parallel and continuous along the source (single DCL and height).

Refer to APPENDIX F for example input and outputs of SBARRIER.

Like a roadside barrier (RBARRIER), beginning with AERMOD version 26135 a vegetative barrier can be input using the VBARRIER keyword. The syntax, type, and order of the VBARRIER keyword for RLINEXT sources are summarized below:

Syntax:	SO VBARRIER Srcid HT1 WT1 DCL1 LAI1 LM1 (HT2 WT2 DCL2 LAI2 LM2)
Type:	Optional, Repeatable
Order:	Must follow the SRCPARAM card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the parameters are defined as follows:

HT1: Height of vegetation (meters); range of 2.0 to 10.0 m

WT1: Width of vegetation (meters); range of 2.5 to 13.0 m

DCL1: The distance from the centerline of the source to the barrier (meters)

LAI1: Vegetation leaf area index (unitless); range of 4.00 to 10.92

LM1: Vegetation maximum leaf area density (1/m); range of 0.55 to 3.75 1/m

(HT2 WT2 DCL2 LAI2 LM2): parameters for optional second barrier on opposite side of source

Table 3-4 Valid range of VBARRIER input parameters

	Minimum	Maximum
HT (m)	2.0	10.0
WT (m)	2.5	13.0
LAI	4.00	10.92
LM (1/m)	0.55	3.75

Vegetative barrier parameters are defined by the vegetation's height (HT), width (WT), distance from centerline (DCL), and vegetation characteristics including the leaf area index (LAI) and leaf area density (LM). Leaf Area Index (LAI) is a dimensionless value that describes how much leaf surface area of a canopy exists in a given ground area. Leaf Area Density (LM) is the vertical distribution of leaf area within the canopy. It describes how leaf area is concentrated through the vertical profile of the vegetative barrier. An error will occur if vegetation parameters are outside the designated ranges.

Optionally, a second vegetative barrier may be specified using the additional set of parameters (HT2 WT2 DCL2 LAI2 LM2), which should be located on the opposite side of the source (i.e., DCL2 should have the opposite sign of DCL1). If both barriers are input on the same side of the source, only the closest barrier (smallest absolute DCL) will be used.

The VBARRIER only influences dispersion when it is located downwind of the source for a given wind direction. Upwind vegetative barriers do not affect dispersion. The VBARRIER keyword cannot be used in combination with RBARRIER or SBARRIER for the same source ID (Srcid). If a vegetative and a solid barrier are both defined for the same source, a warning will be issued, and the VBARRIER will be ignored.

Refer to the APPENDIX F for example input and outputs of VBARRIER.

3.3.2.11 BUOYLINE source inputs

The syntax, type and order for the SRCPARAM, BLPINPUT, and BLPGROUP cards for a BUOYLINE source are summarized below:

Syntax:	SO SRCPARAM Srcid Blemis Relhgt
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each line input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular line within the buoyant line source, and the other parameters are as follows:

Blemis - buoyant line emission rate in g/(s) for the individual line,

Relhgt - average release height of the individual line above ground in meters. Since the original BLP model was developed for elevated sources, a minimum release height of 2.0 m is enforced for the individual buoyant lines when AERMOD processes the buoyant line sources. If a release height less than 2.0 m is detected, AERMOD changes the height to 2.0 meters, issues a warning message, and continues processing.

The buoyant line source also requires the user to enter average values representative of a buoyant line source as a whole and not for the individual lines that comprise the buoyant line source.

As of version 21112, the user can specify multiple buoyant line groups (i.e., multiple buoyant line sources) each comprised of individual buoyant lines. Each buoyant line source group (previously referred to as a buoyant line source) requires the user to enter average values representative of the group using the BLPINPUT keyword. The average parameters are applied to the buoyant line group by associating each individual buoyant line with a buoyant line group using the BLPGROUP keyword (described below) through the BLPGrpID. The BLPGrpID is optional on the BLPINPUT keyword ***if only one buoyant line group is modeled***. Allowing BLPGrpID to be optional when a single buoyant line group is being modeled lets legacy control files run with AERMOD. These are entered as parameters on the BLPINPUT keyword:

Syntax:	SO BLPINPUT BLPGrpID Blavgblen Blavgbhgt Blavgbwid Blavglwid Blavgbsep Blavgfprm
Type:	Mandatory, Repeatable
Order:	BLPINPUT keywords must appear before the BLPGROUP keywords The order of the BLPINPUT records and their associated buoyant lines (as defined on the BLPGROUP keywords and linked through the BLPGrpIDs) must be in the same order as the lines on the SO LOCATION records

where the parameters are defined as follows and illustrated in Figure 3-5. The order shown is the same as the input in BLP with the variable names used in BLP shown in parentheses:

BLPGrpID: buoyant line group ID,

Blavgblen (L): average building length (m),

Blavgbhgt (HB): average building height (m),

Blavgbwid (WB): average building width (m),

Blavglwid (WM): average line source width (m) (of the individual lines),

Blavgbsep (DX): average building separation (m) (between the individual lines),

Blavgfprm (FPRIME): average buoyancy parameter (m^4/s^3).

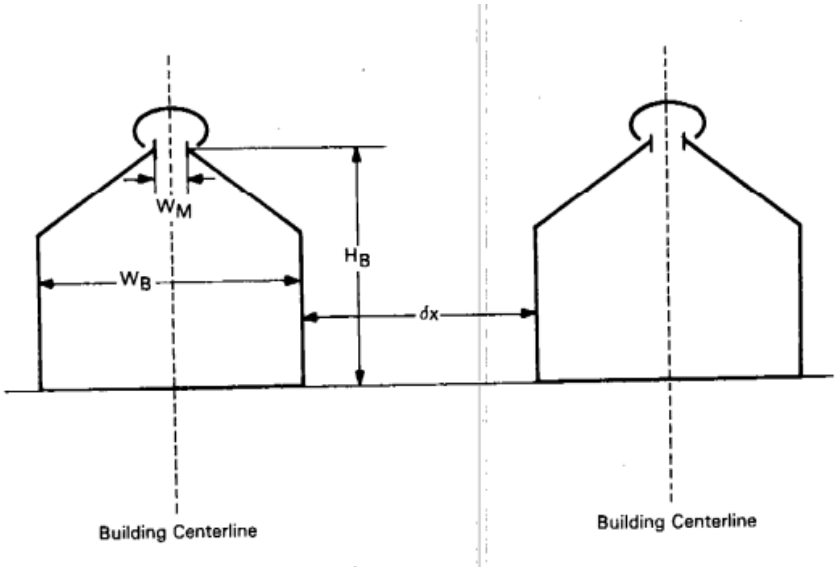


Figure 3-5. BUOYLINE source type input parameters.

When multiple buoyant line groups are in a model run, the order of the individual buoyant lines associated with the BLPINPUT keywords (as defined on the BLPGROUP keywords and linked via the BLPGrpIDs) in the control file must be in the order of the individual buoyant lines

defined by the SO LOCATION keywords. For example, assume a model run consists of SO LOCATION records for a 3-line buoyant line group followed by the SO LOCATION records for a 2-line buoyant line group (i.e., five total individual buoyant lines in two BL groups). The BLPINPUT records for the 3-line group must be specified before the BLPINPUT record for the 2-line group in the control file. If they are in the opposite order, AERMOD will issue an error message and fail to run.

The user should use caution in defining the average buoyancy parameter (FPRIME) above. This parameter should be calculated as in Equation 2-47 of the BLP user guide (Schulman and Scire, 1980), also shown below. The FPRIME parameter is dependent on BUOYLINE parameters listed above and additional source parameters that are not input to AERMOD such as the line source exit velocity and difference in exit and ambient temperatures.

$$\text{FPRIME} = \frac{\text{g L W}_m\text{w}\ (T_s - T_a)}{T_s}$$

Where:

FPRIME = average line source buoyancy parameter (m^4/s^3)
g = acceleration of gravity (9.81 m/s^2)
L = line source length (m)
W_m = line source width (m)
w = exit velocity (m/s)
T_s = exit temperature (◦K)
T_a = ambient air temperature (◦K)

Selection and computation of FPRIME should be done with caution and sufficiently justified before being used in an AERMOD BUOYLINE application. Also note, FPRIME should be computed for each line in a BUOYLINE and averaged for all lines in a BUOYLINE source and source group, as suggested in the BLP user guide (Schulman and Scire, 1980).

The BLPGROUP keyword associates one or more individual buoyant lines with a buoyant line group and a corresponding BLPINPUT keyword. To process two or more buoyant line sources this keyword is mandatory; for modeling a single buoyant line source the keyword is optional, i.e., when omitted all individual lines are treated as a single buoyant line source.

Syntax:	SO BLPGROUP BLPGrpID SrcID (or SrcRng) or SO BLPGROUP ALL
Type:	Mandatory, Repeatable
Order:	BLPGROUP keywords must appear after the BLPINPUT keywords

where BLPGrpID identifies a group individual buoyant lines to be treated as a single buoyant line source and the Srcid or Srcrng identifies the group of buoyant lines to be included in the BLP group. As with the SO SRCGROUP card, individual source IDs and source ranges may be used on the same record, and if more than one input record is needed to define the sources for a particular BLP group, then additional records may be input by repeating the pathway, keyword and BLPGrpID. A user can also specify a BLPGrpID of ALL, which means that all the individual line sources are to be treated as a single buoyant line source. There must be one, and only one, associated BLPINPUT record for BLPGrpID ALL. Another constraint for the BLPGROUP keyword is that a buoyant line source cannot be associated with more than one BLPGrpID. When using buoyant line sources in event processing the BLPGRPID must be equivalent to the SRCGROUP ID, and the source IDs in each must be the same.

Note: The secondary keyword, ALL, is used in different source grouping contexts (e.g., BLPGROUP, SRCGROUP, OLMGROUP). Refer to the appropriate section of this user's guide to see the usage of the secondary keyword, ALL, for the group of sources to be identified. For SRCGROUP see Section 3.3.15. For OLMGROUP, see Section 3.3.6.2.

3.3.2.12 SWPOINT source inputs

The SWPOINT source type has been added beginning with version 22112 as a research tool to further study the phenomena researchers have coined as "sidewash" which is a lateral shift of the building wake cavity that forms on the lee side a building that occurs when the wind is oblique to one of the longer sides of an elongated building. Yang et al. (2020) investigated the flow structures

and concentration fields under oblique wind conditions. A key finding was that the flow is not only entrained downward (downwash) but also directed by the oblique wind along the building leeward surface (sidewash), which creates a sidewash-downwash (S-D) vortex. This S-D vortex causes the plume to shift in the lateral direction. The use of the SWPOINT source type requires the non-regulatory ALPHA flag to be entered as a model option with the MODELOPT keyword on the CO pathway. The syntax, type and order for the SRCPARAM cards for a SWPOINT source are summarized below:

Syntax:	SO SRCPARAM Srcid Swemis Stkhgt Bw Bl Bh Ba
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each line input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular SWPOINT source, and the other parameters are as follows:

Swemis	Sidewash point source emission rate in g/s,
Stkhgt	Release height above ground in meters,
Bw	Building width in meters,
Bl	Building length in meters,
Bh	Building height in meters, and
Ba	Building angle in decimal degrees measured clockwise where north is 0 degrees.

As a research tool, the SWPOINT source has a number of limitations in the implementation in version 23132 that need to be highlighted for the user who uses the SWPOINT source type to investigate and study the sidewash effect. These limitations include the following:

- Produces downwind concentrations from short stacks assumed to be centered along the leeward side of elongated buildings. Refer to Figure X below for an illustration of the assumed stack location with respect to the building and wind flow orientation.
- Model concentrations are limited to the building wake cavity. Impacts at receptors outside or in the transition zone from the building wake cavity are not calculated.
- Terrain impacts are not considered.
- Plume rise due to mechanical and thermal buoyancy is not considered.

- Building representation is assumed to be rectangular.
- PRIME downwash is not applied.
- SWPOINT sources have not been configured for use with EVENT processing, NOx-to-NO_2 conversion methods, or the MAXDCONT source culpability processing.
- Stack top wind speeds below approximately 2 m/s have been shown to cause anomalously high concentrations. This parameter is quite sensitive and currently can shift from reasonable predicted concentrations to values several orders of magnitude with the adjustment of a few tenths of a meter per second.

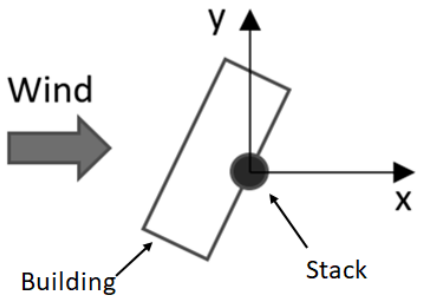


Figure 3-6.Fixed Stack location with respect to Building and Wind Flow Orientation

3.3.3 Specifying gas deposition parameters

3.3.3.1 Source parameters for gas deposition (dry and/or wet)

The input source parameters for dry and wet deposition of gaseous pollutants is controlled by the GASDEPOS keyword on the SO pathway. The gas deposition variables may be input for a single source or may be applied to a range of sources.

The syntax, type, and order for the GASDEPOS keyword are summarized below:

Syntax:	SO GASDEPOS Srcid (or Srcrng) Da Dw rcl Henry
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid or Srcrng identify the source or sources for which the inputs apply, the parameter Da is the diffusivity in air for the pollutant being modeled (cm^2/s), Dw is the diffusivity in water for

the pollutant being modeled (cm^2/s), rcl is the cuticular resistance to uptake by lipids for individual leaves (s/cm), and Henry is the Henry's Law constant (Pa m^3/mol). Values of the physical parameters for several common pollutants may be found in the appendices to the ANL report (Wesely, et. al, 2002).

As of version 21112, optional default gas deposition parameters (Da, Dw, rcl, Henry) are included for elemental mercury, divalent mercury, dioxins, polycyclic aromatic hydrocarbons (PAH), SO_2, and NO_2. There are two requirements to use the default gas deposition parameters. First, the POLLUTID keyword must be set to a specific value, depending on the pollutant (see below). Second, the deposition parameter must be set to a value of 0 in the GASDEPOS keyword. If each parameter is to be a default value, a 0 must be entered for each parameter. The user can also specify a mix of default versus user-entered parameters. For example, the user can specify a value for diffusivity in air with the user entered value and a default value of diffusivity in water by entering a 0. If any default values are used for a particular source, the user will receive a message in the ERRORFIL.

The pollutants, POLLUTID, and default gas deposition parameters used are:

Pollutant	**POLLUTID**	**Diffusivity in air (Da)**	**Diffusivity in water (Dw)**	**Cuticular resistance (rcl)**	**Henry's Law (Henry)**
Elemental Mercury	HG0	0.055	6.4E-6	100000	719
Divalent Mercury	HGII	0.045	5.2E-6	100000	0.000072
Dioxin (as TCDD)	TCDD	0.05196	4.39E-6	9.67	1.46
PAH (as BaP)	BAP	0.0513	4.44E-6	0.441	0.046
SO_2	SO2	0.1122	1.83E-5	732	72
NO_2	NO2	0.1361	1.4E-5	12000	8444

Note, that for elemental mercury, the third character of the POLLUTID is a zero, not a capital O. The POLLUTID for SO2 and NO2 contains a capital O and not a zero.

3.3.3.2 Option for specifying the deposition velocity for gas dry deposition

An optional keyword is available on the Control (CO) pathway to allow the user to specify the dry deposition velocity for gaseous emissions. A single dry deposition velocity can be input for a given model run and is used for all sources of gaseous pollutants. Selection of this option will by-pass the algorithm for computing deposition velocities for gaseous pollutants and should only be used when sufficient data to run the algorithm are not available. Results of the AERMOD model based on a user-specified deposition velocity should be used with extra caution.

The syntax and type of the GASDEPVD keyword are summarized below:

Syntax:	CO GASDEPVD Uservd
Type:	Optional, Non-repeatable

where the parameter Uservd is the gaseous dry deposition velocity (m/s). A non-fatal warning message is generated by the model if a value of Uservd greater than 0.05 m/s (5 cm/s) is input by the user. When the GASDEPVD keyword is used, the GDSEASON, GDLANUSE, and GASDEPRF keywords for the CO pathway, and the GASDEPOS keyword for the SO pathway, are no longer applicable and cannot be used in the same model run. As a result, gas wet deposition processes (DEPOS, WDEP, and WETDPLT) cannot be simulated with the GASDEPVD option is used.

3.3.4 Specifying source parameters for particle deposition

The AERMOD model includes two methods for handling dry and/or wet deposition of particulate emissions. Method 1 is used when a significant fraction (greater than about 10 percent) of the total particulate mass has a diameter of 10 μm or larger, or when the particle size distribution is known. The particle size distribution must be known reasonably well in order to use Method 1. Method 2 may be used when the particle size distribution is not well known and when a small fraction (less than 10 percent of the mass) is in particles with a diameter of 10 μm or larger. The deposition velocity for Method 2 is calculated as the weighted average of the deposition velocity for particles in the fine mode (i.e., less than 2.5 μm in diameter) and the deposition velocity for the coarse mode (i.e., greater than 2.5 μm but less than 10 μm in diameter). As described in Section

3.2.2.2, use of the Method 2 option is considered a non-DFAULT option and cannot be used when the DFAULT keyword is specified.

3.3.4.1 Specifying particle inputs for Method 1

The input of source variables for particle deposition using Method 1 is controlled by three keywords on the SO pathway, PARTDIAM, MASSFRAX, and PARTDENS. These inputs are comparable to the particulate inputs used in the ISCST3 model (EPA,1995a). The particle variables may be input for a single source or may be applied to a range of sources.

The syntax, type and order for these three keywords are summarized below:

Syntax:	SO PARTDIAM Srcid (or Srcrng) Pdiam(i), i=1,Npd SO MASSFRAX Srcid (or Srcrng) Phi(i), i=1,Npd SO PARTDENS Srcid (or Srcrng) Pdens(i), i=1,Npd
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid or Srcrng identify the source or sources for which the inputs apply, and where the Pdiam array consists of the mass-mean aerodynamic particle diameter (microns) for each of the particle size categories, the Phi array is the corresponding mass fractions (between 0 and 1) for each of the categories, and the Pdens array is the corresponding particle density (g/cm^3) for each of the categories.

The number of particle size categories for a particular source is Npd. The user does not explicitly tell the model the number of categories being input, but if continuation cards are used to specify particle size variables, all inputs of a keyword for a particular source or source range must be contiguous, and the number of categories must agree for each of the three keywords input for a particular source. As many continuation cards as needed may be used to define the inputs for a particular keyword. The model checks the inputs to ensure that the mass fractions sum to 1.0 (within 2 percent) for each source input and issues a warning message if that range is exceeded. The model also ensures that mass fractions for each particle size category are within the proper range (between 0 and 1), and issues fatal error messages for any value exceeded that range.

3.3.4.2 Specifying particle inputs for Method 2

The Method 2 particle information is input through the METHOD_2 keyword on the SO pathway. The syntax, type, and order for the METHOD_2 keyword are summarized below:

Syntax:	SO METHOD_2 Srcid (or Srcrng) FineMassFraction Dmm
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid or Srcrng identify the source or sources for which the inputs apply, the parameter FineMassFraction is the fraction (between 0 and 1) of particle mass emitted in the fine mode, less than 2.5 microns, and Dmm is the representative mass-mean aerodynamic particle diameter in microns. Estimated values of fine particle fractions and mass mean diameters for various pollutants are provided in Appendix B of the ANL report (Wesely, et al, 2002).

As of version 21112, optional default Method 2 particle deposition parameters (FineMassFraction and Dmm) are included for arsenic, cadmium, lead, mercury, and polycyclic aromatic hydrocarbons (PAH). There are two requirements to use the default Method 2 particle deposition parameters. First, the POLLUTID keyword must be set to a specific value, depending on the pollutant (see below). Second, the deposition parameter must be set to a value of 0 in the METHOD_2 keyword. If each parameter is to be a default value, a 0 must be entered for each parameter. The user can also specify a mix of default versus user-entered parameters. For example, the user can specify a value for fine mass fraction with the user entered value and a default value of mean particle diameter by entering a 0. If any default values are used for a particular source, the user will receive a message in the ERRORFIL.

The pollutants, POLLUTID, and default Method 2 particle deposition parameters used are:

Pollutant	POLLUTID	Fine mass fraction	Mean particle diameter (Dmm)
Arsenic	AS	0.75	0.5
Cadmium	CD	0.70	0.6
Lead	PB	0.75	0.5
Mercury	HG	0.80	0.4
PAH (as POC)	POC	0.90	0.1

3.3.5 Specifying Emission and Output Units

Since the AERMOD model allows for both concentration and deposition to be output in the same model run, the EMISUNIT keyword (see Section 3.3.13) cannot be used to specify emission unit factors if more than one output type is being generated. The AERMOD model therefore allows for concentration and deposition units to be specified separately through the CONCUNIT and DEPOUNIT keywords, respectively. The syntax and type of the CONCUNIT keyword are summarized below:

Syntax:	SO CONCUNIT Emifac Emilbl Conlbl
Type:	Optional, Non-repeatable

where the parameter Emifac is the factor to convert emission rate input units to the desired output units, Emilbl is the label for the emission input units (up to 40 characters), and Conlbl is the output unit label (up to 40 characters) for concentration calculations. The default conversion is from g/s to $\mu g/m^3$ and the value is $1x10^6$. The conversion from g/s to mg/m^3 would simply be $1x10^3$ and the conversion from g/s to ppb is simply the $grams/m^3$ to ppb conversion factor for the pollutant. The syntax and type of the DEPOUNIT keyword are summarized below:

Syntax:	SO DEPOUNIT Emifac Emilbl Deplbl
Type:	Optional, Non-repeatable

where the parameter Emifac is the factor to convert emission rate input units to the desired output units, Emilbl is the label for the emission input units (up to 40 characters), and Deplbl is the output unit label (up to 40 characters) for deposition calculations. The default conversion is g/s to g/m2 and the value is 3600. To convert to units such as ng/m^2, the conversion would be $3.6x10^{12}$ (3600 *$1x10^9$) where $1x10^9$ is the conversion from g to nanograms.

3.3.6 Source input parameters for NO_2 conversion options

It should be noted that not all NO_2 conversion options have been implemented for all source types in AERMOD. Table 3-2 summarizes which NO_2 conversion options have been implemented for each of the AERMOD source types and which options have not.

The current formulation and implementation of the Tier 2 (ARM2) and Tier 3 (OLM, PVMRM, and GRSM) NO_2 screening options in AERMOD do not support or allow the modeling of negative NO_X emission rates. Thus, AERMOD will issue a fatal error during setup if any source emission rate is found to be negative when one of the Tier 2 or Tier 3 NO_2 screening options is selected. As per Appendix W Section 4.2.3.4(b), "…*modeling of negative [NO_X] emissions rates should only be done after consultation with the EPA Regional office to ensure that decreases in concentrations would not be overestimated.*" Note that AERMOD is currently capable of modeling negative NO_X emissions for Tier 1 NO_2 (i.e., 100% conversion) screening applications; Tier 2 and Tier 3 applications require multiple model runs and appropriate post-processing to determine net emissions NO_2 impacts calculated from negative and positive emissions.

3.3.6.1 Specifying in-stack NO_2/NO_x ratios by source for PVMRM, OLM, TTRM/TTRM2, and GRSM

As noted above, the PVMRM, OLM, TTRM/TTRM2, and GRSM options for modeling NO_2 conversion require in-stack NO_2/NO_x ratios to be specified for each source, i.e., AERMOD no longer assumes a default in-stack ratio of 0.10 for the OLM option. The user can specify in-stack NO_2/NO_x ratios through the optional NO2RATIO keyword on the SO pathway. The syntax of the NO2RATIO keyword is as follows:

Syntax:	SO NO2RATIO SrcID or SrcRange NO2Ratio
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the SrcID or SrcRange identify the source or sources for which the inputs apply, and where the NO2Ratio parameter specifies the in-stack ratio. In this way, the user can specify a single in-stack NO_2/NO_x ratio for a group of stacks. For example, the following input:

```
SO NO2RATIO  STACK1-STACK10   0.15
```

will apply the in-stack ratio of 0.15 to sources with IDs falling within the range STACK1 to STACK10. Any value specified on the SO NO2RATIO card will override the default ratio, if any, specified on the CO NO2STACK card. Users should note that while SO NO2RATIO is an optional keyword, the PVMRM and OLM options require the user to specify an in-stack NO_2/NO_x ratio for each source, using either the CO NO2STACK (Section 3.2.5.4) or SO NO2RATIO cards, or both.

3.3.6.2 Specifying combined plumes for OLM

The OLM option for modeling NO_2 conversion includes an option for specifying which sources are to be modeled as combined plumes, i.e., where the NOx within the plumes competes for the available ambient ozone. Sources which are not specified for modeling as combined plumes will be modeled as individual plumes, i.e., where all of the ambient ozone is available for conversion of NO to NO_2. The selection of individual or combined plume option for OLM is specified through the OLMGROUP keyword on the SO pathway. The syntax of the OLMGROUP card is as follows:

Syntax:	SO OLMGROUP OLMGrpID SrcID's and/or SrcRange's or SO OLMGROUP ALL
Type:	Optional, Repeatable (except for OLMGROUP ALL)
Order:	Must follow the LOCATION card for each source input; OLMGROUP ALL must follow the LOCATION card for all sources

where OLMGrpID identifies a group to be treated as a combined plume with OLM, and the SrcID's and/or SrcRange's identify the sources to be included in the OLM group. As with the SO SRCGROUP card, individual source IDs and source ranges may be used on the same record, and if more than one input card is needed to define the sources for a particular OLM group, then additional records may be input by repeating the pathway, keyword and OLM group ID. A user can also specify an OLMGrpID of ALL, which means that OLM will be applied on a combined plume basis to all sources. However, unlike the SO SRCGROUP card, the results will not be output for a specific OLM group unless the same group of sources is also identified on a SRCGROUP card. Another constraint for the OLMGROUP keyword is that a source cannot be included in more than one OLM group.

Note: The secondary keyword, ALL, is used in different source grouping contexts (e.g., BLPGROUP, SRCGROUP, OLMGROUP). Refer to the appropriate section of this user's guide to see the usage of the secondary keyword, ALL, for the group of sources to be identified. For SRCGROUP see Section 3.3.15. For BLPGROUP, see Section 3.3.2.11.

If a source is not selected for an OLMGROUP card, then OLM will be applied to that source as an individual plume. Other than the similarity in syntax, there is no connection in the model between the groups defined on the OLMGROUP card and groups defined on the SRCGROUP card. The OLMGROUP card relates to how the results are processed within the model for the OLM option, and the SRCGROUP card simply controls how source impacts are grouped in the model outputs.

If the user identifies one or more groups of sources to apply OLM on a combined plume basis using the OLMGROUP card, the model will still need to calculate the concentration for individual plumes within the OLM group in order for the model to sum the results for the sources listed on the SRCGROUP card(s). The individual source concentrations are calculated by applying

the ratio of the combined concentration for the OLM group with and without OLM to each source within the OLM group.

3.3.6.3 Specifying ambient NO_2/NO_x ratios for the ARM2 option

The ARM2 option in AERMOD is based on applying an ambient ratio of NO_2/NO_x to a modeled total NO_x concentration to estimate a total ambient NO_2 concentration. The ARM2 option applies an ambient ratio to the 1-hr modeled NO_x concentrations based on a formula derived empirically from ambient monitored ratios of NO_2/NO_x. The default upper and lower limits on the ambient ratio applied to the modeled NO_x concentration are 0.9 and 0.5, respectively. These limits can be modified using the optional ARMRATIO on the CO pathway as follows:

Syntax:	CO ARMRATIO ARM2_Min ARM2_Max
Type:	Optional, Non-Repeatable

When the regulatory DFAULT keyword is included on the MODELOPT line, the allowed range for the ARM2 ratio represented by ARM2_Min and ARM2_Max is 0.5 to 0.9, respectively. When the DFAULT keyword is not included, the allowed range is extended to a lower limit greater than 0 to an upper limit of 1.0.

3.3.6.4 Inclusion of background NO_2 with source group ALL for GRSM cumulative modeling

For daytime chemistry calculations, GRSM uses background NO_2 inputs on the source pathway to initialize unreacted NO, NO_2, and ozone concentrations for entrainment into the NO_X emissions plume(s) and subsequent full chemistry calculations including photolysis of NO_2. Assignment of the BACKGROUND keyword to the SRCGROUP ALL, i.e., SO SRCGROUP ALL BACKGROUND, will result in *daytime* GRSM NO_2 output concentrations that include background NO_2 that has been converted as a result of the daytime chemistry being applied to both background ambient NO_X and modeled NO_X emissions. This is the correct model configuration appropriate for cumulative NO_2 screening modeling applications.

Inclusion of background NO_2 strictly only on the source pathway, but not assigning it to source group ALL, will result in daytime GRSM NO2 concentrations that represent NO_X emissions

converted to NO_2. This model configuration would be appropriate for situations where source NO_2 impacts are of interest, e.g., single source impact analysis applications.

GRSM daytime chemistry depends on both background NO_2 and NO_X inputs provided on the source and control pathways, respectively. In the case of missing background NO2 inputs, GRSM calculates background NO_2 assuming photo-stationary state (PSS) equilibrium relationship between ambient NO_X and ozone provided on the control pathway (see pg. 35, CERC, 2023); background NO_2 would need to be added as a post-processing step for cumulative applications in this instance. In the case of missing background NO_X inputs on the control pathway, GRSM calculates ambient NO_X based on adjustment of background NO_2 and ozone assuming PSS equilibrium and conservation of oxidants (see pg. 35, CERC, 2023).

3.3.7 Modeling NO_2 increment credits with PVMRM

Due to the ozone limiting effects of the PVMRM option, the predicted concentrations of NO_2 are not linearly proportional to the emission rate. Therefore, the approach of modeling NO_2 increment consumption with PSD credits through the use of a negative emission rate for credit sources cannot be used with the PVMRM option. However, the ALPHA PSDCREDIT option allows modeling PSD increment credits for NO_2 when the PVMRM option is specified. The PSDCREDIT option is currently implemented as an ALPHA option and requires that the PVMRM and ALPHA options be specified on the CO MODELOPT card (see Section 3.2.2). **As an ALPHA option, PSDCREDIT requires additional testing and evaluation before it should be considered for use in a regulatory application.** The PSDCREDIT option utilizes the PSDGROUP keyword, described below, to identify which sources consume or expand increment. This option is not valid if the OLM, TTRM/TTRM2, or GRSM option is specified, and no comparable option is available for modeling increment credits with any of those options. The user should check with the appropriate reviewing authority for further guidance on modeling increment credits for NO_2.

A general discussion of concepts related to modeling increment consumption is provided below, followed by a description of inputs required to use the ALPHA PSDCREDIT option for PVMRM.

3.3.7.1 Increment consuming and baseline sources

Increment is the maximum allowable increase in concentration of a pollutant above a baseline concentration for an area defined under the Prevention of Significant Deterioration (PSD) regulations. The PSD baseline area can be an entire State or a subregion of a State such as a county or group of counties. Increment consumption is the additional air quality impact above a baseline concentration.

The baseline concentration is the ambient concentration of the pollutant that existed in the area at the time of the submittal of the first complete permit application by any source in that area subject to PSD regulations. A baseline source is any source that existed prior to that first application and the baseline date is the date of the PSD application. This baseline date is referred to as the minor source baseline date in PSD regulations. By definition, baseline sources do not consume increment. However, any baseline source that retires from service after the baseline date expands the increment available to new sources. Therefore, a PSD modeling analysis performed for a new source may need to account for this increment expansion. Such an analysis may therefore involve identification of three groups of sources: 1) increment-consuming sources; 2) retired (increment-expanding) baseline sources; and 3) existing, non-retired, baseline sources.

3.3.7.2 Calculating increment consumption under the PSDCREDIT option

Calculating increment consumption under the PSDCREDIT option in AERMOD is not a simple arithmetic exercise involving the three groups of sources defined above. Since the amount of ozone available in the atmosphere limits the conversion of NO to NO_2, interactions of plumes from the existing and retired baseline sources with those from the increment consuming sources must be considered as part of the calculation of net increment consumption. Without the PSDCREDIT option, properly accounting for the potential interaction of plumes among the different source categories would require post-processing of results from multiple model runs. Internal “post”-processing algorithms have been incorporated in AERMOD under the PSDCREDIT option to account for the apportioning of the three groups of sources to properly calculate increment consumption from a single model run.

Define the following three source groupings for the discussion that follows:

A = increment-consuming sources;
B = non-retired baseline sources; and
C = retired baseline, increment-expanding sources.

The calculation of the amount of increment consumption by the **A** sources cannot simply be estimated by modeling the **A** sources alone because of the possible interaction of those plumes with the plumes from **B** sources. The PVMRM algorithm is designed to account for such plume interactions and calculate the total NO to NO_2 conversion in the combined plumes based on the amount of ozone available. Therefore, the total increment consumption by the **A** sources is given by the difference between (1) the total future impact of increment consuming sources and non-retired baseline sources (**A**+**B**) and (2) the total current impact (**B**), which can be expressed as (**A**+**B**) – (**B**). Here (**A**+**B**) represents the value that would be compared against the National Ambient Air Quality Standard (NAAQS) for NO_2 during PSD review of the **A** sources.

In a case where some of the baseline sources have been retired from service (**C** sources), the PSD regulations allow the consideration of increment expansion when assessing compliance with the PSD increment. However, the amount of increment expansion cannot be estimated by simply modeling the **C** sources alone because of the possible interaction of those plumes with the plumes from **B** sources. Therefore, the total increment expansion, i.e., PSD credit, is calculated as the difference between (1) the total impact prior to the retirement of **C** sources, i.e., (**B**+**C**), and (2) the total impact from existing (non-retired) baseline sources (**B**), which can be expressed as (**B**+**C**) – (**B**).

Finally, the net increment consumption is given by the difference between total increment consumption and the total increment expansion, or

$$[(\mathbf{A}+\mathbf{B}) - (\mathbf{B})] - [(\mathbf{B}+\mathbf{C}) - (\mathbf{B})] \qquad \text{(Equation 1)}$$

Note that in the absence of any increment expansion, the net increment consumption is equal to the total increment consumption [(**A**+**B**) – (**B**)], as described above.

These expressions of net increment consumption and expansion cannot be interpreted as algebraic equations. Instead, the terms within parentheses represent the results of separate model runs that account for the combined effects of NO_x conversion chemistry on specific groups of sources. The expression shown in Equation 1 above represents four model simulations: (**A**+**B**), (**B**), (**B**+**C**), and (**B**) again. In this case, the two (**B**) terms do cancel each other, and we are left with:

$$[(\mathbf{A}+\mathbf{B})] - [(\mathbf{B}+\mathbf{C})] \qquad \text{(Equation 2)}$$

The expression presented in Equation 2 summarizes how the net increment consumption calculation is performed under the PSDCREDIT option. Under this option, AERMOD first models the **A** and **B** groups together, then models the **B** and **C** groups together, and finally computes the difference to obtain the desired result, i.e., the value to compare to the PSD increment standard. For AERMOD to perform the special processing associated with this option, the user must define which sources belong to each of the groupings defined above. The next section describes how this is accomplished.

3.3.7.3 Specifying source groups under the PSDCREDIT option

The PSDCREDIT option introduces limitations on grouping sources to calculate increment consumption as described in the previous section. A new keyword, PSDGROUP, is used to group the sources to correctly calculate the increment consumption. The syntax, type, and order are similar to the regular SRCGROUP keyword and are summarized below:

Syntax:	SO PSDGROUP Grpid Srcid's and/or Srcrng's
Type:	Mandatory for PSDCREDIT option, Repeatable
Order:	Must follow the last keyword in the SO pathway before FINISHED

If the PSDCREDIT model option is specified, the PSDGROUP keyword must be used. The SRCGROUP keyword cannot be used with the PSDCREDIT option since results from other groupings beyond these three do not have any meaning when the PSDCREDIT option is invoked, and sources are allocated to the calculation of increment consumption. Special source groups for outputting model results are defined within AERMOD for the PSDCREDIT option, as described in the next section.

Only the following special PSD group ID's can be used. Failure to use these group ID's will result in a fatal error message during setup processing by AERMOD. The group ID's are:

INCRCONS – increment-consuming sources (group **A** above); these can be new sources or modifications to existing sources;

NONRBASE – existing, non-retired baseline sources (group **B** above); and

RETRBASE – retired (increment-expanding or PSD credit) baseline sources (group **C** above).

It is important to note that the source emission inputs for sources included in the RETRBASE PSD group must be entered as positive numbers, unlike other types of PSD credit modeling where negative emissions are input to simulate the impact of the credit sources on the increment calculation. The increment-expanding contribution from RETRBASE sources is accounted for within the AERMOD model under the PSDCREDIT option.

The group ID's can appear in any order, but these are the only three that can be specified. If there are no retired baseline sources (i.e., no baseline sources are retired), the keyword RETRBASE can be omitted. Likewise, if there are no non-retired baseline sources (i.e., all baseline sources have been retired), the NONRBASE keyword can be omitted. The special group ID 'ALL' that can be used with the SRCGROUP keyword **cannot** be used with the PSDGROUP keyword. As with the SRCGROUP keyword for non-PSDCREDIT applications, the group IDs are repeatable, and they must be the last keyword before FINISHED on the SO pathway when the PSDCREDIT option is specified.

Source ranges, which are described in more detail in Section 3.3.9, are input as two source IDs separated by a dash, e.g., STACK1-STACK10. Individual source IDs and source ranges may be used on the same card. If more than one input card is needed to define the sources for a particular group, then additional cards may be input, repeating the pathway, keyword and group ID. A source can appear in only one of these source groups and must be assigned to one of the groups.

The requirements for specifying sources and source groups under the PSDCREDIT option are summarized below:

- The SRCGROUP keyword cannot be used with the PSDCREDIT option;
- Special PSD group ID's must be used with the PSDGROUP keyword;
- The group ID ALL is not allowed when the PSDCREDIT option is specified;
- A source must appear in one, and only one, of the PSDGROUPs; and
- Emission rates for increment-expanding (RETRBASE) sources must be entered as positive values.

3.3.7.4 Model outputs under the PSDCREDIT option

Unlike the regular SRCGROUP keyword, the PSDGROUP keyword does not define how the source impacts are grouped for model output. As described in the previous sections, the PSDGROUP keyword defines the different categories of sources needed, in order to properly account for NO_x conversion chemistry under the PVMRM option.

The model outputs under the PSDCREDIT option in AERMOD are based on demonstrating compliance with the air quality standards, i.e., the NAAQS and PSD increment for NO_2. As a result, AERMOD uses hardcoded "SRCGROUP" names of 'NAAQS' and 'PSDINC' to label these two types of outputs. The results output under the 'NAAQS' source group label are based on the calculation of (**A**+**B**) as described above in Section 3.3.7.2. The results reported under the 'PSDINC' source group label are based on the expression presented above in Equation 2.

3.3.8 Background concentrations

Beginning with version 11059, users can specify uniform or temporally varying background concentrations using the BACKGRND keyword on the SO pathway and beginning with version 13350 users can vary background concentrations by wind sector. Background concentrations can be included with any source group to estimate cumulative ambient impacts. Background concentrations can be specified using a range of options, similar to those available with the EMISFACT keyword for source emissions, or on an hourly basis from a separate data file.

3.3.8.1 Defining background concentration sectors

For applications where multiple ambient monitors outside of the modeling domain are available and representative of background concentrations within the modeling domain depending

on the wind direction, the user may define sector-varying background concentrations. The sectors are defined based on the SO BGSECTOR keyword, as follows:

Syntax:	SO BGSECTOR StartSect1 StartSect2 . . . StartSect*N*, where $N \leq 6$
Type:	Optional, Non-Repeatable

For applications that include sector-varying background concentration the minimum sector width allowed is 30 degrees and warning messages will be issued for sector widths less than 60 degrees. **Sector-varying background concentrations will be selected based on the flow vector, i.e., the downwind direction, based on the wind direction specified in the surface meteorological data file. During periods of specific wind directions, the associated user input sector-varying background concentrations will be applied to the entire modeling domain (i.e., all receptors).**

For applications that do not include sector-varying background concentrations, the syntax of the BACKGRND keyword is as follows:

Syntax:	SO BACKGRND BGflag BGvalue(i), i=1,n and/or SO BACKGRND HOURLY BGfilnam (BGformat)
Type:	Optional, Repeatable

where the BGflag parameter is the variable background concentration flag, BGvalue is the array of background concentration values associated with BGflag, HOURLY indicates use of an hourly background file, BGfilnam is the filename for the hourly background data, and BGformat is the optional Fortran format of the hourly background file ('free' format is used by default). The BGfilnam can be up to 200 characters in length based on the default parameters in AERMOD. Double quotes (") at the beginning and end of the filename can also be used as field delimiters to allow filenames with embedded spaces.

For applications that include sector-varying background concentrations, the syntax of the BACKGRND keyword is as follows:

Syntax:	SO BACKGRND SECT*x* BGflag BGvalue(i) i=1, and $x \leq 6$ and/or SO BACKGRND SECT*x* HOURLY BGfilnam (BGformat) where $x \leq 6$
Type:	Optional, Repeatable

where the SECT*x* parameter identifies the applicable sector as defined on the SO BGSECTOR keyword. Implement as SECT1 or SECT2 …or SECT*x* where $x \leq 6$, and *x* is an integer and corresponds to the *N*th sector defined by BGSECTOR. The other parameters are as defined above.

The HOURLY background file must include the year, month, day, and hour, followed by the background concentration, in that order (unless specified differently through the BGformat parameter). The year can be specified as either a 2-digit or 4-digit year. If an optional Fortran format is specified using the BGformat parameter, the year, month, day, and hour variables must be read as integers using the Fortran I format, and the background concentration must be read as a real variable, using the Fortran F, E, or D format, e.g., (4I2,F8.3). Note that background values that do not include decimal places can be read as Fx.0, where x is the length of the data field. The BGformat parameter must include the open and close parentheses as shown in the example and may also include embedded spaces if double quotes (“) are used to delimit the field. A warning message will be generated if the specified format does not meet these requirements, and AERMOD may also issue a fatal error message when reading the file in cases where real variables are read with an integer format, or vice versa.

If the optional BGformat parameter is missing, then the model will read the background data using a Fortran ‘free’ format, i.e., assuming commas or spaces separate the data fields, and that the fields are in the order given above. The date sequence in the background data file must also match the date sequence in the hourly meteorological data files.

Note that the HOURLY option and an option to specify values based on the BGflag parameter can both be specified in the same model run. This allows the user to specify background concentrations on a temporally varying basis, such as SEASHR, that can be used to substitute for missing values in an hourly background file. **NOTE: AERMOD will issue a fatal error message and abort processing if missing data are encountered in an HOURLY background file unless**

the user provides other temporally varying background concentrations (e.g., SEASHR, etc.) to substitute for missing data. Background concentration units can be specified using the BACKUNIT keyword, described below. If the BACKUNIT keyword is omitted, default units of PPB are assumed for background NO_2 and SO_2, PPM for CO, and UG/M3 for all other pollutants. Background concentrations specified in units of PPB or PPM are converted to UG/M3 based on reference temperature (25 C) and pressure (1013.25 mb).

To include background concentrations with a particular source group, the reserved "source ID" of BACKGROUND (or BACKGRND) can be included on the SRCGROUP keyword, including source group ALL. **NOTE:** AERMOD will NOT automatically include background concentrations in source group ALL, but the user can specify that background be included in results for group ALL by including the BACKGROUND (or BACKGRND) keyword after 'ALL' on the SRCGROUP keyword. Users can also include the NOBACKGROUND (or NOBACKGRND) keyword after 'ALL' on the SRCGROUP keyword to explicitly indicate that BACKGROUND is NOT included with group 'ALL.' The contribution of background concentrations can also be tracked separately by including a source group with BACKGROUND as the only "source ID." **NOTE: The source of background concentrations and the method used to incorporate background concentrations in a cumulative impact assessment involves several considerations and should be documented and justified on a case-by-case basis.**

Background concentrations specified with the BACKGRND keyword are combined with source impacts on a temporally paired basis to estimate cumulative ambient impacts. However, since modeled concentrations are not calculated for hours with calm or missing meteorological data, background concentrations are also omitted for those hours. This may result in the background contribution being lower than expected for short-term averages of 3-hours up to 24-hours for periods when the denominator used to calculate the multi-hour average is adjusted in accordance with EPA's calms policy (see Section 8.4.6.2 of the Guideline, EPA, 2024b), which is implemented within the AERMOD model. Section 8.4.6.2 of the Guideline states:

> "Model predicted concentrations for 3-, 8-, and 24-hour averages should be calculated by dividing the sum of the hourly concentrations for the period by the number of valid or non-missing hours. If the total number of valid hours is less than 18 for 24-hour averages, less

than 6 for 8-hour averages, or less than 3 for 3- hour averages, the total concentration should be divided by 18 for the 24-hour average, 6 for the 8-hour average, and 3 for the 3-hour average. For annual averages, the sum of all valid hourly concentrations is divided by the number of non-calm hours during the year."

For example, if 12 hours out of a 24-hour period are calm or missing, the calms policy dictates that the 24-hour average concentration would be based on the sum of the 12 non-calm/non-missing hours divided by 18. The contribution from background concentrations would also be based on the sum of background values for the 12 non-calm/non-missing hours, divided by 18. If background was specified as uniform during that 24-hour period, then the contribution from background would appear to be 33.3% lower than expected (i.e., 12/18).

The BGflag parameter must be specified as one of the following secondary keywords (the number in parentheses indicates the number of values required for each option):

ANNUAL - annual background value (n=1),

SEASON - background values vary seasonally (n=4),

MONTH - background values vary monthly (n=12),

HROFDY - background values vary by hour-of-day (n=24),

WSPEED - background values vary by wind speed (n=6),

SEASHR - background values vary by season and hour-of-day (n=96),

HRDOW - background values vary by hour-of-day, and day-of-week [M-F, Sat, Sun] (n=72),

HRDOW7 - background values vary by hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n=168),

SHRDOW - background values vary by season, hour-of-day, and day-of-week [M-F, Sat, Sun] (n=288),

SHRDOW7 - background values vary by season, hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n=672),

MHRDOW - background values vary by month, hour-of-day, and day-of-week [M-F, Sat, Sun] (n=864), and

MHRDOW7 - background values vary by month, hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n=2,016).

The seasons are defined in the following order: Winter (Dec., Jan., Feb.), Spring (Mar., Apr., May), Summer (Jun., Jul., Aug.), and Fall (Sep., Oct., Nov.).[4] The wind speed categories used with the WSPEED option may be defined using the ME WINDCATS keyword (Section 3.5.6). If the WINDCATS keyword is not used, the default wind speed categories are defined by the upper bound of the first five categories as follows (the sixth category is assumed to have no upper bound): 1.54, 3.09, 5.14, 8.23, and 10.8 m/s. The BACKGRND keyword may be repeated as many times as necessary to input all of the background values and repeat values may be used for the numerical inputs, e.g., 12*25.6 can be used to specify a value of 25.6 for 12 adjacent "cells" within the array of values.

3.3.8.2 Specifying background concentration units

Background concentration units can be specified on the optional BACKUNIT keyword on the SO pathway. The syntax of the BACKUNIT keyword is as follows:

Syntax:	SO BACKUNIT BGUnits
Type:	Optional, Non-repeatable

where the BGUnits parameter specifies the units as parts-per-billion (PPB), parts-per-million (PPM), or micrograms/cubic-meter (UG/M3). Units specified on the BACKUNIT keyword are applied to HOURLY and temporally varying background values if both are included in the same model run. If the BACKUNIT keyword is omitted, default units of PPB are assumed for background NO_2 and SO_2, PPM for CO, and UG/M3 for all other pollutants. Background concentrations specified in units of PPB or PPM are converted to UG/M3 based on reference temperature (25 C) and pressure (1013.25 mb). NOTE: When using the BACKUNIT keyword, PPB and PPM may only be used with the NO2, SO2, and CO POLLUTID. AERMOD will issue a fatal error if PPB and PPM are used with any other pollutant types. Use micrograms/cubic-meter (UG/M3) when specifying any other pollutant type.

4 Note that the seasons are based on northern hemisphere seasons. For applications in the southern hemisphere using the seasonal factors (SEASHR, SHRDOW, and SHRDOW7), background concentrations that would be associated with the southern hemisphere winter, for example, should be assigned to the summer seasonal background concentrations input to AERMOD. Similarly, spring southern hemisphere concentrations should be assigned to the fall season background concentrations input to AERMOD.

3.3.9 Specifying building downwash information

As noted above, the AERMOD model includes algorithms to model the effects of buildings downwash on emissions from nearby or adjacent point sources. The building downwash algorithms do not apply to volume or area sources. For a technical description of the building downwash algorithms in AERMOD, the user is referred to Schulman, et. al. (2000). The AERMOD model uses direction-specific information for all building downwash cases.

There are five keywords that are used to specify building downwash information: BUILDHGT, BUILDWID, BUILDLEN, XBADJ, YBADJ. The syntax, type and order for the BUILDHGT keyword, used to input direction specific building heights, are summarized below:

Syntax:	SO BUILDHGT Srcid (or Srcrng) Dsbh(i),i=1,36 (16 for LT)
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source. The user also has the option of specifying a range of sources (the Srcrng parameter) for which the building heights apply, instead of identifying a single source. This is accomplished by two source ID character strings separated by a dash, e.g., STACK1-STACK10. Since the model reads the source range as a single input field there must not be any spaces between the source IDs. The model then places the building heights that follow (the Dsbh(i) parameter) into the appropriate arrays for all Srcid's that fall within that range, including STACK1 and STACK10.

When comparing a source ID to the range limits for a Srcrng parameter, the model separates the source IDs into three parts: an initial alphabetical part, a numerical part, and then the remainder of the string. Each part is then compared to the corresponding parts of the source range, and all three parts must satisfy the respective ranges for the source ID to be included. If there is no numeric part, then the ID consists of only one alphabetical part. If the ID begins with a numeric character, then the initial alphabetical part defaults to a single blank. If there is no trailing alphabetical part, then the third part also defaults to a single blank part. If the trailing part consists of more than one alphabetical or numeric field, it is all lumped into one-character field. For

example, the source ID 'STACK2' consists of the parts 'STACK' plus '2' plus a single trailing blank, ' '. By comparing the separate parts of the source IDs, it can be seen that STACK2 falls between the range 'STACK1-STACK10.' For a three-part example, it can also be seen that VENT1B falls within the range of VENT1A-VENT1C. However, VENT2 does not fall within the range of VENT1A to VENT3B, since the third part of VENT2 is a single blank, which does not fall within the range of A to C. This is because a blank character will precede a normal alphabetical character. Normally, the source ranges will work as one would intuitively expect for simple source names. Most importantly, for names that are made up entirely of numeric characters, the source ranges will be based simply on the relative numerical values. The user is strongly encouraged to check the summary of model inputs to ensure that the source ranges were interpreted as expected and to avoid using complex source names in ranges, such as AA1B2C-AB3A3C. Since the order of keywords within the SO pathway is quite flexible, it is also important to note that the building heights will only be applied to those sources that have been defined previously in the input file.

Following the Srcid or the Srcrng parameter, the user inputs 36 direction-specific building heights (Dsbh parameter) in meters, beginning with the 10-degree flow vector (wind blowing toward 10 degrees from north), and incrementing by 10 degrees in a clockwise direction. Some examples of building height inputs are presented below:

```
SO BUILDHGT STACK1 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34.
SO BUILDHGT STACK1 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34.
SO BUILDHGT STACK1 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34.

SO BUILDHGT STACK1 36*34.0

SO BUILDHGT STACK1-STACK10 33*34.0 3*0.0

SO BUILDHGT STACK1 35.43  36.45  36.37  35.18  32.92  29.66  25.50  20.56
SO BUILDHGT STACK1 15.00  20.56  25.50  29.66  32.92  35.18  36.37  36.45
SO BUILDHGT STACK1 35.43  33.33  35.43  36.45   0.00  35.18  32.92  29.66
SO BUILDHGT STACK1 25.50  20.56  15.00  20.56  25.50  29.66  32.92  35.18
SO BUILDHGT STACK1 36.37  36.45  35.43  33.33
```

The first example illustrates the use of repeat cards if more than one card is needed to input all of the values. The values are processed in the order in which they appear in the input file and are identified as being repeat cards by repeating the Srcid parameter. The first and second examples produce identical results within the model. The second one illustrates the use of a repeat value that can simplify numerical input in some cases. The field "36*34.0" is interpreted by the model as "repeat the value 34.0 a total of 36 times." This is also used in the third example where the building height is constant for directions of 10 degrees through 330 degrees, and then is set to 0.0 (e.g., the stack may be outside the region of downwash influence) for directions 340 through 360. The third example also uses a source range rather than a single source ID. The last example illustrates building heights which vary by direction and shows that the number of values on each card need not be the same. For improved readability of the input file, the user may want to put the numerical inputs into "columns," but there are no special rules regarding the spacing of the parameters on this keyword.

The BUILDWID keyword is used to input direction-specific building widths for downwash analyses. The syntax for this keyword, which is very similar to the BUILDHGT keyword, is summarized below, along with the type and order information:

Syntax:	SO BUILDWID Srcid (or Srcrng) Dsbw(i),i=1,36 (16 for LT)
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

For a description of the Srcid and Srcrng parameters, and for a discussion and examples of the numeric input options, refer to the BUILDHGT keyword above. The Dsbw(i) parameter contains the 36 direction-specific building widths. The directions proceed in a clockwise direction, beginning with the 10-degree flow vector.

The BUILDLEN keyword is used to input direction-specific along-flow building lengths for downwash analyses. Figure 3-7 shows the relationship of the projected building to this dimension. The syntax for this keyword, which is very similar to the BUILDHGT keyword, is summarized below, along with the type and order information:

Syntax:	SO BUILDLEN Srcid (or Srcrng) Dsbl(i),i=1,36
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

For a description of the Srcid and Srcrng parameters, and for a discussion and examples of the numeric input options, refer to the BUILDHGT keyword above. The Dsbl(i) parameter contains the 36 direction-specific building lengths. The directions proceed in a clockwise direction, beginning with the 10-degree flow vector. Figure 3-7 shows the relationship of the projected building to these distances.

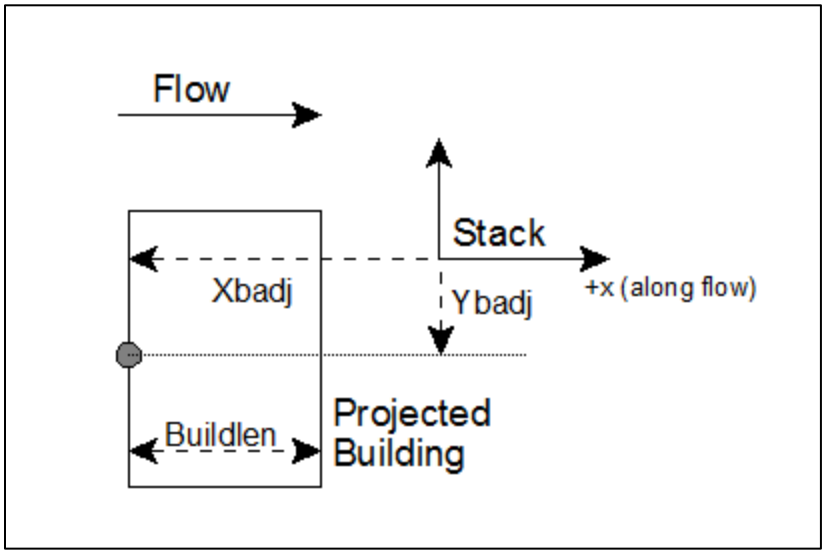


Figure 3-7. Schematic Diagram Identifying New Building Data for Prime Downwash

The XBADJ and YBADJ keywords are used to input direction-specific along-flow and across-flow distances from the stack to the center of the upwind face of the projected building, respectively. Figure 3-2 shows the relationship of the projected building to these distances. The syntax for these keywords, which is very similar to the BUILDHGT keyword, are summarized below, along with the type and order information:

Syntax:	SO XBADJ Srcid (or Srcrng) Xbadj(i),i=1,36
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

Syntax:	SO YBADJ Srcid (or Srcrng) Ybadj(i),i=1,36
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

For a description of the Srcid and Srcrng parameters, refer to the BUILDHGT keyword above. The Xbadj(i) parameter contains the 36 direction-specific along-flow distances from the stack to the center of the upwind face and the Ybadj(i) parameter contains the 36 direction-specific across-flow distances from the stack to the center of the upwind face. The directions proceed in a clockwise direction, beginning with the 10-degree flow vector.

3.3.10 Specifying urban sources

As discussed in Section 3.2.8, the AERMOD model allows the user to incorporate the effects of increased surface heating from an urban area on pollutant dispersion under stable atmospheric conditions. The user specifies the parameters for one or more urban areas on the CO URBANOPT card (see Section 3.2.8), and identifies which sources are to be modeled with urban effects and the urban area that will apply to each source affected using the SO URBANSRC card. If a source is not included on the URBANSRC card, it will be modeled without the urban effects. The syntax, type and order for the URBANSRC keyword are summarized below:

Syntax:	**For Multiple Urban Areas:** SO URBANSRC UrbanID SrcID's and/or SrcRng's **For Single Urban Areas:** SO URBANSRC SrcID's and/or SrcRng's or SO URBANSRC ALL (to specify all sources as URBAN)
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the UrbanID parameter is the alphanumeric urban ID (up to eight characters) defined by the user on the CO URBANOPT keyword when multiple urban areas are defined, and the SrcID's and SrcRng's are the individual source IDs and/or source ID ranges that are to be modeled with urban

effects. Source ranges are described in more detail in Section 3.3.9. As with the URBANOPT keyword, the syntax of the URBANSRC keyword for applications with single urban areas has not changed from the previous version of AERMOD, so that existing input files will not require modification. However, beginning with version 12060, users can specify that all sources are to be treated as urban sources by specifying 'ALL' on the SO URBANSRC keyword for applications with a single urban area. Since the URBANSRC ALL option is identified during the pre-SETUP phase, there are no restrictions on the order of the URBANSRC ALL keyword within the SO pathway.

3.3.11 Specifying variable emission factors (EMISFACT)

The AERMOD model provides the option of specifying variable emission rate factors for individual sources or for groups of sources. The syntax, type and order of the EMISFACT keyword are summarized below:

Syntax:	SO EMISFACT SrcID or SrcRange Qflag Qfact(i), i=1,n
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the SrcID parameter is the same source ID that was entered on the LOCATION card for a particular source. The user also has the option of using the SrcRange parameter for specifying a range of sources for which the emission rate factors apply, instead of identifying a single source. This is accomplished by two source ID character strings separated by a dash, e.g., STACK1-STACK10. The use of the SrcRange parameter is explained in more detail in the description of the BUILDHGT keyword (see Section 3.3.9).

The parameter Qflag is the variable emission rate flag, and must be specified as one of the following secondary keywords (the number in parentheses indicates the number of values required for each option):

SEASON - emission rates vary seasonally (n=4),
MONTH - emission rates vary monthly (n=12),
HROFDY - emission rates vary by hour-of-day (n=24),
WSPEED - emission rates vary by wind speed (n=6),

SEASHR - emission rates vary by season and hour-of-day (n=96),

HRDOW - emission rates vary by hour-of-day, and day-of-week [M-F, Sat, Sun] (n=72),

HRDOW7 - emission rates vary by hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n=168),

SHRDOW - emission rates vary by season, hour-of-day, and day-of-week [M-F, Sat, Sun] (n=288),

SHRDOW7 - emission rates vary by season, hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n=672),

MHRDOW - emission rates vary by month, hour-of-day, and day-of-week [M-F, Sat, Sun] (n=864), and

MHRDOW7 - emission rates vary by month, hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n=2,016).

The Qfact array is the array of factors, where the number of factors is shown above for each Qflag option. The seasons are defined in the following order: Winter (Dec., Jan., Feb.), Spring (Mar., Apr., May), Summer (Jun., Jul., Aug.), and Fall (Sep., Oct., Nov.).5 The wind speed categories used with the WSPEED option may be defined using the ME WINDCATS keyword (Section 3.5.6). If the WINDCATS keyword is not used, the default wind speed categories are defined by the upper bound of the first five categories as follows (the sixth category is assumed to have no upper bound): 1.54, 3.09, 5.14, 8.23, and 10.8 m/s. The EMISFACT card may be repeated as many times as necessary to input all of the factors and repeat values may be used for the numerical inputs. Examples for the more recent HRDOW and MHRDOW options are presented below, with column headers to indicate the order in which values are to be to input:

5 Note that the seasons are based on northern hemisphere seasons. For applications in the southern hemisphere using the seasonal factors (SEASHR, SHRDOW, and SHRDOW7), emission factors that would be associated with the southern hemisphere winter, for example, should be assigned to the summer seasonal emission factors input to AERMOD. Similarly, spring southern hemisphere emission factors should be assigned to the fall season emission factors input to AERMOD.

```
SO EMISFACT STK1 HRDOW   enter 24 hourly scalars for each of the "days", first for Weekdays
                         (Monday-Friday), then for Saturdays, and finally for Sundays, e.g.,
** Weekdays:          Hrs:   1-5    6    7-17   18   19-24
SO EMISFACT STK1 HRDOW      5*0.3  0.5  11*1.0  0.5  6*0.3
** Saturdays:         Hrs:   1-5    6    7-17   18   19-24
SO EMISFACT STK1 HRDOW      5*0.3  0.5  11*1.0  0.5  6*0.3
** Sundays:           Hrs:   1-5    6    7-17   18   19-24
SO EMISFACT STK1 HRDOW      5*0.3  0.5  11*1.0  0.5  6*0.3
```

```
SO EMISFACT STK1 HRDOW7  enter 24 hourly scalars for each of the "days",
                         first for Mondays, then for Tuesdays, ..., then for Saturdays,
                         and finally for Sundays, e.g.,
** Mondays:            Hrs:   1-5    6    7-17   18   19-24
SO EMISFACT STK1 HRDOW7     5*0.3  0.5  11*1.0  0.5  6*0.3
** Tuesdays:           Hrs:   1-5    6    7-17   18   19-24
SO EMISFACT STK1 HRDOW7     5*0.3  0.5  11*1.0  0.5  6*0.3
       .
       .
       .
** Saturdays:          Hrs:   1-5    6    7-17   18   19-24
SO EMISFACT STK1 HRDOW7     5*0.3  0.5  11*1.0  0.5  6*0.3
** Sundays:            Hrs:   1-5    6    7-17   18   19-24
SO EMISFACT STK1 HRDOW7     5*0.3  0.5  11*1.0  0.5  6*0.3
```

```
SO EMISFACT STK1 MHRDOW  enter 24 hourly scalars for each of the twelve months, first for Weekdays
                         (Monday-Friday), then for Saturdays, and finally for Sundays, e.g.,
** Weekdays              JAN    FEB    MAR    APR    MAY    JUN  . . .  NOV    DEC
SO EMISFACT STK1 MHRDOW 24*1.0 24*0.8 24*0.6 24*0.8 24*1.0 24*0.8      24*0.6 24*0.8
** Saturdays:
SO EMISFACT STK1 MHRDOW 24*1.0 24*0.8 24*0.6 24*0.8 24*1.0 24*0.8      24*0.6 24*0.8
** Sundays:
SO EMISFACT STK1 MHRDOW 24*1.0 24*0.8 24*0.6 24*0.8 24*1.0 24*0.8      24*0.6 24*0.8
```

```
SO EMISFACT STK1 MHRDOW7 enter 24 hourly scalars for each of the twelve months,
                         first for Mondays, then for Tuesdays, ..., then for Saturdays,
                         and finally for Sundays, e.g.,
** Mondays                JAN    FEB    MAR    APR    MAY    JUN  . . .  NOV    DEC
SO EMISFACT STK1 MHRDOW7 24*1.0 24*0.8 24*0.6 24*0.8 24*1.0 24*0.8      24*0.6 24*0.8
** Tuesdays               JAN    FEB    MAR    APR    MAY    JUN  . . .  NOV    DEC
SO EMISFACT STK1 MHRDOW7 24*1.0 24*0.8 24*0.6 24*0.8 24*1.0 24*0.8      24*0.6 24*0.8
       .
       .
       .
** Saturdays:
SO EMISFACT STK1 MHRDOW7 24*1.0 24*0.8 24*0.6 24*0.8 24*1.0 24*0.8      24*0.6 24*0.8
** Sundays:
SO EMISFACT STK1 MHRDOW7 24*1.0 24*0.8 24*0.6 24*0.8 24*1.0 24*0.8      24*0.6 24*0.8
```

3.3.12 Specifying an hourly emission rate file (HOUREMIS)

The source (SO) pathway includes an option for inputting hourly emission rates for the AERMOD model, controlled by the HOUREMIS keyword. Beginning with AERMOD 26135 multiple hourly emission files can be used in a model run. The syntax, type and order for this keyword are summarized below:

Syntax:	SO HOUREMIS Emifil Srcid's (and/or Srcrng's)
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Emifil parameter specifies the filename for the hourly emission file, and Srcid or Srcrng identify the source or sources for which hourly emission rates are included. The Emifil filename can be up to 200 characters in length based on the default parameters in AERMOD. Double quotes (“) at the beginning and end of the filename can also be used as field delimiters to allow filenames with embedded spaces. Source ranges, which are described in more detail in Section 3.3.9, are input as two source IDs separated by a dash, e.g., STACK1-STACK10. The HOUREMIS keyword is repeatable and can be repeated to continue a list of source IDs associated with a file or to identify multiple files and the source IDs associated with each file. **While multiple hourly emission files can be specified in a single model run, a source can only be associated with one hourly emissions file. Sources must be listed in the hourly emission file in the order they appear in the control file, though sources should be omitted if they are not associated with an hourly emissions file or are associated with a different emission file.**

The format of each record of the hourly emissions file includes a pathway and keyword (SO HOUREMIS), followed by the Year, Month, Day, Hour, Source ID, and emission rate (in the appropriate units). For POINT/POINTHOR/POINTCAP sources, an hourly stack gas exit temperature (K) and stack gas exit velocity (m/s) are also required. Beginning with version 09292, the release heights and initial dispersion coefficients can also be varied on an hourly basis for AREA, AREAPOLY, AREACIRC, LINE, and VOLUME sources using the HOUREMIS option.

As discussed in Sections 3.2.12, 3.3.2.2, 3.3.2.4, and 3.3.18, the ALPHA option ARCFTOPT was added to AERMOD beginning in version 23132 to account for plume rise associated with aircraft emissions due to momentum and buoyancy when modeling aircraft as AREA (including AREAPOLY, AREACIRC, and LINE) and/or VOLUME source types. To characterize an aircraft source requires additional source parameters beyond those required for non-aircraft AREA and VOLUME source types. The additional aircraft source parameters **must be specified in an hourly emission rate file**. In addition to the required hourly emission rate for AREA and VOLUME

source types, the following aircraft parameters must be included for each hour and aircraft source in the hourly emission rate file, appended to each record, in the following order:

- MFUEL: Fuel burn rate (g/s)
- THRUST: Aircraft thrust (newtons)
- VAA: Aircraft speed (m/s)
- AFR: Air-fuel ratio
- BYPR: Bypass ratio (> 0 for turbofan and -999 for shaft-based engines)
- RPWR: Rated power (kW) (-99999 for turbofan and > 0 for shaft-based)
- SRCANGLE: Landing/takeoff angle with the ground (degrees) (airborne sources)

The parameters listed above must be included each hour in the hourly emission rate file for all AREA and VOLUME sources identified as an aircraft source with the ARCFTSRC keyword. These parameters must not be included for any AREA or VOLUME source that is not identified as an aircraft source. If AERMOD determines there are too many or too few parameters, a fatal error message will be issued, and processing will not complete.

Beginning with version 19191, release heights and initial dispersion can be varied for RLINE and RLINEXT sources. The user selects this enhanced option by including the additional source parameters in the hourly emissions file. AERMOD determines whether hourly release heights and initial dispersion coefficients are being used based on the first HOUREMIS record for each source, and these additional parameters must be included on all HOUREMIS records unless the emissions are missing, which is indicated by leaving the emission rate and all fields beyond the source ID blank.

When hourly emissions are specified for a buoyant line source, each of the individual lines (BUOYLINE sources) that comprise the buoyant line source must be represented in the hourly emissions file for every hour, and the buoyancy (m^4/s^3) of each line must be specified after the hourly emission rate. The buoyancy of each line can vary within an hour and from hour

to hour. AERMOD computes an average buoyancy of the buoyant line source for each hour using the buoyancy values specified for each individual line that comprises the buoyant line source.

The hourly emissions file is processed using the same routines used to process the control file, therefore each of the parameters must be separated by at least one space, but otherwise the format is flexible. It is also not necessary to include the SO HOUREMIS on each line, as long as the parameters (Year, Month, etc.) do not begin before column 13. The data in the hourly emission file must also include the exact same dates as are included in the meteorological input files, and the source IDs must correspond to the source IDs defined on the SO LOCATION cards and be in the same order as defined in the 'aermod.inp' file.

The model will check for a date mismatch between the hourly emissions file and the meteorological data files. However, it is not necessary to process the entire hourly emissions file on each model run, i.e., the correct emissions data will be read if the ME DAYRANGE or the ME STARTEND cards (see Section 3.5.4) are used, as long as all the dates (including those that are processed and those that are skipped) match the meteorological data files.

An example of several lines from an hourly emissions file for two point sources is provided below:

```
SO HOUREMIS 88 8 16 1 STACK1  52.5  382.60  12.27
SO HOUREMIS 88 8 16 1 STACK2  44.3  432.33  22.17
SO HOUREMIS 88 8 16 2 STACK1  22.3  377.88   9.27
SO HOUREMIS 88 8 16 2 STACK2  42.2  437.68  19.67
SO HOUREMIS 88 8 16 3 STACK1  51.5  373.72  11.87
SO HOUREMIS 88 8 16 3 STACK2  41.3  437.28  18.77
SO HOUREMIS 88 8 16 4 STACK1  36.0  374.83   9.63
SO HOUREMIS 88 8 16 4 STACK2  43.7  437.68  18.23
```

The use of hourly varying release heights and initial dispersion coefficients for VOLUME and AREA sources is illustrated in the following example:

```
SO HOUREMIS 88  3  1   1   VOL1  500.0  2.0 2.0 2.0
SO HOUREMIS 88  3  1   1   AREA1 5.000  2.0 2.0
SO HOUREMIS 88  3  1   2   VOL1  500.0  2.0 2.0 3.0
SO HOUREMIS 88  3  1   2   AREA1 5.000  2.0 3.0
SO HOUREMIS 88  3  1   3   VOL1  500.0  2.0 2.0 4.0
SO HOUREMIS 88  3  1   3   AREA1 5.000  2.0 4.0
```

For POINT/POINTHOR/POINTCAP sources, the model will use the stack release height and stack inside diameter defined on the SO SRCPARAM card, but will use the emission rate, exit temperature and exit velocity from the hourly emission file. As noted above regarding VOLUME and AREA sources, if the emission rate, exit temperature and exit velocity are not included for a particular hour, i.e., any or all of those fields are blank, the model will interpret emissions data for that hour as missing and will set the parameters to zero. Since the emission rate will be zero, there will be no calculations made for that hour and that source.

3.3.13 Adjusting the emission rate units for output

The default emission rate units for the AERMOD model are grams per second (g/s) for POINT/POINTHOR/POINTCAP, VOLUME, and BUOYLINE sources, grams per second per meter (g/s/m) for RLINEXT sources, and grams per second per square meter ($g/s/m^2$) for AREA, LINE, OPENPIT, and RLINE sources. By default, the model converts these input units to output units of micrograms per cubic meter ($\mu g/m^3$) for concentration calculations. This is accomplished by applying a default emission rate unit factor of 1.0E06 for concentration.

The EMISUNIT keyword on the SO pathway allows the user to specify a different unit conversion factor, and to specify the appropriate label for the output units for either concentration calculations. The syntax and type of the EMISUNIT keyword are summarized below:

Syntax:	SO EMISUNIT Emifac Emilbl Conlbl
Type:	Optional, Non-repeatable
Order:	Must follow the LOCATION card for each source input

where the parameter Emifac is the emission rate unit factor, Emilbl is the label for the emission units (up to 40 characters), and Conlbl is the output unit label (up to 40 characters) for concentration calculations. For example, to produce output concentrations in milligrams per cubic meter, assuming input units of grams per sec, the following card could be input:

```
SO EMISUNIT        1.0E3   GRAMS/SEC  MILLIGRAMS/M**3
```

since there are 1.0E3 milligrams per gram. The emission rate unit factor applies to all sources for a given run. Since the model uses one or more spaces to separate different fields on the input control file commands, it is important that there not be any spaces within the label fields on this card. Thus, instead of entering 'GRAMS PER SECOND' for the emission label, a label of 'GRAMS/SECOND', or 'GRAMS-PER-SECOND' or an equivalent variation should be used.

For the RLINE or RLINEXT source types, an additional keyword was introduced in version 19191to allow alternate units of grams per link per hour. These alternate units can be used if the keyword RLEMCONV (RLine EMission CONVersion) is used on the SO card. This keyword has no additional inputs, but when present, emissions for all RLINE and RLINEXT sources are assumed to be in grams per link per hour. The model converts such units internally to its native units for each source and the computation proceeds as normal. The syntax and type of the RLEMCONV keyword are summarized below:

Syntax:	SO RLEMCONV
Type:	Optional, Non-repeatable
Order:	Can be present anywhere on the SO card

3.3.14 Including source data from an external file

The user has the option of including source data from an external file by using the INCLUDED keyword on the source (SO) pathway. A SO INCLUDED card may be placed anywhere within the source pathway, after the STARTING card and before the FINISHED card (i.e., the SO STARTING and SO FINISHED cards cannot be included in the external file). The data

in the included file will be processed as though it were part of the control file. The syntax and type of the INCLUDED keyword are summarized below:

Syntax:	SO INCLUDED Incfil
Type:	Optional, Repeatable

where the Incfil parameter is a character field of up to 200 characters that identifies the filename for the included file. The contents of the included file must be valid control file commands for the source pathway. If an error is generated during processing of the included file, the error message will report the line number of the included file (see APPENDIX B). If more than one INCLUDED file is specified for the source pathway, the user will first need to determine which file the error occurred in. If the starting column of the main control input file is shifted from column 1 (see Section 2.4.8), then the control file commands in the included file must be offset by the same amount.

3.3.15 Using source groups

The AERMOD model allows the user to group contributions from particular sources together. Several source groups may be set up in a single run, and they may, for example, be used to model impacts from the source being permitted, the group of increment consuming PSD sources, and the group of all sources for comparison to a NAAQS in a single run. There is always at least one source group in a run, which may consist of all sources, so the SRCGROUP keyword has been made mandatory in the AERMOD model unless the PSDGROUP is specified, which is mandatory when using the PSDCREDIT keyword with the PVMRM NO to NO_2 conversion option (See Section 3.3.7). The SRCGROUP keyword cannot be used when the PSDGROUP keyword is used. The syntax, type and order of the SRCGROUP keyword are summarized below:

Syntax:	SO SRCGROUP Grpid Srcid's and/or Srcrng's
Type:	Mandatory (conditional), Repeatable
Order:	Must be the last keyword in the SO pathway before FINISHED

where the Grpid parameter is an alphanumeric string of up to eight characters that identifies the group name. The Srcid's and Srcrng's are the individual source IDs and/or source ranges that make up the group of sources. Source ranges, which are described in more detail in the description of the BUILDHGT keyword (Section 3.3.9), are input as two source IDs separated by a dash, e.g., STACK1-STACK10. Individual source IDs and source ranges may be used on the same card. If more than one input card is needed to define the sources for a particular group, then additional cards may be input, repeating the pathway, keyword and group ID.

A special group ID has been reserved for use in specifying the group of all sources. When Grpid = ALL, the model will automatically set up a source group called ALL that includes all sources modeled for that run. If desired, the user can set up a group of all sources with a different group ID by explicitly specifying all sources on the input card(s).

Note: The secondary keyword, ALL, is used in different source grouping contexts (e.g., BLPGROUP, SRCGROUP, OLMGROUP). Refer to the appropriate section of this user's guide to see the usage of the secondary keyword, ALL, for the group of sources to be identified. For BLPGROUP see Section 3.3.2.11. For OLMGROUP, see Section 3.3.6.2.

The number of source groups is allocated dynamically at the time AERMOD is run. This value, in concert with the other dynamically allocated arrays and input requirements, is limited only by the amount of available memory.

As discussed in Sections 1.2.9 and 3.2.14, it is sometimes important for a user to know the contribution of a particular source to the total result for a group. These source contribution analyses are facilitated for short-term averages by the use the EVENT processing capabilities in the AERMOD model. EVENT processing uses the same source groups that are identified by AERMOD (when the input file is generated using the CO EVENTFIL option), but the model is structured in a way that it retains individual source results for particular events. Refer to the sections noted above for a more complete description of EVENT processing and its uses.

With respect to buoyant line sources, note that the SRCGROUP keyword treats the individual lines (BUOYLINE) that comprise a buoyant line source as if they are individual sources.

A SRCGROUP can consist of all or a subset of the individual lines by specifying the source IDs from the LOCATION keyword for those lines that should make up the SRCGROUP.

Note that when modeling with Tier 2 or Tier 3 NO_2 conversion and using source groups, the conversion mechanism will be based on the total NOx at each receptor for all sources rather than the NOx concentration just for each source group.

3.3.16 Specifying platform downwash information (POINT, POINTHOR, POINTCAP sources ONLY)

The Offshore and Coastal Dispersion (OCD) Model is the EPA's preferred model for estimating near field air pollutant impacts from overwater emission sources, for both deep water and shoreline applications. The original platform downwash algorithms were developed by Petersen (1984) and adapted when implemented into OCD by Hanna and Dicristofaro (1988). The platform downwash algorithms from OCD were integrated into AERMOD for POINT/POINTHOR/POINTCAP source types ONLY.

The SRCPARAM input for stack height is used with inputs via a new PLATFORM keyword to simulate a platform's influence on the dispersion from a POINT or POINTHOR or POINTCAP source. When the PLATFORM keyword is included in the AERMOD control file, platform downwash will be applied to the source identified by the source ID. The syntax, type, and order for the PLATFORM keyword are summarized below:

Syntax:	SO PLATFORM Srcid Zelp Hb Wb
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular POINT/POINTHOR/POINTCAP source, and the other parameters are as follows:

Zelp - Base height (in meters) defined as the height of the bottom of the platform above the sea surface. NOTE: This input is consistent with the input for OCD, but this input is not currently used in the AERMOD implementation of platform downwash specific algorithms,

because the full height of the source as defined for the POINT/POINTHOR/POINTCAP source is used, no adjustment is made for the height of the platform.

Hb - Total height (in meters), above the sea surface, of the tallest solid or "influential" building (i.e., the sum of the height of the base of the platform above the sea surface and the height of the building above the base of the platform)

Wb - The **lesser of the two distances (in meters)** from outer edges of the leftmost and rightmost buildings on top of the platform that can influence downwash when comparing the side and end views of the platform as shown in Figure 3--3-8. The platform downwash influence is not adjusted for platform dimension normal to the wind, the influence will be identical for all wind directions.

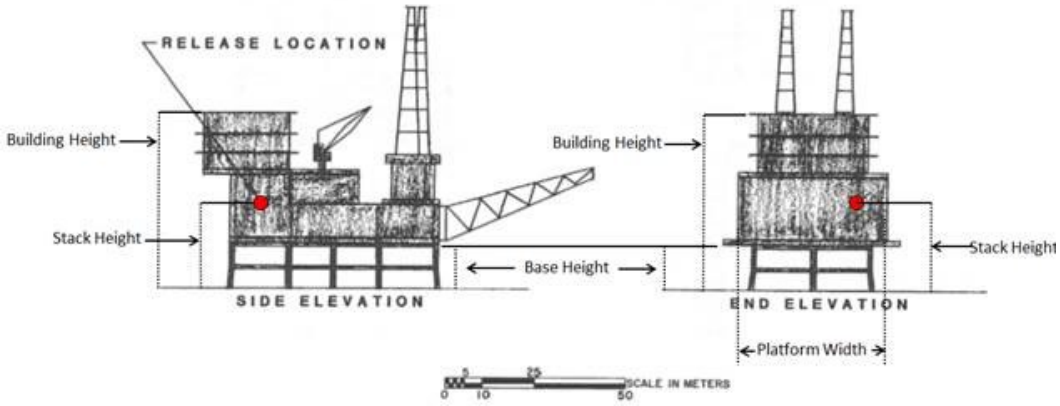


Figure 3--3-8. New platform parameter figure with correct parameter definitions. Adapted from Petersen (1984)

All parameters are required for a POINT or POINTHOR or POINTCAP source located on a platform. POINT or POINTHOR or POINTCAP sources located on a platform are NOT subject to the PRIME building downwash options. An ERROR message will occur if the same source ID is used with the building downwash keywords.

3.3.17 Specifying highly buoyant point sources for HBP option (POINT, POINTHOR, POINTCAP sources ONLY)

Beginning with version 23132, HBP, specified with the MODELOPT keyword in the CO pathway (see Section 3.2.2), was added as an ALPHA option for highly buoyant plumes that penetrate the top of the convective mixed layer (Weil, 2020; Warren et. al., 2022). The HBP option is only applicable to POINT, POINTHOR, and POINTCAP source types. When the HBP option is

specified with the MODELOPT keyword, the sources to which the HBP option should be applied must be identified using the HBPSRCID keyword on the SO pathway.

Syntax:	SO HBPSRCID	Srcid's and/or Srcrng's
	or	
	SO HBPSRCID	ALL
Type:	Mandatory (conditional), Repeatable	

where the Srcid's and Srcrng's are the individual source IDs and/or source ranges that make up the group of sources. Source ranges, which are described in more detail in the description of the BUILDHGT keyword (Section 3.3.9), are input as two source IDs separated by a dash, e.g., STACK1-STACK10. Individual source IDs and source ranges may be used on the same card. If more than one input card is needed to define the sources for a particular group, then additional cards may be input, repeating the pathway (SO), keyword (HBPSRCID), and source IDs and/or ranges. The secondary keyword ALL can be entered in the place of specific source IDs or ranges to apply the HBP option to all POINT, POINTHOR, and POINTCAP source types. Any source types other than POINT, POINTHOR, and POINTCAP that are included in the model simulation and specified with the HBPSRCID keyword, either by source ID or by specifying ALL, will be ignored. In that case, AERMOD will generate an informational message to indicate the non-POINT source type that was ignored.

3.3.18 Specifying aircraft sources (AREA and VOLUME sources ONLY)

As discussed in Section 3.2.12, the ALPHA option ARCFTOPT was added to AERMOD version 23132 to account for plume rise from aircraft emissions when aircraft are modeled as either VOLUME or AREA source types. Because additional parameters are required to characterize an aircraft source, all aircraft sources must be identified in the AERMOD control file using the ARCFTSRC primary keyword in the SO pathway, followed by a list of source IDs or ranges of source IDs. The syntax for the ARCFTSRC keyword is shown here

Syntax:	SO ARCFTSRC Srcid's and/or Srcrng's or SO ARCFTSRC ALL
Type:	Mandatory (conditional), Repeatable

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source. The user also has the option of specifying a range of sources (the Srcrng parameter) instead of identifying a single source or a list of single sources.

Source ranges, which are described in more detail in the description of the BUILDHGT keyword (Section 3.3.9), are input as two source IDs separated by a dash, e.g., STACK1-STACK10. Individual source IDs and source ranges may be used on the same card. If more than one input card is needed to identify all aircraft sources, then additional cards may be input, repeating the pathway, keyword, and group ID. The secondary keyword ALL can be entered in the place of specific source IDs or ranges to apply the AIRCFTOPT option to all AREA and VOLUME source types. Source types other than AREA and VOLUME sources that are included in the model simulation and specified with the ARCFTSRC keyword, either by source ID or by specifying ALL, will be ignored. The ARCFTSRC keyword is mandatory when the ARCFTOPT keyword is included in the CO pathway as described in Section 3.2.12. Failure to identify aircraft sources in the SO pathway with the ARCFTSRC keyword will generate a fatal error and processing will stop.

3.4 Receptor pathway inputs and options

The **RE**ceptor pathway contains keywords that define the receptor information for a particular model run. The RE pathway contains keywords that allow the user to define Cartesian grid receptor networks and/or polar grid receptor networks, with either uniform or non-uniform grid spacing, as well as discrete receptor locations referenced to a Cartesian or a polar system. The number of receptors and receptor networks are allocated dynamically at the time AERMOD is run. This value, in combination with the other dynamically allocated arrays and input requirements, is limited only by the amount of available memory.

All of the receptor options in AERMOD allow the user to input terrain elevations and hill height scales for each receptor, both of which are needed when applying AERMOD in an elevated

terrain situation. To facilitate the generation of hill height scales for AERMOD, a terrain preprocessor, called AERMAP, has been developed (EPA, 2004c). The AERMAP terrain preprocessor, which can process U.S. Geological Survey (USGS) Digital Elevation Model (DEM) data and data from the National Elevation Dataset (NED), may also be used to generate the terrain elevations for the receptor locations. The AERMAP program generates an output file that contains the receptor pathway data for AERMOD in the format described below. This file may be cut and pasted into the AERMOD control file or included as an external file using the RE INCLUDED card (see Section 3.4.4).

The default units for receptor elevations for the AERMOD model are in meters; however, the user may specify receptor elevations to be in units of feet by adding the RE ELEVUNIT FEET card immediately after the RE STARTING card. Since the AERMAP terrain preprocessor outputs elevations in meters and includes the RE ELEVUNIT METERS card as the first record, the AERMAP data must be placed at the beginning of the receptor pathway.

3.4.1 Defining networks of gridded receptors

Two types of receptor networks are allowed by the AERMOD model. A Cartesian grid network, defined through the GRIDCART keyword, includes an array of points identified by their x (east-west) and y (north-south) coordinates. A polar network, defined by the GRIDPOLR keyword, is an array of points identified by direction and distance from a user-defined origin. Each of these keywords has a series of secondary keywords associated with it that are used to define the network, including any receptor elevations for elevated terrain and flagpole receptor heights. The GRIDCART and GRIDPOLR keywords can be thought of as "sub-pathways," since their secondary keywords include a STArt and an END card to define the start and end of inputs for a particular network.

3.4.1.1 Cartesian grid receptor networks

Cartesian grid receptor networks are defined by use of the GRIDCART keyword. The GRIDCART keyword may be thought of as a "sub-pathway," in that there are a series of secondary keywords that are used to define the start and the end of the inputs for a particular network, and to

select the options for defining the receptor locations that make up the network. The syntax and type of the GRIDCART keyword are summarized below:

Syntax:	RE GRIDCART Netid STA XYINC Xinit Xnum Xdelta Yinit Ynum Ydelta or XPNTS Gridx1 Gridx2 Gridx3 .... Gridxn, and YPNTS Gridy1 Gridy2 Gridy3 .... Gridyn ELEV Row Zelev1 Zelev2 Zelev3 ... Zelevn HILL Row Zhill1 Zhill2 Zhill3 ... Zhilln FLAG Row Zflag1 Zflag2 Zflag3 ... Zflagn END
Type:	Optional, Repeatable

where the parameters are defined as follows:

Netid	Receptor network identification code (up to eight alphanumeric characters)
STA	Indicates the STArt of GRIDCART inputs for a particular network, repeated for each new Netid
XYINC	Keyword identifying uniform grid network generated from x and y increments
Xinit	Starting x-axis grid location in meters
Xnum	Number of x-axis receptors
Xdelta	Spacing in meters between x-axis receptors
Yinit	Starting y-axis grid location in meters
Ynum	Number of y-axis receptors
Ydelta	Spacing in meters between y-axis receptors
XPNTS	Keyword identifying grid network defined by a series of discrete x and y coordinates (used with YPNTS)
Gridx1	Value of first x-coordinate for Cartesian grid (m)
Gridxn	Value of 'nth' x-coordinate for Cartesian grid (m)
YPNTS	Keyword identifying grid network defined by a series of discrete x and y coordinates (used with XPNTS)
Gridy1	Value of first y-coordinate for Cartesian grid (m)
Gridyn	Value of 'nth' y-coordinate for Cartesian grid (m)
ELEV	Keyword to specify that receptor elevations follow (optional)
Row	Indicates which row (y-coordinate fixed) is being input (Row=1 means first, i.e., southmost row)
Zelev	An Array of receptor terrain elevations (m) for a particular Row (default units of meters may be changed to feet by use of RE ELEVUNIT keyword), number of entries per row equals the number of x-coordinates for that network

HILL Row Zelev	Keyword to specify that hill height scales follow (optional) Indicates which row (y-coordinate fixed) is being input (Row=1 means first, i.e., southmost row) An Array of hill height scales (m) for a particular Row (default units of meters may be changed to feet by use of RE ELEVUNIT keyword), number of entries per row equals the number of x-coordinates for that network
FLAG Row Zflag	Keyword to specify that flagpole receptor heights follow (optional) Indicates which row (y-coordinate fixed) is being input (Row=1 means first, i.e., southmost row) An array of receptor heights (m) above local terrain elevation for a particular Row (flagpole receptors), number of entries per row equals the number of x-coordinates for that network
END	Indicates the END of GRIDCART inputs for a particular network, repeated for each new Netid

The ELEV, HILL, and FLAG keywords are optional inputs, and are only needed if elevated terrain or flagpole receptor heights are to be used. If elevated terrain is being used, then both the ELEV and HILL inputs are needed for each receptor. If the ELEV and HILL keywords are used and the model is being run with the flat terrain option (see Section 3.2.2), then the elevated terrain height inputs will be ignored by the model, and a non-fatal warning message will be generated. If the elevated terrain option is selected, and no elevated terrain heights are entered, the elevations will default to 0.0 meters, and warning messages will also be generated. The model handles flagpole receptor height inputs in a similar manner.

The order of cards within the GRIDCART subpathway is not important, as long as all inputs for a particular network are contiguous and start with the STA secondary keyword and end with the END secondary keyword. It is not even required that all ELEV cards be contiguous, although the input file will be more readable if a logical order is followed. The network ID is also not required to appear on each control file command (except for the STA card). The model will assume the previous ID if none is entered, similar to the use of continuation cards for pathway and keywords. Thus, the following two examples produce the same 8 X 4 Cartesian grid network:

```
RE GRIDCART CAR1 STA
RE GRIDCART CAR1 XPNTS  -500.  -400.  -200.  -100. 100.  200.  400.  500.
RE GRIDCART CAR1 YPNTS  -500.  -250.  250.  500.
RE GRIDCART CAR1 ELEV 1  10.  10.  10.  10.  10.  10.  10.  10.
RE GRIDCART CAR1 ELEV 2  20.  20.  20.  20.  20.  20.  20.  20.
RE GRIDCART CAR1 ELEV 3  30.  30.  30.  30.  30.  30.  30.  30.
RE GRIDCART CAR1 ELEV 4  40.  40.  40.  40.  40.  40.  40.  40.
RE GRIDCART CAR1 HILL 1  50.  50.  50.  50.  50.  50.  50.  50.
RE GRIDCART CAR1 HILL 2  60.  60.  60.  60.  60.  60.  60.  60.
RE GRIDCART CAR1 HILL 3  70.  70.  70.  70.  70.  70.  70.  70.
RE GRIDCART CAR1 HILL 4  80.  80.  80.  80.  80.  80.  80.  80.
RE GRIDCART CAR1 FLAG 1  10.  10.  10.  10.  10.  10.  10.  10.
RE GRIDCART CAR1 FLAG 2  20.  20.  20.  20.  20.  20.  20.  20.
RE GRIDCART CAR1 FLAG 3  30.  30.  30.  30.  30.  30.  30.  30.
RE GRIDCART CAR1 FLAG 4  40.  40.  40.  40.  40.  40.  40.  40.
RE GRIDCART CAR1 END
```

```
RE GRIDCART CAR1 STA
                XPNTS -500. -400. -200. -100. 100. 200. 400. 500.
                YPNTS -500. -250. 250. 500.
                ELEV 1 8*10.
                HILL 1 8*50.
                FLAG 1 8*10.
                ELEV 2 8*20.
                HILL 2 8*60.
                FLAG 2 8*20.
                ELEV 3 8*30.
                HILL 3 8*70.
                FLAG 3 8*30.
                ELEV 4 8*40.
                HILL 4 8*80.
                FLAG 4 8*40.
RE GRIDCART CAR1 END
```

The Row parameter on the ELEV, HILL, and FLAG inputs may be entered as either the row number, i.e., 1, 2, etc., or as the actual y-coordinate value, e.g., -500., -250., etc. in the example above. The model sorts the inputs using Row as the index, so the result is the same. The above example could therefore be entered as follows, with the same result:

```
RE GRIDCART CAR1 STA
                XPNTS  -500.  -400.  -200.  -100.  100.  200.  400.  500.
                YPNTS  -500.  -250.  250.  500.
                ELEV   -500.  8*10.
                FLAG   -500.  8*10.
                ELEV   -250.  8*20.
                FLAG   -250.  8*20.
                ELEV    250.  8*30.
                FLAG    250.  8*30.
                ELEV    500.  8*40.
                FLAG    500.  8*40.
RE GRIDCART CAR1 END
```

Of course, one must use either the row number or y-coordinate value consistently within each network to have the desired result.

The following simple example illustrates the use of the XYINC secondary keyword to generate a uniformly spaced Cartesian grid network. The resulting grid is 11 x 11, with a uniform spacing of 1 kilometer (1000. meters), and is centered on the origin (0., 0.). No elevated terrain heights or flagpole receptor heights are included in this example.

```
RE GRIDCART CG1 STA
               XYINC  -5000.  11  1000.  -5000.  11  1000.
RE GRIDCART CG1 END
```

3.4.1.2 Polar grid receptor networks

Polar receptor networks are defined by use of the GRIDPOLR keyword. The GRIDPOLR keyword may also be thought of as a "sub-pathway," in that there are a series of secondary keywords that are used to define the start and the end of the inputs for a particular network, and to select the options for defining the receptor locations that make up the network. The syntax and type of the GRIDPOLR keyword are summarized below:

Syntax:	RE GRIDPOLR Netid STA ORIG Xinit Yinit, or ORIG Srcid DIST Ring1 Ring2 Ring3 ... Ringn DDIR Dir1 Dir2 Dir3 ... Dirn, or GDIR Dirnum Dirini Dirinc ELEV Dir Zelev1 Zelev2 Zelev3 ... Zelevn HILL Dir Zhill1 Zhill2 Zhill3 ... Zhilln FLAG Dir Zflag1 Zflag2 Zflag3 ... Zflagn END
Type:	Optional, Repeatable

where the parameters are defined as follows:

Netid	Receptor network identification code (up to eight alphanumeric characters)
STA	Indicates STArt of GRIDPOLR inputs for a particular network, repeat for each new Netid
ORIG Xinit Yinit Srcid	Keyword to specify the origin of the polar network (optional) x-coordinate for origin of polar network y-coordinate for origin of polar network Source ID of source used as origin of polar network
DIST Ring1 Ringn	Keyword to specify distances for the polar network Distance to the first ring of polar coordinates Distance to the 'nth' ring of polar coordinates
DDIR Dir1 Dirn	Keyword to specify discrete direction radials for the polar network First direction radial in degrees (1 to 360) The 'nth' direction radial in degrees (1 to 360)

GDIR Dirnum Dirini Dirinc	Keyword to specify generated direction radials for the polar network Number of directions used to define the polar system Starting direction of the polar system Increment (in degrees) for defining directions
ELEV Dir Zelev	Keyword to specify that receptor elevations follow (optional) Indicates which direction is being input (direction number or radial number) An array of receptor terrain elevations for a particular direction radial (default units of meters may be changed to feet by use of RE ELEVUNIT keyword), number of entries per radial equals the number of distances for that network
HILL Dir Zelev	Keyword to specify that hill height scales follow (optional) Indicates which direction is being input (direction number or radial number) An array of receptor hill height scales for a particular direction radial (default units of meters may be changed to feet by use of RE ELEVUNIT keyword), number of entries per radial equals the number of distances for that network
FLAG Dir Zflag	Keyword to specify that flagpole receptor heights follow (optional) Indicates which direction is being input (direction or radial number) An array of receptor heights above local terrain elevation for a particular direction (flagpole receptors)
END	Indicates END of GRIDPOLR subpathway, repeat for each new Netid

The ORIG secondary keyword is optional for the GRIDPOLR inputs. If omitted, the model assumes a default origin of (0.,0.) in x,y coordinates. The ELEV, HILL, and FLAG keywords are also optional inputs, and are only needed if elevated terrain or flagpole receptor heights are to be used. If elevated terrain is being used, then both the ELEV and HILL inputs are needed for each receptor. If the ELEV and HILL keywords are used and the model is being run with the flat terrain option (see Section 3.2.2), then the elevated terrain height inputs will be ignored by the model, and a non-fatal warning message will be generated. If the elevated terrain option is selected, and no elevated terrain heights are entered, the elevations will default to 0.0 meters, and warning messages will also be generated. The model handles flagpole receptor height inputs in a similar manner.

As with the GRIDCART keyword described above, the order of cards within the GRIDPOLR subpathway is not important, as long as all inputs for a particular network are

contiguous and start with the STA secondary keyword and end with the END secondary keyword. It is not even required that all ELEV cards be contiguous, although the input file will be more readable if a logical order is followed. The network ID is also not required to appear on each control file command (except for the STA card). The model will assume the previous ID if none is entered, similar to the use of continuation cards for pathway and keywords.

The following example of the GRIDPOLR keyword generates a receptor network consisting of 180 receptor points on five concentric distance rings centered on an assumed default origin of (0.,0.). The receptor locations are placed along 36 direction radials, beginning with 10. degrees and incrementing by 10. degrees in a clockwise fashion.

```
RE GRIDPOLR POL1 STA
                 DIST  100.  300.  500.  1000.  2000.
                 GDIR  36  10.  10.
RE GRIDPOLR POL1 END
```

Another example is provided illustrating the use of a non-zero origin, discrete direction radials and the specification of elevated terrain and flagpole receptor heights:

```
RE GRIDPOLR POL1 STA
                  ORIG  500.  500.
                  DIST  100.  300.  500.  1000.  2000.
                  DDIR   90.  180.  270.  360.
                  ELEV   90.  5. 10. 15. 20. 25.
                  ELEV  180.  5. 10. 15. 20. 25.
                  ELEV  270.  5. 10. 15. 20. 25.
                  ELEV  360.  5. 10. 15. 20. 25.
                  HILL   90. 50. 60. 75. 80. 95.
                  HILL  180. 50. 60. 75. 80. 95.
                  HILL  270. 50. 60. 75. 80. 95.
                  HILL  360. 50. 60. 75. 80. 95.
                  FLAG   90.  5. 10. 15. 20. 25.
                  FLAG  180.  5. 10. 15. 20. 25.
                  FLAG  270.  5. 10. 15. 20. 25.
                  FLAG  360.  5. 10. 15. 20. 25.
RE GRIDPOLR POL1 END
```

The user has the option of specifying the radial number (e.g., 1, 2, 3, etc.) on the ELEV, HILL, and FLAG inputs, or the actual direction associated with each radial.

For purposes of model calculations, all receptor locations, including those specified as polar, are stored in the model arrays as x, y and z coordinates and flagpole heights. For the purposes of reporting the results by receptor in the main print file, the tables are labeled with the polar inputs, i.e., directions and distances.

3.4.2 Using multiple receptor networks

For some modeling applications, the user may need a coarsely spaced network covering a large area to identify the area of significant impacts for a plant, and a denser network covering a smaller area to identify the maximum impacts. To accommodate this modeling need, the AERMOD model allows the user to specify multiple receptor networks in a single model run. The user can define either Cartesian grid networks or polar networks, or both. With the use of the ORIG option

in the GRIDPOLR keyword, the user can easily place a receptor network centered on the facility being permitted, and also place a network centered on another background source known to be a significant contributor to high concentrations. Alternatively, the polar network may be centered on a receptor location of special concern, such as a nearby Class I area.

As noted in the introduction to this section (3.4), the model dynamically allocates array storage based on the number of receptors and receptor networks when the AERMOD model is run, up to the maximum amount of memory available on the computer.

3.4.3 Specifying discrete receptor locations

In addition to the receptor networks defined by the GRIDCART and GRIDPOLR keywords described above, the user may also specify discrete receptor points for modeling impacts at specific locations of interest. This may be used to model critical receptors, such as the locations of schools or houses, nearby Class I areas, or locations identified as having high concentrations by previous modeling analyses. The discrete receptors may be input as either Cartesian x,y points (DISCCART keyword) or as polar distance and direction coordinates (DISCPOLR keyword). Both types of receptors may be identified in a single run. In addition, for discrete polar receptor points the user specifies the source whose location is used as the origin for the receptor.

3.4.3.1 Discrete Cartesian receptors.

Discrete Cartesian receptors are defined by use of the DISCCART keyword. The syntax and type of this keyword are summarized below:

Syntax:	RE DISCCART Xcoord Ycoord (Zelev Zhill) (Zflag)
Type:	Optional, Repeatable

where the Xcoord and Ycoord parameters are the x-coordinate and y-coordinate (m), respectively, for the receptor location. The Zelev parameter is an optional terrain elevation (m) and Zhill is a corresponding hill height scale for the receptor for use in elevated terrain modeling. Both the Zelev and Zhill parameters must be specified for use with the elevated terrain algorithms and are referenced to the same reference elevation (e.g., mean sea level) used for source elevations. The

Zflag parameter is the optional receptor height above ground (m) for modeling flagpole receptors. All of the parameters are in units of meters, except for Zelev and Zhill, which default to meters but may be specified in feet by use of the RE ELEVUNIT keyword.

If neither the elevated terrain option (Section 3.2.2) nor the flagpole receptor height option (Section 3.2.11) are used, then the optional parameters are ignored if present. In other words, the FLAGPOLE keyword is required on the CO pathway if Zflag values are to be used and, the ELEV option must be specified with the MODELOPT keyword on the CO pathway if Zelev and Zhill values are to be used. If only the elevated terrain height option is used (no flagpoles), then the third parameter (the field after the Ycoord) is read as the Zelev parameter. If only the flagpole receptor height option is used (no elevated terrain), then the third parameter is read as the Zflag parameter. If both options are used, then the parameters are read in the order indicated for the syntax above. If the optional parameters are left blank, then default values will be used. The default value for Zelev is 0.0, and the default value for Zflag is defined by the CO FLAGPOLE card (see Section 3.2.11). Note: If both the elevated terrain and flagpole receptor height options are used, then the third parameter will always be used as Zelev, and it is not possible to use a default value for Zelev while entering a specific value for the Zflag parameter.

3.4.3.2 Discrete polar receptors

Discrete polar receptors are defined by use of the DISCPOLR keyword. The syntax and type of this keyword are summarized below:

Syntax:	RE DISCPOLR Srcid Dist Direct (Zelev Zhill) (Zflag)
Type:	Optional, Repeatable

where the Srcid is the alphanumeric source identification for one of the sources defined on the SO pathway which will be used to define the origin for the polar receptor location. The Dist and Direct parameters are the distance in meters and direction in degrees for the discrete receptor location. Degrees are measured clockwise from north. The Zelev parameter is an optional terrain elevation for the receptor and Zhill is the corresponding hilltop elevation (m) for use in elevated terrain modeling. Both the Zelev and Zhill parameters must be specified for use with the elevated terrain

algorithms and are referenced to the same reference elevation (e.g., mean sea level) used for source elevations. The units of Zelev and Zhill are in meters, unless specified as feet by the RE ELEVUNIT keyword. The Zflag parameter is the optional receptor height above ground (meters) for modeling flagpole receptors.

If neither the elevated terrain option (Section 3.2.2) nor the flagpole receptor height option (Section 3.2.11) are used, then the optional parameters are ignored if present. If only the elevated terrain height option is used (no flagpoles), then the third parameter (the field after the Ycoord) is read as the Zelev parameter. If only the flagpole receptor height option is used (no elevated terrain), then the third parameter is read as the Zflag parameter. If both options are used, then the parameters are read in the order indicated for the syntax above. If the optional parameters are left blank, then default values will be used. The default value for Zelev is 0.0, and the default value for Zflag is defined by the CO FLAGPOLE card (see Section 3.2.11). Note: If both the elevated terrain and flagpole receptor height options are used, then fourth parameter will always be used as Zelev, and it is not possible to use a default value for Zelev while entering a specific value for the Zflag parameter.

3.4.3.3 Discrete Cartesian receptors for evalfile output

The EVALCART keyword is used to define discrete Cartesian receptor locations, similar to the DISCCART keyword, but it also allows for grouping of receptors, e.g., along arcs. It is designed to be used with the EVALFILE option, described later for the output pathway, which outputs arc maxima values to a separate file for evaluation purposes. The EVALCART keyword can be used without the use of the EVALFILE option, in which case the receptor groupings are ignored. The syntax and type for the modified EVALCART keyword are summarized below:

Syntax:	RE EVALCART Xcoord Ycoord Zelev Zhill Zflag Arcid (Name)
Type:	Optional, Repeatable

where the Xcoord and Ycoord parameters are the x-coordinate and y-coordinate (m), respectively, for the receptor location. The Zelev parameter is the terrain elevation (m) for the receptor and Zhill is the corresponding hilltop elevation (m) for use in elevated terrain modeling. Both the Zelev and Zhill parameters must be specified for use with the elevated terrain algorithms and are referenced to

the same reference elevation (e.g., mean sea level) used for source elevations. The elevation (Zelev) and hill heights (Zhill) inputs are set to zero, by default, if ELEV is NOT specified as a MODELOPT on the CO card. The Zflag parameter is the receptor height above ground (m) for modeling flagpole receptors and must be specified for use with the receptor flagpole option. The flagpole height (Zflag) inputs are set to zero, by default, if CO FLAGPOLE is NOT specified on the CO card. All of the parameters are in units of meters, except for Zelev and Zhill, which default to meters but may be specified in feet by use of the RE ELEVUNIT keyword. The Arcid parameter is the receptor grouping identification, which may be up to eight characters long, and may be used to group receptors by arc. The Name parameter is an optional name field that may be included to further identify a particular receptor location. The Name parameter is ignored by the model. Unlike the DISCCART keyword, all of the parameters (except for the Name) must be present on each card with the EVALCART keyword. The elevation, hill height, and flagpole height are set to zero, by default, if the appropriate options are not specified the CO card.

3.4.4 Including receptor data from an external file

The user has the option of including receptor data from an external file by using the INCLUDED keyword on the receptor pathway. A RE INCLUDED card may be placed anywhere within the source pathway, after the STARTING card and before the FINISHED card (i.e., the RE STARTING and RE FINISHED cards cannot be included in the external file). The data in the included file will be processed as though it were part of the control file. The syntax and type of the INCLUDED keyword are summarized below:

Syntax:	RE INCLUDED Incfil
Type:	Optional, Repeatable

where the Incfil parameter is a character field of up to 200 characters that identifies the filename for the included file. The contents of the included file must be valid control file commands for the receptor pathway. If an error is generated during processing of the included file, the error message will report the line number of the included file (see APPENDIX B). If more than one INCLUDED file is specified for the receptor pathway, the user will first need to determine which file the error occurred in. If the starting column of the main control input file is shifted from column 1 (see

Section 2.4.8), then the control file commands in the included file must be offset by the same amount. The INCLUDED option allows the user to include receptor data that have been generated by the AERMOD Terrain Preprocessor, AERMAP, in the control file without having to cut and paste the AERMAP output file. Since AERMAP generates terrain elevations in meters and includes the RE ELEVUNIT METERS card as the first record, an AERMAP file must be INCLUDED at the beginning of the receptor pathway, immediately following the RE STARTING card. If more than one AERMAP output file is INCLUDED on the receptor pathway, the RE ELEVUNIT METERS card must be deleted from all but the first one.

3.5 Meteorology pathway inputs and options

The **Me**teorology pathway contains keywords that define the input meteorological data for a particular model run.

3.5.1 Specifying the input data files and formats

The AERMOD model uses hourly meteorological data from separate surface and profile data files as one of the basic model inputs. These input meteorological data filenames for AERMOD are identified by the SURFFILE and PROFFILE keywords on the ME pathway. The syntax and type of these keywords are summarized below:

Syntax:	ME SURFFILE Sfcfil (Format) ME PROFFILE Profil (Format)
Type:	Optional, Repeatable

where the Srcfil and Profil parameters are character fields of up to 200 characters that identify the filenames for the input meteorological data files. For running the model on an IBM-compatible PC, the filename parameters may include the complete DOS pathname for the file or will assume the current directory if only the filename is given. The optional Format parameter specifies the format of the meteorological data files. The default formats for the surface and profile data files corresponds with the format of the files generated by the AERMET meteorological preprocessor program. The user also has the option of specifying the Fortran read format for each of these files. The contents of the meteorological data files are described below, and the file formats are documented in APPENDIX C.

The surface meteorological data file consists of a header record containing information on the meteorological station locations, and one record for each hour of data. These data are delimited by at least one space between each element, i.e., the data may be read as free format. The contents of the surface file are as follows:

- Year
- Month (1 – 12)
- Day of Month (1 – 31)
- Julian Day (Day of Year) (1 – 366)
- Hour of Day (1 – 24)
- Heat Flux (W/m2)
- Surface Friction Velocity, u* (m/s)
- Convective Velocity Scale, w* (m/s)
- Lapse Rate above Mixing Height (K/m)
- Convective Mixing Height (m)
- Mechanical Mixing Height (m)
- Monin-Obukhov Length, L (m)
- Surface Roughness Length, zo (m)
- Bowen Ratio
- Albedo
- Reference Wind Speed (m/s)
- Reference Wind Direction (degrees)
- Reference Height for Wind (m)
- Ambient Temperature (K)
- Reference Height for Temperature (m)
- Precipitation Code (0-45)
- Precipitation Amount (mm)
- Relative Humidity (%)
- Surface Pressure (mb)
- Cloud Cover (tenths)
- Wind Speed Adjustment and Data Source Flag

The sensible heat flux, Bowen ratio and albedo are not used by the AERMOD model but are passed through by AERMET for information purposes only.

The profile meteorological data file consists of one or more records for each hour of data. As with the surface data file, the data are delimited by at least one space between each element and

may be read as Fortran free format. The contents of the profile meteorological data file are as follows:

- Year
- Month (1 – 12)
- Day (1 – 31)
- Hour (1 – 24)
- Measurement height (m)
- Top flag = 1, if this is the last (highest) level for this hour,
  0, otherwise
- Wind direction for the current level (degrees)
- Wind speed for the current level (m/s)
- Temperature at the current level (°C)
- Standard deviation of the wind direction, σ_2 (degrees)
- Standard deviation of the vertical wind speed, σ_w (m/s)

The data in this file include the on-site meteorological data processed by AERMET. Since AERMET was designed to be able to perform dispersion parameter calculations with NWS data only, i.e., no on-site data, the profile data may consist of a one-level "profile" based on the NWS winds and temperature.

3.5.2 Specifying station information

Three keywords are used to specify information about the meteorological stations, SURFDATA for the surface meteorological station, UAIRDATA for the upper air station, and the optional SITEDATA for any on-site meteorological data that may be used. The syntax and type of these keywords are summarized below:

Syntax:	ME SURFDATA	Stanum	Year	(Name)	(Xcoord)	(Ycoord)
Syntax:	ME UAIRDATA	Stanum	Year	(Name)	(Xcoord)	(Ycoord)
Syntax:	ME SITEDATA	Stanum	Year	(Name)	(Xcoord)	(Ycoord)
Type:	Mandatory, Non-repeatable for SURFDATA and UAIRDATA Optional, Non-repeatable for SITEDATA					

where Stanum is the station number, e.g., the 5-digit WBAN number for NWS stations; Year is the year of data being processed (either 2 or 4 digits); Name is an optional character field (up to 40 characters with no blanks) specifying the name of the station; and Xcoord and Ycoord are optional

parameters for specifying the x and y coordinates for the location of the stations. **Note: The Year should indicate the first year of data that are present in the meteorological data, regardless if only a subset of complete temporal period will be modeled by AERMOD using the STARTEND keyword (Section 3.5.4).** The station locations are not utilized in the model. Therefore, no units are specified for Xcoord and Ycoord, although meters are suggested for consistency with the source and receptor coordinates. The AERMOD model compares the station numbers that are input using these keywords with the numbers in the header record of the surface meteorological data file, and issues non-fatal warning messages if there are any mismatches.

3.5.3 Specifying the base elevation for potential temperature profile

The AERMOD model generates a gridded vertical profile of potential temperatures for use in the plume rise calculations. Since potential temperature is dependent on the elevation above mean sea level (MSL), the user must define the base elevation for the profile with the PROFBASE keyword. The syntax and type for the PROFBASE keyword are summarized below:

Syntax:	ME PROFBASE BaseElev (Units)
Type:	Mandatory, Non-repeatable

where the BaseElev parameter specifies the base elevation above MSL for the potential temperature profile, and the optional Units parameter specifies the units of BaseElev. Valid inputs of Units are the secondary keywords METERS or FEET. The default units for BaseElev are in meters if Units is left blank. The base elevation should correspond with the base elevation of the primary meteorological tower.

3.5.4 Specifying a data period to process

There are two keywords that allow the user to specify particular days or ranges of days to process from the sequential meteorological file input for the AERMOD model. The STARTEND keyword controls which period within the meteorological data file is read by the model, while the DAYRANGE keyword controls which days or ranges of days (of those that are read) for the model to process. When the STARTEND keyword is omitted from the control file, the default for the model is to read the entire meteorological data file and to process all days within that period.

The syntax and type for the STARTEND keyword are summarized below:

Syntax:	ME STARTEND Strtyr Strtmn Strtdy (Strthr) Endyr Endmn Enddy (Endhr)
Type:	Optional, Non-repeatable

where the Strtyr Strtmn Strtdy parameters specify the year, month and day of the first record to be read (e.g., 87 01 31 for January 31, 1987), and the parameters Endyr Endmn Enddy specify the year, month and day of the last record to be read. The Strthr and Endhr are optional parameters that may be used to specify the start and end hours for the data period to be read. If either Strthr or Endhr is to be specified, then both must be specified. Any records in the data file that occur before the start date are ignored, as are any records in the data file that occur after the end date. In fact, once the end date has been reached, the model does not read any more data from the meteorological file. If Strthr and Endhr are not specified, then processing begins with hour 1 of the start date, and ends with hour 24 of the end date, unless specific days are selected by the DAYRANGE card described below.

Any PERIOD averages calculated by the model will apply only to the period of data actually processed. Therefore, if someone wanted to calculate a six-month average, they could select PERIOD averages on the CO AVERTIME card, and then specify the period as follows:

```
ME STARTEND   87 01 01      87 06 30
```

for the period January 1, 1987 through June 30, 1987.

The syntax and type for the DAYRANGE keyword are summarized below:

Syntax:	ME DAYRANGE Range1 Range2 Range3 … Range*N*
Type:	Optional, Repeatable

where the Range parameters specify particular days or ranges of days to process. The days may be specified as individual days (e.g., 1 2 3 4 5) or as a range of days (e.g., 1-5). The user also has the option of specifying Julian day numbers, from 1 to 365 (366 for leap years), or specifying month and day (e.g., 1/31 for January 31). Any combination of these may also be used. For example, the

following card will tell the model to process the days from January 1 (Julian day 1) through January 31 (1/31):

```
ME DAYRANGE   1-1/31
```

The DAYRANGE keyword is also repeatable, so that as many cards as needed may be included in the ME pathway.

As with the STARTEND keyword, any PERIOD averages calculated by the model will apply only to the period of data actually processed. If the STARTEND keyword is also used, then only those days selected on the DAYRANGE cards that fall within the period from the start date to the end date will be processed. Thus, if the ME pathway included the following two cards:

```
ME STARTEND  87 02 01   87 12 31
ME DAYRANGE  1-31
```

then no data would be processed, since the days 1 through 31 are outside the period 2/1 to 12/31.

3.5.5 Correcting wind direction alignment problems

The WDROTATE keyword allows the user to correct the input meteorological data for wind direction alignment problems. All input wind directions or flow vectors are rotated by a user-specified amount. Since the model results at particular receptor locations are often quite sensitive to the transport wind direction, this optional keyword should be used only with extreme caution and with clear justification.

The syntax and type of this keyword are summarized below:

Syntax:	ME WDROTATE Rotang
Type:	Optional, Non-repeatable

where the Rotang parameter specifies the angle in degrees to rotate the input wind direction measurements. The value of Rotang is subtracted from the wind direction measurements. It may be

used to correct for known (and documented) calibration errors, or to adjust for the alignment of a valley if the meteorological station is located in a valley with a different alignment than the source location.

3.5.6 Specifying wind speed categories

Variable emission rate factors may be input to the model that vary by wind speed category. The model uses six wind speed categories, and these are defined by the upper bound wind speed for the first five categories (the sixth category is assumed to have no upper bound). The default values for the wind speed categories are as follows: 1.54, 3.09, 5.14, 8.23, and 10.8 m/s. The syntax and type of the WINDCATS keyword, which may be used to specify different category boundaries, are summarized below:

Syntax:	ME WINDCATS Ws1 Ws2 Ws3 Ws4 Ws5
Type:	Optional, Non-repeatable

where the Ws1 through Ws5 parameters are the upper bound wind speeds of the first through fifth categories in meters per second. The upper bound values are inclusive, i.e., a wind speed equal to the value of Ws1 will be placed in the first wind speed category.

3.5.7 Specifying SCIM parameters

The SCIM parameters on the SCIMBYHR card specify the starting hour and sampling interval for the regular sample and an optional file name. The syntax and type of the SCIMBYHR keyword are summarized below:

Syntax:	ME SCIMBYHR NRegStart NRegInt NwetStart NwetInt (SfcFilnam PflFilnam)
Type:	Optional, Non-repeatable

where the NRegStart and NRegInt parameters specify the first hour to be sampled and the sampling interval, respectively, when performing the regular sampling. The NWetStart and NWetInt parameters are used to specify the first wet hour (i.e., with non-zero precipitation) and the wet sampling interval for wet sampling. However, since the AERMOD model currently does not

include wet deposition algorithms, the wet sampling option is not operational, and the user should enter a value of zero (0) for bot NWetStart and NWetInt. Optionally, the user can create output files containing the surface and profile meteorological data for the sampled hours by specifying the SfcFilnam and PflFilnam parameters. These output files are in the same format used in the summary of the first 24 hours of data included in the main output file.

In order to use the SCIM option, the user must specify the non-DFAULT SCIM option on the CO MODELOPT card. Although the ME SCIMBYHR is an optional card, it is required when using the SCIM option. NRegStart is required to have a value from 1 through 24, i.e., the first sampled hour must be on the first day in the meteorological data file. There are no restrictions for NRegInt; however, NRegInt would generally be greater than one. For example, NRegInt could be based on the formula (24n+1), where "n" is the number of days to skip between samples, in order to ensure a regular diurnal cycle to the sampled hours (e.g., 25 or 49).

3.5.8 Specify the number of years to process

The NUMYEARS keyword on the ME pathway allows the user to specify the number of years of data being processed for purposes of allocating array storage for the MAXDCONT option (see Section 3.7.2.8), with a default value of five (5) years being assumed if the optional NUMYEARS keyword is omitted. The syntax of the optional NUMYEARS keyword is summarized below:

Syntax:	ME NUMYEARS NumYrs
Type:	Optional, Non-repeatable

where NumYrs specifies the number of (full) years of meteorological data being processed.

3.5.9 Specify turbulence treatment options

Beginning with version 21112, the user can prompt AERMOD to set non-missing values for turbulence (σ_θ or σ_w) from the profile file to missing for certain conditions. These options were included to facilitate the use of meteorological data with turbulence under certain conditions. For example, these options allow the user to use an urban meteorological site

with turbulence data with the URBAN option in AERMOD without rerunning AERMET to ignore the site-specific turbulence as discussed Section 3.3 of the AERMOD Implementation Guide (EPA, 2026b). The syntax of the turbulence options is summarized below:

Syntax:	ME TurbOpt
Type:	Optional, Non-repeatable

Where TurbOpt is defined as:

- NOTURB: set σ_θ and σ_w to missing for all hours
- NOTURBST: set σ_θ and σ_w for stable hours only
- NOTURBCO: set σ_θ and σ_w for convective hours only
- NOSA: set σ_θ to missing for all hours
- NOSW: set σ_w to missing for all hours
- NOSAST: set σ_θ to missing for stable hours only
- NOSWST: set σ_w to missing for stable hours only
- NOSACO: set σ_θ to missing for convective hours only
- NOSWCO set σ_w to missing for convective hours only

Where stable (convective) hours are defined as hours where the Monin-Obukhov length is positive (negative). The options NOTURB and NOTURBST can be used with the DFAULT keyword on the MODELOPT pathway. The remaining options cannot be used with the DFAULT keyword and if they are used with the DFAULT keyword, AERMOD will warn the user that the option can not be used with the DFAULT keyword and the option will not set the appropriate turbulence parameters to missing, i.e., AERMOD will ignore the turbulence option. For the options that only reset turbulence under stable conditions only or convective conditions only, AERMOD will report the day and hour and turbulence parameter that is being reset to the file specified with the ERRORFIL keyword.

3.6 Event pathway inputs and options

EVENT processing is specifically designed to facilitate analysis of source contributions to specific events for short-term averages (less than or equal to 24 hours). These events may be design concentrations generated by the AERMOD model, occurrences of violations of an air quality

standard, or user-specified events. These events are input to the AERMOD model through the **EV**ent pathway. Each event is defined by an averaging period and specific data period, a source group, and a receptor location. Since the locations are only of interest in combination with particular averaging and data periods, the REceptor pathway is not used with EVENT processing.

There are two keywords that are used to define the events on the EV pathway. The EVENTPER keyword defines the averaging period, data period and source group, while the EVENTLOC keyword defines the receptor location for the event. Each event is also given an alphanumeric name that links the two input cards for that event.

The syntax and type of the EVENTPER and EVENTLOC keywords are summarized below:

Syntax:	EV EVENTPER Evname Aveper Grpid Date
Syntax:	EV EVENTLOC Evname XR= Xr YR= Yr (Zelev) (Zflag) Or Evname RNG= Rng DIR= Dir (Zelev) (Zflag)
Type:	Mandatory, Repeatable

where the parameters are as follows:

Evname - event name (an alphanumeric string of up to 8 characters),

Aveper - averaging period for the event (e.g., 1, 3, 8, 24 hr)

Grpid - source group ID for the event (must be defined on SO pathway),

Date - date for the event, input as an eight-digit integer for the ending hour of the data period (YYMMDDHH), e.g., 84030324 defines a data period ending at hour 24 on March 3, 1984. The length of the period corresponds to Aveper.

XR= - X-coordinate (m) for the event location, referenced to a Cartesian coordinate system

YR= - Y-coordinate (m) for the event location, referenced to a Cartesian coordinate system

RNG= - distance range (m) for the event location, referenced to a polar coordinate system with an origin of (0., 0.)

DIR= - radial direction (deg.) for the event location, referenced to a polar coordinate system with an origin of (0., 0.)

Zelev - optional terrain elevation for the event location (m)

Zflag - optional receptor height above ground (flagpole receptor) for the event location (m)

Each event is defined by the two input cards EVENTPER and EVENTLOC, and these inputs are linked by the event name, which must be unique among the events being processed in a given run. There is no requirement for the order of cards on the EV pathway. Note that the location for the event may be specified by either Cartesian coordinates or by polar coordinates, however, the polar coordinates must be relative to an origin of (0,0).

3.6.1 Using events generated by the AERMOD model

The AERMOD model has an option (CO EVENTFIL described in Section 3.2.14) to generate an input file for the AERMOD EVENT processing. When this option is used, the AERMOD model copies relevant inputs from the AERMOD control input file to the Event processing input file and generates the inputs for the EVent pathway from the results of the modeling run. These events are the design concentrations identified by the OU RECTABLE keyword (see Section 2.1.1.1), such as the highest and high-second-high 24-hour averages, etc., and any threshold violations identified by the OU MAXIFILE keyword (see Section 2.1.1.2). The inputs generated by the AERMOD model correspond to the syntax described above for the EVENTPER and EVENTLOC keywords. The locations for events generated by the AERMOD model are always provided as Cartesian coordinates.

To easily identify the events generated by the AERMOD model, and to provide a mechanism for the AERMOD model to manage the events generated from the model run, a naming convention is used for the EVNAME parameter. The following examples illustrate the event names used by the AERMOD model:

H1H01001: High-first-high 1-hour average for source group number 1

H2H24003: High-second-high 24-hour average for source group number 3

TH030010: Threshold violation number 10 for 3-hour averages

TH240019: Threshold violation number 19 for 24-hour averages

The high value design concentrations are listed first in the EVENT processing input file, followed by the threshold violations (grouped by averaging period). To make it easier for the user to review the EVENT processing input file generated by the AERMOD model, and determine which events are of most concern, the actual concentration value associated with the event is included as the last field on the EVENTPER card. This field is ignored by the AERMOD model and is included only for informational purposes. The user should be aware that the same event may appear in the AERMOD model input file as both a design value and as a threshold violation, depending on the options selected and the actual results. Since the model processes the events by date sequence and outputs the results for each event as it is processed, the order of events in the output file will generally not follow the order of events in the input file, unless all of the events were generated by the MAXIFILE option.

3.6.2 Specifying discrete events

The user can specify discrete events by entering the EVENTPER and EVENTLOC cards as described above. The averaging period and source group selected for the event must be among those specified on the CO AVERTIME and SO SRCGROUP cards. If the EVENT processing input file was generated by the AERMOD model, the user may include additional events for those averaging periods and source groups used in the original AERMOD model run. They may also add averaging periods or define new source groups in the Event processing input file in order to define additional events.

3.6.3 Including event data from an external file

The user has the option of including event data from an external file by using the INCLUDED keyword on the source (EV) pathway. An EV INCLUDED card may be placed anywhere within the event pathway, after the STARTING card and before the FINISHED card (i.e., the EV STARTING and EV FINISHED cards cannot be included in the external file). The data in

the included file will be processed as though it were part of the control file. The syntax and type of the INCLUDED keyword are summarized below:

Syntax:	EV INCLUDED Incfil
Type:	Optional, Repeatable

where the Incfil parameter is a character field of up to 40 characters that identifies the filename for the included file. The contents of the included file must be valid control file commands for the event pathway. If an error is generated during processing of the included file, the error message will report the line number of the included file (see APPENDIX B). If more than one INCLUDED file is specified for the event pathway, the user will first need to determine which file the error occurred in. If the starting column of the main control input file is shifted from column 1 (see Section 2.4.8), then the control file commands in the included file must be offset by the same amount.

3.7 Output pathway inputs and options

The **OU**tput pathway contains keywords that define the output options for the model runs. Beginning with version 11059, several enhancements have been incorporated in AERMOD to more fully support the form of more recent 1-hour NO_2 and SO_2 standards, as well as the 24-hour $PM_{2.5}$ standard. The form of these NAAQS is similar in that they are based on a ranked percentile value averaged over the number of years processed.

The options on the **OU**tput pathway have been divided into five categories: 1) options that control different types of tabular output in the main output files of the model; 2) output files for specialized purposes that that can be generated for any pollutant and averaging period; 3) options that are specific to more recent 24-hour $PM_{2.5}$, 1-hour NO_2, and/or 1-hour SO_2 standards; 4) options related to EVENT processing; and 5) miscellaneous options. The user may select any combination of output option for a particular application.

3.7.1 Selecting options for tabular printed outputs

The three tabular printed output options are controlled by the following keywords:

RECTABLE: Controls output option for high value summary tables by receptor;

MAXTABLE: Controls output option for overall maximum value summary tables; and

DAYTABLE: Controls output option for tables of concurrent values summarized by receptor for each day processed.

The keywords are described in more detail in the order listed above.

The syntax and type for the RECTABLE keyword are summarized below:

Syntax:	OU RECTABLE Aveper FIRST SECOND ... SIXTH ... TENTH and/or 1ST 2ND ... 6TH .... [1]0TH and/or 1 2 ... 6 ... 10 .... *N* 999
Type:	Optional, Repeatable

where the Aveper parameter is the short-term averaging period (e.g., 1, 3, 8 or 24 hr or MONTH) for which the receptor table is selected, and the secondary keywords, FIRST, SECOND, etc., indicate which high values are to be summarized by receptor for that averaging period. The RECTABLE card may be repeated for each averaging period. For cases where the user wants the same RECTABLE options for all short-term averaging periods being modeled, the input may be simplified by entering the secondary keyword ALLAVE for the Aveper parameter.

To support the implementation of recent guidance regarding modeling to demonstrate compliance with these NAAQS, the RECTABLE keyword had been modified to allow user-specified ranks of short-term averages (for all pollutants) up to the 999th highest value. The previous version of AERMOD was limited to the 10th-highest value and restricted the rank for the 24-hour $PM_{2.5}$ NAAQS to the 8th highest value (corresponding to the 98th percentile of daily values during a year).

The following example will select summaries of the highest, second highest and third highest values by receptor for all averaging periods:

```
OU RECTABLE ALLAVE FIRST  SECOND  THIRD
```

The model will also recognize a range of high values on the RECTABLE input card, and therefore the following card will have the effect:

```
OU RECTABLE ALLAVE FIRST-THIRD
```

The output file will include tables for only the high values selected. Tables for all source groups for a particular averaging period are grouped together, and the averaging periods are output in the order they appear the CO AVERTIME card. For each averaging period and source group combination, the tables of high values for the receptor networks (if any) are printed first, followed by any discrete Cartesian receptors, and any discrete polar receptors.

If the CO EVENTFIL keyword has been used to generate an input file for EVENT processing, then the design values identified by the RECTABLE options, e.g., the high-second-high 24-hour average, are included in the events that are defined in the EVENT processing input file.

If the PLOTFILE (3.7.2.3) and/or MAXDCONT (3.7.2.8) keywords are used, the RECTABLE keyword is required and must be specified prior to these keywords in the OU pathway. The rank or high value (e.g., FIRST, SECOND, etc.) specified for each PLOTFILE must also be included on the RECTABLE keyword. There will need to be a RECTABLE entry that includes each of the high values and averaging periods for which a PLOTFILE is generated, or a single RECTABLE entry with the ALLAVE keyword and each high value specified can be used. However, because RECTABLE only relates to short-term averaging periods, a RECTABLE entry is not required for a PLOTFILE that is generated for either an ANNUAL or a PERIOD average. When the MAXDCONT keyword is used, the UpperRank and LowerRank values of the MAXDCONT file must be within the range of ranks specified on the RECTABLE keyword. The MAXDCONT THRESH value analysis is limited to the range of ranks specified on the RECTABLE keyword (but not the individual ranks that are specified). Read more about the requirements of the of RECTABLE as it relates to the PLOTFILE and MAXDCONT keywords in Sections 3.7.2.3 and 3.7.2.8, respectively.

The syntax and type for the MAXTABLE keyword are summarized below:

Syntax:	OU MAXTABLE Aveper Maxnum
Type:	Optional, Repeatable

where the Aveper parameter is the short-term averaging period (e.g., 1, 3, 8 or 24 hr or MONTH) for which the receptor table is selected, and the Maxnum parameter specifies the number of overall maximum values to be summarized for each averaging period. The MAXTABLE card may be repeated for each averaging period. As with the RECTABLE keyword, for cases where the user wants the same MAXTABLE options for all short-term averaging periods being modeled, the input may be simplified by entering the secondary keyword ALLAVE for the Aveper parameter. The following example will select the maximum 50 table for all averaging periods:

```
OU MAXTABLE ALLAVE      50
```

A separate maximum overall value table is produced for each source group. The maximum value tables follow the RECTABLE outputs in the main print file. All source group tables for a particular averaging period are grouped together, and the averaging periods are output in the order that they appear on the CO AVERTIME card.

The syntax and type for the DAYTABLE keyword are summarized below:

Syntax:	OU DAYTABLE Avper1 Avper2 Avper3 . . .
Type:	Optional, Non-repeatable

where the Avper*n* parameters are the short-term averaging periods (e.g., 1, 3, 8 or 24 hr or MONTH) for which the daily tables are selected. The DAYTABLE card is non-repeatable, but as with the RECTABLE and MAXTABLE keywords, for cases where the user wants daily tables for all short-term averaging periods being modeled, the input may be simplified by entering the secondary keyword ALLAVE for the first parameter. The following example will select the daily tables for all averaging periods:

```
OU DAYTABLE ALLAVE
```

For each averaging period for which the DAYTABLE option is selected, the model will print the concurrent averages for all receptors for each day of data processed. The receptor networks (if any) are printed first, followed by any discrete Cartesian receptors, and any discrete polar receptors. Results for each source group are output. For example, if 1, 3, and 24-hour averages are calculated, and the OU DAYTABLE ALLAVE option is used, then for the first day of data processed, there will be 24 sets of tables of hourly averages (one for each hour in the day), eight sets of 3-hour averages (one for each 3-hour period in the day), and one set of 24-hour averages. The averages are printed as they are calculated by the model, but for hours where more than one averaging period is calculated (e.g., hour 24 is the end of an hourly average, a 3-hour average, and a 24-hour average), the order in which the averages are output will follow the order used on the CO AVERTIME card. Note: This option can produce very large output files, especially when used with a full year of data and very short period averages, such 1-hour and 3-hour. It should therefore be used with CAUTION.

3.7.2 Selecting options for special purpose output files

The AERMOD model provides options for seven types of output files for specialized purposes. These options are controlled by the following keywords that create the output file described:

MAXIFILE -	Occurrences of violations of user-specified threshold value;
POSTFILE -	Concurrent (raw) results at each receptor suitable for post-processing;
PLOTFILE -	Design values that can be imported into graphics software for plotting contours;
TOXXFILE -	Unformatted files of raw results above a threshold value with a special structure for use with the TOXX model component of TOXST;
RANKFILE -	Output values by rank for use in Q-Q (quantile) plots;

EVALFILE - Output values, including arc-maximum normalized concentrations, suitable for model evaluation studies;

SEASONHR - Output values by season and hour-of-day;

MAXDCONT - Ranked values for individual source groups to determine source contributions for 24-hour $PM_{2.5}$, 1-hour NO_2 and 1-hour SO_2 standards;

MAXDAILY - Daily maximum 1-hour concentrations for a specified source group, for each day in the data period processed, useful for analyzing the 1-hour NO_2 and SO_2 NAAQS; and

MXDYBYYR - Summary of daily maximum 1-hour concentrations by year for each rank specified on the RECTABLE keyword.

The keywords are described in more detail in the order listed above.

3.7.2.1 MAXIFILE

The syntax and type for the MAXIFILE keyword are summarized below:

Syntax:	OU MAXIFILE Aveper Grpid Thresh Filnam (Funit)
Type:	Optional, Repeatable

where the Aveper parameter is the short-term averaging period (e.g., 3, 8, 24 for 3, 8 and 24-hour averages, or MONTH for monthly averages) and Grpid is the source group ID for which the MAXIFILE option is selected. The Thresh parameter is the user-specified threshold value, and Filnam is the name of the file where the MAXIFILE results are to be written. Please note, when specifying the FUNIT, to ensure there will be no file conflicts, it is recommended that user-specified units begin at a large integer value such as 10,000 and increment by one. By specifying the same filename and unit for more than one MAXIFILE card, results for different source groups and/or averaging periods may be combined into a single file. If the Funit parameter is omitted, then the model will dynamically allocate a unique file unit for this file (see Section 2.1.2).

The MAXIFILE card may be repeated for each combination of averaging period and source group, and a different filename should be used for each file. The resulting maximum value file will include several header records identifying the averaging period, source group and the threshold value for that file, and a listing of every occurrence where the result for that averaging period/source group equals or exceeds the threshold value. Each of these records includes the averaging period, source group ID, date for the threshold violation (ending hour of the averaging period), the x, y, z and flagpole receptor height for the receptor location where the violation occurred, and the concentration value.

Each of the threshold violations, except for monthly averages, identify events that may be modeled for source contribution information with EVENT processing by selecting the CO EVENTFIL option (see Sections 3.2.14 and 2.1). Each of the threshold violations is included as an event on the EV pathway and is given a name of the form THxxyyyy, where xx is the averaging period, and yyyy is the violation number for that averaging period. For example, an event name of TH240019 identifies the 19th threshold violation for 24-hour averages. Monthly average threshold violations are included in the file specified on the MAXIFILE card but are not included in the EVENT processing input file since the AERMOD model currently handles only averaging periods of up to 24 hours.

The following examples illustrate the use of the MAXIFILE option:

```
OU MAXIFILE   24     ALL    364.0   MAX24ALL.OUT
OU MAXIFILE   24     PSD     91.0   MAXPSD.OUT    50
OU MAXIFILE   3      PSD    365.0   MAXPSD.OUT    50
OU MAXIFILE   3      PLANT   25.0   C:\OUTPUT\MAXI3HR.FIL
OU MAXIFILE   MONTH  ALL     10.0   MAXMONTH.OUT
```

where the 3-hour example illustrates the use of a DOS pathname for the PC, and the last example illustrates the use of monthly averages. The FILNAM parameter may be up to 200 characters in length. It should also be noted that only one MAXIFILE card may be used for each averaging period/source group combination. Note: The MAXIFILE option may produce very large files for

runs involving a large number of receptors if a significant percentage of the results exceed the threshold value.

3.7.2.2 POSTFILE

The syntax and type for the POSTFILE keyword are summarized below:

Syntax:	OU POSTFILE Aveper Grpid Format Filnam (Funit)
Type:	Optional, Repeatable

where the Aveper parameter is the averaging period (e.g., 3, 8, 24 for 3, 8 and 24-hour averages, MONTH for monthly averages, PERIOD for period averages, or ANNUAL for annual averages) and Grpid is the source group ID for which the POSTFILE option is selected. The Format parameter specifies the format of the POSTFILE output and may either be the secondary keyword UNFORM for unformatted concentration files, or the secondary keyword PLOT to obtain formatted files of receptor locations (x- and y-coordinates) and concentrations suitable for plotting contours of concurrent values. The Filnam parameter is the name of the file where the POSTFILE results are to be written. The optional Funit parameter allows the user the option of specifying the Fortran logical file unit for the output file. Please note, when specifying the FUNIT, to ensure there will be no file conflicts, it is recommended that user-specified units begin at a large integer value such as 10,000 and increment by one. If the Funit parameter is omitted, then the model will dynamically allocate a unique file unit for this file (see Section 2.1.2).

The POSTFILE card may be repeated for each combination of averaging period and source group, and a different filename should be used for each file. If UNFORM is specified for the Format parameter, then the resulting unformatted file includes a constant-length record for each of the selected averaging periods calculated during the model run. The first variable of each record is an integer variable (4 bytes) containing the ending date (YYMMDDHH) for the averages on that record. The second variable for each record is an integer variable (4 bytes) for the number of hours in the averaging period. The third variable for each record is a character variable of length eight containing the source group ID. The remaining variables of each record contain the calculated

average concentration values for all receptors, in the order in which they were defined in the input runstream.

The following examples illustrate the use of the POSTFILE option:

```
OU POSTFILE  24    ALL    UNFORM  PST24ALL.BIN
OU POSTFILE  24    PSD    UNFORM  PST24PSD.BIN
OU POSTFILE  3     PLANT  UNFORM  C:\BINOUT\PST3HR.FIL
OU POSTFILE  MONTH ALL    PLOT    PSTMONTH.PLT
OU POSTFILE  PERIOD ALL   PLOT    PSTANN.PLT
```

where the 3-hour example illustrates the use of a DOS pathname for the PC, and the last example illustrates the use of monthly averages. The Filnam parameter may be up to 200 characters in length. The use of separate files for each averaging period/source group combination allows the user flexibility to select only those results that are needed for post-processing for a particular run and also makes the resulting unformatted files manageable. Note: The POSTFILE option can produce very large files and should be used with some caution. For a file of hourly values for a full year (8760 records) and 400 receptors, the resulting file will use about 14 megabytes of disk space. To estimate the size of the file (in bytes), use the following equation:

$$File\ Size\ (bytes) = \frac{\#\ Hrs/Yr}{\#\ Hrs/Ave} * (\#\ Rec + 4) * 4$$

Divide the result by 1000 to estimate the number of kilobytes (KB) and divide by 1.0E6 to estimate the number of megabytes (MB).

3.7.2.3 PLOTFILE

The syntax and type for the PLOTFILE keyword are summarized below:

Syntax:	OU PLOTFILE Aveper Grpid Hivalu Filnam (Funit) or OU PLOTFILE PERIOD Grpid Filnam (Funit) or OU PLOTFILE ANNUAL Grpid Filnam (Funit)
Type:	Optional, Repeatable

where the Aveper parameter is the averaging period (e.g., 3, 8, 24 for 3, 8 and 24-hour averages, MONTH for monthly averages, PERIOD for period averages, or ANNUAL for annual averages), Grpid is the source group ID for which the PLOTFILE option is selected, and Hivalu specifies which short-term high values are to be output (FIRST for the first highest at each receptor, SECOND for the second highest at each receptor, etc.) Note that the Hivalu parameter is not specified for PERIOD or ANNUAL averages, since there is only one period or annual average for each receptor. The Filnam parameter is the name of the file where the PLOTFILE results are to be written. The optional Funit parameter allows the user the option of specifying the Fortran logical file unit for the output file. Please note, when specifying the FUNIT, to ensure there will be no file conflicts, it is recommended that user-specified units begin at a large integer value such as 10,000 and increment by one. By specifying the same filename and unit for more than one PLOTFILE card, results for different source groups and/or averaging periods may be combined into a single file. If the Funit parameter is omitted, then the model will dynamically allocate a unique file unit for this file (see Section 2.1.2).

Note: The averaging period and high value for which a PLOTFILE is generated must also be included on the RECTABLE keyword (see Section 3.7.1). The RECTABLE keyword entry must be specified on the OU pathway prior to the PLOTFILE entry. However, a RECTABLE entry is not required for a PLOTFILE generated for the ANNUAL or PERIOD average.

The PLOTFILE card may be repeated for each combination of averaging period, source group, and high value, and a different filename should be used for each file. The resulting formatted file includes several records with header information identifying the averaging period,

source group and high value number of the results, and then a record for each receptor which contains the x and y coordinates for the receptor location, the appropriate high value at that location, and the averaging period, source group and high value number. The data are written to the file in the order of x-coord, y-coord, concentration so that the file can easily be imported into a graphics package designed to generate contour plots. Many such programs will read the PLOTFILEs directly without any modification, ignoring the header records, and produce the desired plots.

The following examples illustrate the use of the PLOTFILE option:

```
OU  PLOTFILE   24    ALL   FIRST   PLT24ALL.FST
OU  PLOTFILE   24    ALL  SECOND   PLT24ALL.SEC
OU  PLOTFILE   24    PSD    2ND   PLTPSD.OUT  75
OU  PLOTFILE        3    PSD    2ND   PLTPSD.OUT  75
OU  PLOTFILE    3    PLANT  1ST   C:\PLOTS\PLT3HR.FIL
OU  PLOTFILE  MONTH  ALL  THIRD    PLTMONTH.OUT
OU  PLOTFILE  PERIOD  ALL          PSTANN.PLT
```

where the 3-hour example illustrates the use of a DOS pathname for the PC, and the last example illustrates the use of monthly averages. As illustrated by the second and third examples, the high value parameter may also be input as secondary keywords using the standard abbreviations of 1ST, 2ND, 3RD . . . 10TH. The Filnam parameter may be up to 40 characters in length. The use of separate files for each averaging period, source group, high value combination allows the user flexibility to select only those results that are needed for plotting from a particular run.

3.7.2.4 TOXXFILE

The syntax and type for the TOXXFILE keyword are summarized below:

Syntax:	OU TOXXFILE Aveper Cutoff Filnam (Funit)
Type:	Optional, Repeatable

where the Aveper parameter is the short-term averaging period (e.g., 1, 3, 8, 24 for 1, 3, 8 and 24-hour averages, or MONTH for monthly averages) for which the TOXXFILE option has been

selected. The Cutoff (threshold) parameter is the user-specified threshold cutoff value in g/m^3, and Filnam is the name of the file where the TOXXFILE results are to be written. It is important to note that the units of the Cutoff parameter are g/m^3, regardless of the input and output units selected with the SO EMISUNIT card. The optional Funit parameter allows the user the option of specifying the Fortran logical file unit for the output file. Please note, when specifying the FUNIT, to ensure there will be no file conflicts, it is recommended that user-specified units begin at a large integer value such as 10,000 and increment by one.. If the Funit parameter is omitted, then the model will dynamically allocate a unique file unit for this file (see Section 2.1.2). While the TOXXFILE option may be specified for any of the short-term averaging periods that are identified on the CO AVERTIME card for a particular run, a non-fatal warning message will be generated if other than 1-hour averages are specified. This is because the TOXST model currently supports only 1-hour averages.

The TOXXFILE card may be repeated for each averaging period, but a different filename should be used for each file since the structure of the output file generated by the TOXXFILE option does not allow for a clear way to distinguish between results for different averaging periods. The resulting output file for the AERMOD model is an unformatted file with several header records identifying the title, averaging period, receptor information, and the threshold value for that file, followed by records listing every occurrence where the result for any source group for that averaging period equals or exceeds the threshold value. When one of the source groups exceeds the threshold value, the results for all source groups for that averaging period and receptor location are output. Each concentration that is output through the TOXXFILE option is paired with an integer ID variable that identifies the averaging period (hour number of the year), the source group number, and the receptor number corresponding to that value. The concentration values and corresponding ID variables are stored in buffer arrays, and the arrays are then written to the unformatted output file when full. The size of the arrays is controlled by the NPAIR PARAMETER defined in MODULE MAIN1 and is initially set at 100. At the end of the modeling run, any values remaining in the buffer arrays are written to the file, padded to the right with zeroes. The structure of the output file generated by the TOXXFILE option is described in more detail in Section 2.1.2 and in APPENDIX C. When using the TOXXFILE option, the user will normally place a single source in each source

group. The user should refer to the user's guide for TOXST for further instructions on the application of the TOXXFILE option of the AERMOD model.

The following examples illustrate the use of the TOXXFILE option:

```
OU TOXXFILE   1  1.0E-5  TOXX1HR.BIN

OU TOXXFILE  24  2.5E-3  TOXX24HR.BIN  50
```

The Filnam parameter may be up to 200 characters in length. It should be noted that only one TOXXFILE card may be used for each averaging period. Note: The TOXXFILE option may produce very large files for runs involving a large number of receptors if a significant percentage of the results exceed the threshold value.

3.7.2.5 RANKFILE

The RANKFILE keyword outputs values by rank for use in Q-Q (quantile) plots. The MAXTABLE option must be specified first in order to use the RANKFILE option for a particular averaging period. However, the RANKFILE output differs from the results in the MAXTABLE output in that duplicate date/hour occurrences are removed. The syntax and type for the RANKFILE keyword are summarized below:

Syntax:	OU RANKFILE Aveper Hinum Filnam (Funit)
Type:	Optional, Repeatable

where the Aveper parameter is the averaging period (e.g., 3, 8, 24 for 3, 8, and 24-hour averages, or MONTH for monthly averages), and Hinum is the number of high values to be ranked. The RANKFILE keyword cannot be used with PERIOD averages. As noted above, the MAXTABLE option must be specified first for the particular Aveper, and the Hinum parameter on the RANKFILE card must be less than or equal to the Maxnum parameter on the corresponding MAXTABLE card. Since duplicate dates are removed from the RANKFILE output, the output file may contain less than the number of requested high values. The NMAX parameter, which controls the maximum number of values that can be stored, has been set initially to 400. The Filnam parameter is the name of the file (up to 200 characters) where the RANKFILE results are to be

written. The optional Funit parameter allows the user the option of specifying the Fortran logical file unit for the output file. Please note, when specifying the FUNIT, to ensure there will be no file conflicts, it is recommended that user-specified units begin at a large integer value such as 10,000 and increment by one. By specifying the same filename and unit for more than one RANKFILE card, results for different averaging periods may be combined into a single file. If the Funit parameter is omitted, the model will dynamically allocate a unique file unit for this file.

3.7.2.6 EVALFILE

The EVALFILE option is specifically designed for use in generating residuals for model evaluation studies. The EVALFILE output consists of the arc-maximum normalized concentration values for each hour of meteorology and for each source specified. The arc groupings of the receptors must be specified using the RE EVALCART keyword described above. The syntax and type for the EVALFILE keyword are summarized below:

Syntax:	OU EVALFILE Srcid Filnam (Funit)
Type:	Optional, Repeatable

where the Srcid parameter is the source ID for which EVALFILE results are requested, the Filnam parameter is the name of the file (up to 200 characters) where the EVALFILE results are to be written, and the optional Funit parameter allows the user the option of specifying the Fortran logical file unit for the output file. Please note, when specifying the FUNIT, to ensure there will be no file conflicts, it is recommended that user-specified units begin at a large integer value such as 10,000 and increment by one. By specifying the same filename and unit for more than one EVALFILE card, results for different sources may be combined into a single file.

For each hour of meteorological data processed and for each receptor grouping (e.g., arc), the EVALFILE option outputs five records containing the source ID, date, arc ID, arc-maximum normalized concentration (P/Q), emission rate, and other plume dispersion and meteorological variables associated with the arc-maximum. Since the EVALFILE option looks at receptor groupings, it must be used in conjunction with the EVALCART keyword described above for the RE pathway, and a fatal error is generated if no receptor groups are identified.

3.7.2.7 SEASONHR

The SEASONHR option is used to output a file containing the average results by season and hour-of-day. To select this option, the user must include the SEASONHR keyword on the OU pathway. The syntax, type, and order for the SEASONHR keyword are summarized below:

Syntax:	OU SEASONHR GroupID Filenam (FUnit)
Type:	Optional, Repeatable

where the GroupID parameter specifies the source group to be output, FileName specifies the name of the output file, and the optional FileUnit parameter specifies an optional file unit.Please note, when specifying the FUNIT, to ensure there will be no file conflicts, it is recommended that user-specified units begin at a large integer value such as 10,000 and increment by one. If FileUnit is left blank, then the model will dynamically assign a file unit A sample from a SEASONHR output file is shown below:

```
* MODELING OPTIONS USED:
*  CONC                    WDEP   RURAL   FLAT        TOXICS
*         FILE OF SEASON/HOUR VALUES FOR SOURCE GROUP: ALL
*         FOR A TOTAL OF   216 RECEPTORS.
*         FORMAT: (4(1X,F13.5),1X,F8.2,2X,A8,2X,I4,2X,I4,2X,I4,2X,A8)
*        X             Y      AVERAGE CONC   ZELEV     GRP     NHRS  SEAS  HOUR  NET ID
*  __________   ____________   ____________   ______   _______ _____ _____  ____ _________
      8.68241       49.24039       0.00000     0.00   ALL        87     1     1  POL1
     17.36482       98.48077       0.00000     0.00   ALL        87     1     1  POL1
     86.82409      492.40387       0.18098     0.00   ALL        87     1     1  POL1
    173.64818      984.80774       2.52520     0.00   ALL        87     1     1  POL1
    868.24091     4924.03857       2.07470     0.00   ALL        87     1     1  POL1
   1736.48181     9848.07715       0.93252     0.00   ALL        87     1     1  POL1
     17.10101       46.98463       0.00000     0.00   ALL        87     1     1  POL1
     34.20201       93.96926       0.00000     0.00   ALL        87     1     1  POL1
    171.01007      469.84631       0.15772     0.00   ALL        87     1     1  POL1
    342.02014      939.69263       2.48554     0.00   ALL        87     1     1  POL1
   1710.10071     4698.46289       6.09119     0.00   ALL        87     1     1  POL1
   3420.20142     9396.92578       4.49830     0.00   ALL        87     1     1  POL1
     25.00000       43.30127       0.00000     0.00   ALL        87     1     1  POL1
     50.00000       86.60254       0.00000     0.00   ALL        87     1     1  POL1
    250.00000      433.01270       0.10114     0.00   ALL        87     1     1  POL1
    500.00000      866.02539       2.12970     0.00   ALL        87     1     1  POL1
   2500.00000     4330.12695       2.79993     0.00   ALL        87     1     1  POL1
   5000.00000     8660.25391       1.97200     0.00   ALL        87     1     1  POL1
```

The NHRS column in the output file contains the number of non-calm and non-missing hours used to calculate the season-by-hour-of-day averages. The SEAS column is the season index, and is 1 for winter, 2 for spring, 3 for summer and 4 for fall. The records loop through hour-of-day first, and then through the seasons.

3.7.2.8 MAXDCONT

Beginning with version 11059, three output options have been incorporated on the OU pathway to support the 1-hour NO_2 and SO_2 standards, especially the analyses that may be required to determine a source's (or group of sources) contributions to modeled violations of the NAAQS for comparison to the Significant Impact Level (SIL). The form of the standards, based on averages of ranked values across years, complicates this analysis, especially for the 1-hour NO_2 and SO_2 standards which are based on ranked values from the distribution of daily maximum 1-hour averages. One of the options (MAXDCONT) can also be used for the 24-hour $PM_{2.5}$ NAAQS.

The MAXDCONT option, applicable to 24-hour $PM_{2.5}$, 1-hour NO_2 and 1-hour SO_2 standards, can be used to determine the contribution of each user-defined source group to the high ranked values for a target source group, paired in time and space. This is accomplished as an internal post-processing routine after the main model run is completed. The user can specify the range of ranks to analyze, or can specify an upper bound rank, e.g., 8th-highest for 1-hour NO_2 (note that "upper bound" rank implies a higher concentration, while "lower bound" rank implies a lower concentration), and a threshold value, such as the NAAQS, for the target source group. The model will process each rank within the range specified but will stop after the first rank (in descending order of concentration) that is below the threshold.

The syntax, type and order of the optional MAXDCONT keyword are summarized below:

Syntax:	OU MAXDCONT GrpID UpperRank LowerRank FileName (FileUnit) or OU MAXDCONT GrpID UpperRank THRESH ThreshValue FileName (FileUnit)
Type:	Optional, Repeatable

where GrpID is the target or reference source group toward which contributions are being determined, UpperRank and LowerRank are the upper bound and lower bound ranks (where upper bound rank implies higher concentrations and lower bound rank implies lower concentrations), THRESH indicates that the lower bound rank is determined based on a lower concentration threshold, ThreshValue is the user-specified concentration threshold for GrpID impacts which serves as a lower bound on the range of ranks analyzed, FileName is the output file name, and

(FileUnit) is the optional file unit. The filename can be up to 200 characters in length based on the default parameters in AERMOD. Double quotes (“) at the beginning and end of the filename can also be used as field delimiters to allow filenames with embedded spaces. Please note, when specifying the FUNIT, to ensure there will be no file conflicts, it is recommended that user-specified units begin at a large integer value such as 10,000 and increment by one. When the THRESH option is selected AERMOD will skip the contribution analysis for any receptor where the target GrpID impact is less than the threshold and will stop processing completely after the first rank where the target GrpID values are below the threshold for all receptors; zero contribution values are still printed to the MAXDCONT output file up to the point no target group concentrations are above the THRESH value for the range of ranks analyzed. **NOTE: It is important note that the range of ranks that can be analyzed under the MAXDCONT option is limited to the range of ranks (not the individual ranks) specified on the OU RECTABLE keyword, even when the THRESH option is used in lieu of specifying a LowerRank value. AERMOD will issue a fatal error if the THRESH option is used and the range of ranks is less than or equal to 8 for the 1-hr SO_2 NAAQS, or less than or equal to 12 for the 1-hr NO_2 and 24-hr $PM_{2.5}$ NAAQS. Non-fatal warning messages will be generated if the THRESH option is used and the range of ranks is less than or equal to 24 for the 1-hr SO_2 NAAQS, or less than or equal to 28 for the 1-hr NO_2 and 24-hr $PM_{2.5}$ NAAQS. The RECTABLE keyword entry must be specified on the OU pathway prior to the MAXDCONT entry.**

When the MAXDCONT option is specified, AERMOD stores all meteorological variables in memory for each hour during the initial stage of processing in order to optimize the model runtime during the post-processing stage. Any temporally varying emissions and background concentrations, including background ozone concentrations for the OLM and PVMRM options, are also stored in memory for each hour. While optimizing runtime for the post-processing, this approach may also significantly increase the memory storage requirements of the model. In addition, since the MAXDCONT option extracts meteorological variables and other temporally-varying data stored in memory to optimize runtime, the MAXDCONT option cannot be used with the model “re-start” option using the INITFILE and SAVEFILE keywords (Section 3.2.15) on the CO pathway, or with the MULTYEAR option (Section 3.2.7) on the CO pathway.

3.7.2.9 MAXDAILY

The MAXDAILY option, introduced with version 11059, is applicable to 1-hour NO_2 and 1-hour SO_2 NAAQS and generates a file of daily maximum 1-hour concentrations for a specified source group, for each day in the data period processed. The MAXDAILY file provides an interim output that may be useful for analyzing the 1-hour NO_2 and SO_2 NAAQS. The syntax, type and order of the optional MAXDAILY keyword are summarized below:

Syntax:	OU MAXDAILY GrpID FileName (FileUnit)
Type:	Optional, Non-repeatable

where GrpID is the source group selected for daily maximum 1-hour values, FileName is the name of the MAXDAILY output file, and FileUnit is the optional file unit. The filename can be up to 200 characters in length based on the default parameters in AERMOD. Double quotes (“) at the beginning and end of the filename can also be used as field delimiters to allow filenames with embedded spaces. Please note, when specifying the FUNIT, to ensure there will be no file conflicts, it is recommended that user-specified units begin at a large integer value such as 10,000 and increment by one.

3.7.2.10 MXDYBYYR

Another option applicable to 1-hour NO_2 and 1-hour SO_2 NAAQS introduced with version 11059, the MXDYBYYR keyword, generates a summary of daily maximum 1-hour concentrations by year for each rank specified on the RECTABLE keyword. The ranks included in the MXDYBYYR file are the ranks used in the MAXDCONT postprocessing option. The syntax, type and order of the optional MXDYBYYR keyword are summarized below:

Syntax:	OU MXDYBYYR GrpID FileName (FileUnit)
Type:	Optional, Non-repeatable

where GrpID is the source group selected for daily maximum 1-hour values summarized by year, FileName is the name of the MXDYBYYR output file, and FileUnit is the optional file unit. The filename can be up to 200 characters in length based on the default parameters in AERMOD.

Double quotes (“) at the beginning and end of the filename can also be used as field delimiters to allow filenames with embedded spaces. Please note, when specifying the FUNIT, to ensure there will be no file conflicts, it is recommended that user-specified units begin at a large integer value such as 10,000 and increment by one.

3.7.3 EVENT processing options

EVENT processing in the AERMOD model is designed specifically to perform source contribution analyses for short-term average (less than or equal to 24-hour) events. The events may either be generated by the AERMOD model, or they may be user-specified events, or both. Because of this rather narrow focus of applications, the output options are limited to a single keyword. The EVENTOUT keyword controls the level of detail in the source contribution output from the EVENT model. The syntax and type of the EVENTOUT keyword are summarized below:

Syntax:	OU EVENTOUT SOCONT DETAIL
Type:	Mandatory, Non-repeatable

where the SOCONT secondary keyword specifies the option to produce only the source contribution information in the output file, and the DETAIL secondary keyword specifies the option to produce more detailed summaries in the output file. The SOCONT option provides the average concentration (or total deposition) value (i.e., the contribution) from each source for the period corresponding to the event for the source group. The basic source contribution information is also provided with the DETAIL option. In addition, the DETAIL option provides the hourly average concentration (or total deposition) values for each source for every hour in the averaging period, and a summary of the hourly meteorological data for the event period. In general, the DETAIL option produces a larger output file than the SOCONT file, especially if there are a large number of sources. There is no default setting for the EVENTOUT options.

3.7.4 Miscellaneous output options

The optional SUMMFILE keyword can be used to generate a separate formatted output file containing the summary of high ranked values included at the end of the standard ‘aermod.out’ file.

The optional FILEFORM keyword can be used to specify the use of exponential notation, rather than fixed format as currently used, for results that are output to separate result files.

The optional NOHEADER keyword can be used to suppress file headers in formatted output file options. These new options are described below.

The syntax, type, and order of the optional SUMMFILE keyword are summarized below:

Syntax:	OU SUMMFILE SummFileName
Type:	Optional, Non-repeatable

where the SummFileName is the name of the external file containing the summary of high ranked values. The SUMMFILE filename can be up to 200 characters in length based on the default parameters in AERMOD. Double quotes (“) at the beginning and end of the filename can also be used as field delimiters to allow filenames with embedded spaces. In addition to the summary of high ranked values, the SUMMFILE also includes the “MODEL SETUP OPTIONS SUMMARY” page from the main ‘aermod.out’ file.

The syntax, type, and order of the optional FILEFORM keyword are summarized below:

Syntax:	OU FILEFORM EXP or FIX
Type:	Optional, Non-repeatable

where the EXP parameter specifies that output results files will use exponential-formatted values, and the FIX parameter specifies that the output results files will use fixed-formatted values. The default option is to use fixed-formatted results, so use of FILEFORM = ‘FIX’ is extraneous. Note that AERMOD only examines the first three characters of the input field, so that the full terms of ‘EXPONENTIAL’ or ‘FIXED’ can also be used. Beginning with AERMOD version 26135, the format specified on this optional keyword is applicable to all result files including the standard ‘aermod.out’ file and the optional SUMMFILE. The FILEFORM optional may be useful to preserve precision in applications with relatively small impacts such as hazardous air pollutants (HAPs). The option may also be useful for applications with relatively large impacts that may overflow the Fortran format specifier of F13.5 used for fixed-formatted outputs. AERMOD will

issue a warning message if values that exceed the range allowed for fixed format are detected unless the FILEFORM EXP option has been selected. **However, FILEFORM EXP cannot be used with the DFAULT option with the MODELOPT keyword when the pollutant specified with the POLLUTID is a criteria pollutant (POLLUTID = SOX, SO2, NOX, NO2, CO, TSP, PM10, PM-10, PM25, PM-2.5, PM2.5, PM-25, LEAD, or PB). If FILEFORM EXP is specified when modeling any one of the criteria pollutants, the DFAULT option must be omitted from the MODELOPT list of options specified or AERMOD will automatically reset FILFORM to FIXed format.**

The syntax, type, and order of the optional NOHEADER keyword are summarized below:

Syntax:	OU NOHEADER FileType1 FileType2 FileType3 … FileTypeN or OU NOHEADER ALL
Type:	Optional, Non-repeatable

where FileTypeN identifies the keywords for formatted output files for which the file headers will be suppressed, which may include the following file types: POSTFILE, PLOTFILE, MAXIFILE, RANKFILE, SEASONHR, MAXDAILY, MXDYBYYR, and MAXDCONT. The keyword ALL may be used to specify that header records will be suppressed for ALL applicable output file types.

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Note: Many of the references listed can be found on the U.S. EPA SCRAM website at the following url: https://www.epa.gov/scram.

APPENDIX A. Functional keyword/parameter reference

This appendix provides a functional reference for the primary keywords and related secondary keywords and parameters used by the input control files for the AERMOD model. The keywords are organized by functional pathway. Except where noted, there is not a required order that the primary keywords within a pathway must be specified. Similarly, there is not a required order in which secondary keywords that follow a primary keyword must be specified, unless noted. However, AERMET assumes that user-entered values for parameters following a primary keyword are specified in the order listed in the tables below. The pathways used by the model are as follows, in the order in which they appear in the control file and in the tables that follow:

CO - for specifying overall job **CO**ntrol options;
SO - for specifying **SO**urce information;
RE - for specifying **RE**ceptor information;
ME - for specifying **ME**teorology information and options;
EV - for specifying **EV**ent information and options;
OU - for specifying **OU**tput options.

The pathways and keywords are presented in the same order as in the Detailed Keyword Reference in Section 3.0, and in the Quick Reference at the end of the manual.

Two types of tables are provided for each pathway. The first table lists all of the keywords for that pathway, identifies each keyword as to its type (either mandatory or optional and either repeatable or non-repeatable), and provides a brief description of the function of the keyword. The second type of table, which takes up more than one page for most pathways, presents the parameters for each keyword, in the order in which they should appear in the control file where order is important, and describes each parameter in detail.

The following convention is used for identifying the different types of input parameters. Parameters corresponding to secondary keywords which should be input "as is" are listed on the tables with all capital letters and are underlined, although none of the inputs to AERMOD are treated as case sensitive. Other parameter names are given with an initial capital letter and are not input "as is." In all cases, the parameter names are intended to be descriptive of the input

variable being represented, and they often correspond to the Fortran variable names used in the AERMOD code. Parentheses around a parameter indicate that the parameter is optional for that keyword. The default that is taken when an optional parameter is left blank is explained in the discussion for that parameter.

Table A-1. Description of Control Pathway Keywords

CO Keywords	Type	Keyword Description
STARTING	M – N	Identifies the start of CONTROL pathway inputs
TITLEONE	M – N	First line of title for output
TITLETWO	O – N	Optional second line of title for output
MODELOPT	M – N	Job control and dispersion options
AVERTIME	M – N	Averaging time(s) to process
URBANOPT	O – R	Specifies parameters for urban dispersion option
POLLUTID	M – N	Identifies type of pollutant being modeled
HALFLIFE[1]	O – N	Optional half life used for exponential decay
DCAYCOEF[1]	O – N	Optional decay coefficient
GASDEPDF	O – N	Option to override default parameters for gas dry deposition
GASDEPVD	O – N	Option to specify deposition velocity for gas dry deposition
GDLANUSE	O – N	Specify land use categories by sector for gas dry deposition
GDSEASON	O – N	Specify seasonal definitions for gas dry deposition
LOW_WIND	O – N	ALPHA option for low wind conditions that allows user to specify values for minimum sigma-v, minimum wind speed, and maximum meander factor
AWMADWNW	O – N	Specifies downwash options developed by AWMA
ORD_DWNW	O – N	Specifies downwash options developed by ORD
NO2EQUIL	O – N	Option to override default NO_2/NO_x equilibrium ratio for PVMRM, OLM, or TTRM/TTRM2
NO2STACK	O – N	Option to specify default in-stack NO_2/NO_x equilibrium ratio for PVRM, OLM, TTRM/TTRM2, and GRSM options; may be overridden by NO2RATIO option on SO pathway
NOX_FILE	O – N	Specifies hourly NO_X file for the GRSM option
NOX_UNIT	O – N	Option to specify units for temporally varying NO_X concentrations for the NOX_VALS keyword used with the GRSM option for estimating NO_2
NOXVALUE	O – N	Specifies background value of NO_X for the GRSM option for estimating NO_2
NOXSECTR	O – N	Option to specify wind sectors for use in varying background NO_X concentrations by wind direction for use with the GRSM option for estimating NO_2; can be used with the NOX_FILE, NOXVALUE, and NOX_VALS options

NOX_VALS	O – R	Option to specify temporally varying NO_X concentrations for use with the GRSM option for estimating NO_2
ARMRATIO	O – N	Option to override default minimum and maximum (equilibrium) ratios for the ARM2 option
O3SECTOR	O – N	Specifies optional wind sectors for use in varying background ozone (O3) concentrations by wind direction for use with OLM, PVMRM, TTRM/TTRM2, and GRSM options; can be used with the OZONEFIL, OZONEVAL, and O3VALUES options
OZONEFIL	O – N	Specifies filename for hourly ozone file for use with OLM, PVMRM, TTRM/TTRM2, and GRSM options
OZONEVAL	O – R	Specifies background value of ozone for use with OLM, PVMRM, TTRM/TTRM2, and GRSM options
O3VALUES	O – R	Option to specify temporally varying ozone concentrations for use with OLM, PVMRM, TTRM/TTRM2, and GRSM options for estimating NO_2
OZONUNIT	O – N	Option to specify units for temporally varying ozone concentrations for the O3VALUES keyword
FLAGPOLE	O – N	Specifies whether to accept receptor heights above local terrain (m) for use with flagpole receptors, and allows for default flagpole height to be specified
ARCFTOPT	O – N	Option to apply aircraft plume rise to AREA and VOLUME source types identified as aircraft using the ARCFTSRC keyword in the SO pathway
RUNORNOT	M – N	Identifies whether to run model or process setup information only
EVENTFIL[2]	O – N	Specifies whether to generate an input file for EVENT model
SAVEFILE[3]	O – N	Option to store intermediate results for restart of model after user or system interrupt
INITFILE[3]	O – N	Option to initialize model from intermediate results generated by SAVEFILE option
MULTYEAR[3]	O – N	Option to process multiple years of meteorological data (one year per run) and accumulate high short-term values across years
DEBUGOPT	O – N	Option to generate detailed result and meteorology files for debugging purposes
ERRORFIL	O – N	Option to generate detailed error listing file
FINISHED	M – N	Identifies the end of CONTROL pathway inputs

Type: M – Mandatory, O – Optional, N – Non-Repeatable, R – Repeatable

1) Either HALFLIFE or DCAYCOEF may be specified. If both cards appear a warning message will be issued and the first value entered will be used in calculations. The DFAULT option assumes a half-life of 4 hours for SO_2 modeled in urban mode.

2) The EVENTFIL keyword controls whether to generate an input file for EVENT processing. The primary difference between AERMOD "regular" processing and EVENT processing by AERMOD is in the treatment of source group contributions. The AERMOD model treats the source groups independently, whereas EVENT processing determines individual source contributions to particular events, such as the design concentrations determined from AERMOD, or user specified events. By specifying the EVENTFIL keyword, an input control file will be generated that can be used directly for EVENT processing. The events included in the generated EVENT processing input file are defined by the RECTABLE and MAXIFILE keywords on the OU pathway and are placed in the EVENT pathway.

3) The SAVEFILE and INITFILE keywords work together to implement the model's re-start capabilities. Since the MULTYEAR option utilizes the re-start features in a special way to accumulate high short-term values from year to year, it cannot be used together with the SAVEFILE or INITFILE keyword in the same model run.

Table A-2. Description of Control Pathway Keywords and Parameters

Keyword	Parameters	
TITLEONE	Title1	
where:	Title1	First line of title for output, character string of up to 68 characters (additional characters can be included on the TITLEONE keyword, but only the first 68 characters are printed in the output files).
TITLETWO	Title2	
where:	Title2	Optional second line of title for output, character string of up to 68 characters (any additional characters are not printed).
MODELOPT	DFAULT ALPHA BETA CONC AREADPLT FLAT NOSTD NOCHKD NOWARN SCREEN SCIM NOMINO3 RLINEFDH ELEV WARNCHKD NOURBTRAN VECTORWS PSDCREDIT FASTALL FASTAREA GRSM TTRM TTRM2 PVMRM OLM ARM2 DEPOS DDEP WDEP DRYDPLT WETDPLT NODRYDPLT NOWETDPLT AREAMNDR HBP	
where:	DFAULT	Specifies that the regulatory default options will be used; note that specification of the DFAULT option will override some non-DFAULT options that may be specified in the input file, while other non-DFAULT options will cause fatal errors when DFAULT is specified (see below for details).
	ALPHA	Non-regulatory option flag that allows the input control file to include research/experimental options for review and evaluation by the user community; (e.g., LOW_WIND, PSDCREDIT, ORD_DWNW, AWMADWNW, PLATFORM, METHOD 2 particle deposition, gas deposition, RLINEFDH, and RLINEXT with options for modeling barriers and depressed roadways) and cannot be used with DFAULT keyword.
	BETA	Non-regulatory option flag that allows the input control file to include options that have been vetted through the scientific community and are waiting to be promulgated as regulatory options. Prior to promulgation, BETA options require alternative model approval for use in regulatory applications and cannot be used with DFAULT keyword.
	CONC	Specifies that concentration values will be calculated.
	DEPOS	Specifies that total deposition flux values will be calculated.
	DDEP	Specifies that dry deposition flux values will be calculated.
	WDEP	Specifies that wet deposition flux values will be calculated.

Keyword	Parameters	
	AREADPLT	Specifies use of non-regulatory method for optimized plume depletion due to dry removal mechanisms for area sources (cannot be used when the DFAULT keyword is specified).
	FLAT	Specifies that the non-regulatory option of assuming flat terrain will be used; Note that FLAT and ELEV may be specified in the same model run to allow specifying the non-regulatory FLAT terrain option on a source-by-source basis; FLAT sources are identified by specifying the keyword FLAT in place of the source elevation field on the SO LOCATION keyword (cannot be used simultaneously with the DFAULT keyword)..
	ELEV	Specifies that the default option of assuming elevated terrain will be used; Note that FLAT and ELEV may be specified in the same model run to allow specifying the non-regulatory FLAT terrain option on a source-by-source basis (the ELEV option is set as a regulatory option with the DFAULT keyword).
	NOSTD	Specifies that the non-regulatory option of no stack-tip downwash will be used (cannot be used with the DFAULT keyword).
	NOCHKD	Specifies that the non-regulatory option of suspending date checking will be used for non-sequential meteorological data files (cannot be used with the DFAULT keyword).
	WARNCHKD	Specifies that the option of issuing warning messages rather than fatal errors will be used for non-sequential meteorological data files.
	NOWARN	Specifies that the option of suppressing the detailed listing of warning messages in the main output file will be used (the number of warning messages is still reported, and warning messages are still included in the error file controlled by the CO ERRORFIL keyword).
	SCREEN	Non-regulatory option for running AERMOD in a screening mode for AERSCREEN will be used (cannot be used when the DFAULT keyword is specified).
	SCIM	Sampled Chronological Input Model – non-regulatory option used only with the ANNUAL average option to reduce runtime by sampling meteorology at a user-specified regular interval; SCIM sampling parameters must be specified on the ME pathway (cannot be used with the DFAULT keyword).
	PVMRM	Specifies that the Plume Volume Molar Ratio Method (PVMRM) for NO_2 conversion will be used (regulatory

Keyword	Parameters	
		option, can be used simultaneously with DFAULT); cannot be used with OLM, ARM2, or GRSM; cannot be used with TTRM without TTRM2.
	OLM	Specifies that the Ozone Limiting Method (OLM) for NO_2 conversion will be used (regulatory option, can be used simultaneously with DFAULT keyword); cannot be used with PVMRM, ARM2, or GRSM; cannot be used with TTRM without TTRM2.
	ARM2	Specifies that the Ambient Ratio Method - 2 (ARM2) for NO_2 conversion will be used (regulatory option, can be used with DFAULT keyword); cannot be used with PVMRM, OLM, or GRSM; cannot be used with TTRM without TTRM2.
	TTRM	Specifies that the non-regulatory Travel Time Reaction Method (TTRM) will be used for NO_2 conversion (non-regulatory alpha option, requires the ALPHA keyword and cannot be used with the DFAULT keyword); cannot be used with PVMRM, OLM, ARM2 without TTRM2; cannot be used with GRSM; cannot be used with TTRM2 without PVMRM, OLM, or ARM2.
	TTRM2	Specifies that the non-regulatory Travel Time Reaction Method (TTRM) will be paired with OLM, PVMRM, or ARM2 for NO_2 conversion (non-regulatory alpha option, requires the ALPHA keyword and cannot be used with the DFAULT keyword); cannot be used with TTRM alone or GRSM; must be paired with one of PVMRM, OLM, or ARM2
	GRSM	Specifies that the Generic Reaction Set Method (GRSM) will be used for NO_2 conversion; cannot be used with PVMRM, OLM, TTRM, TTRM2, or ARM2.
	PSDCREDIT	Specifies that the non-regulatory ALPHA option will be used to calculate the increment consumption with PSD credits using the PVMRM option (cannot be used with the DFAULT keyword).
	FASTALL	Non-regulatory option to optimize model runtime through use of an alternative implementation of horizontal meander for POINT and VOLUME sources; also optimizes model runtime for AREA/AREAPOLY/AREACIRC/LINE, OPENPIT, RLINE, and RLINEXT sources (formerly associated with TOXICS option, now controlled by the FASTAREA and FASTALL option, cannot be used with the DFAULT keyword).

Keyword	Parameters	
	FASTAREA	Non-regulatory option to optimize model runtime through hybrid approach for AREA/ AREAPOLY/AREACIRC and OPENPIT sources (formerly associated with TOXICS option, cannot be used with the DFAULT keyword).
	DRYDPLT	Option to incorporate dry depletion (removal) processes associated with dry deposition algorithms; this requires specification of dry deposition source parameters and additional meteorological variables; dry depletion will be used by default if dry deposition algorithms are invoked; cannot be used with NODRYDPLT.
	NODRYDPLT	Option to disable dry depletion (removal) processes associated with dry deposition algorithms; cannot be used with DRYDPLT.
	WETDPLT	Option to incorporate wet depletion (removal) processes associated with wet deposition algorithms; this requires specification of wet deposition source parameters and additional meteorological variables; wet depletion will be used by default if wet deposition algorithms are invoked; cannot be used with NOWETDPLT.
	NOWETDPLT	Option to disable wet depletion (removal) processes associated with wet deposition algorithms; cannot be used with WETDPLT.
	NOURBTRAN	Non-regulatory option to ignore the transition from nighttime urban boundary layer to daytime convective boundary layer (i.e., to revert to the urban option as implemented prior to version 11059) (cannot be used with the DFAULT keyword).
	VECTORWS	Option to specify that input wind speeds are vector mean (or resultant) wind speeds, rather than scalar means. Under the VECTORWS option, the adjustments to wind speeds based on Equation 112 of the AERMOD Model Formulation document (EPA, 2026a) will be applied (can be used with the DFAULT keyword).
	NOMINO3	Option to remove the minimum ozone used for Tier 3 NO_2 options. Without this option, AERMOD will use the minimum of 40ppb and O3MAX24 for nighttime stable conditions, regardless of the value in an hourly input file (can be used with the DFAULT keyword).
	RLINEFDH	Option to have wind profile calculations without a displacement height for RLINE and RLINEXT source types. This makes the wind profile closer to other AERMOD source types, which do not use a displacement height in wind profile (requires the

Keyword	Parameters	
		ALPHA keyword and cannot be used with the DFAULT keyword).
	AREAMNDR	Option to apply plume meander to AREA. AREAPOLY, AREACIRC, and LINE source types. Note that AREAMNDR and FASTAREA or FASTALL can be specified in the same model run, but in that case, meander will not be applied to those source types listed.
	HBP	Option for highly buoyant plumes (HBP) when plume penetrates the top of the convective mixed layer. Limited to point source types (POINT, POINTHOR, POINTCAP). Compares convective mixing height for the current hour and next hour to determine how much of the penetrated plume has been captured by the CBL by the end of the current hour (requires the ALPHA keyword and cannot be used with the DFAULT keyword).
	BAREDGE	Option to turn on solid barrier edge effects with RLINEXT source and SBARRIER inputs.
AVERTIME	Time1 Time2 . . . Time*N* MONTH PERIOD or ANNUAL	
where:	Time*N*	*Nth* optional averaging time (1, 2, 3, 4, 6, 8, 12, or 24-hr)
	MONTH	Option to calculate MONTHly averages.
	PERIOD	Option to calculate averages for the entire data PERIOD; for the MULTYEAR option, the summary of highest PERIOD averages is based on the highest PERIOD average across the individual years processed with MULTYEAR.
	ANNUAL	Option to calculate ANNUAL averages (assumes complete years); for multi-year meteorological data files, with and without the MULTYEAR option, the multi-year average of the ANNUAL values is reported.
URBANOPT	For multiple urban areas: UrbanID Urbpop (Urbname) (UrbRoughness) For single urban area: Urbpop (Urbname) (UrbRoughness)	
where:	UrbanID	Specifies the alphanumeric urban ID (up to eight characters).
	UrbPop	Specifies the population of the urban area.
	(UrbName)	Specifies the name of the urban area (optional).
	(UrbRoughness)	

Keyword	Parameters	
		Specifies the urban surface roughness length, meters (optional, defaults to 1.0m; value other than 1.0m treated as non-DFAULT).
POLLUTID	Pollut (H1H or H2H or INC)	
where:	Pollut	Identifies type of pollutant being modeled. Any name of up to eight characters may be used, e.g., SO2, NOX, CO, PM25, PM-2.5, PM10, PM-10, TSP or OTHER. NOTE: Some processing options are pollutant-specific, and require the user to specify the appropriate pollutant ID. For example, use of PM10, PM-10, PM25, PM2.5, PM-2.5, PM-25, LEAD, NO2, SO2, or OTHER allows for the use of the MULTYEAR option. Use of PM25, PM2.5, PM-2.5, or PM-25, triggers special processing for the PM-2.5 NAAQS, based on values averaged across the number of years processed (see Section 3.2.16.1). Use of NO2 or SO2 triggers special processing for their respective 1-hr NAAQS based on daily maximum 1-hr concentrations, averaged across the number of years modeled if the CO AVERTIME keyword includes 1-hr averages (see Section 3.2.17). Use of NO2 is required in order to use the OLM and PVMRM options for simulating conversion of NO to NO_2. Use of SO2 also triggers the use of a 4-hour half-life for SO_2 decay for urban applications under the regulatory default option.
	H1H or H2H or INC	Use of the H1H or H2H or INC keyword (not case-specific) disables the special processing requirements associated the 1-hr NO_2 and SO_2 NAAQS and the 24-hr $PM_{2.5}$ NAAQS. Specifying one of these keywords would allow for modeling $PM_{2.5}$ 24-hr increments which are based on the H2H value and allow evaluating NO_2 options in AERMOD based on incomplete years of field measurements.
HALFLIFE	Haflif	

Keyword	Parameters	
where:	Haflif	Half-life used for exponential decay (s).
DCAYCOEF	Decay	
where:	Decay	Decay coefficient for exponential decay (s^{-1}) = 0.693/HAFLIF
GASDEPDF	React F_Seas2 F_Seas5 (Refpoll) **The ALPHA option must be specified as a MODELOPT on the CO pathway to use the GASDEPDF keyword.**	
where:	React F_Seas2 F_Seas5 (Refpoll)	Value for pollutant reactivity factor (f_o). Fraction (F) of maximum green LAI for seasonal category 2. Fraction (F) of maximum green LAI for seasonal category 5. Optional name of reference pollutant.
GASDEPVD	Uservd **The ALPHA option must be specified as a MODELOPT on the CO pathway to use the GASDEPVD keyword.**	
where:	Uservd	User-specified dry deposition velocity (m/s) for gaseous pollutants.
GDLANUSE	Sec1 Sec2 ... Sec36 **The ALPHA option must be specified as a MODELOPT on the CO pathway to use the GDLANUSE keyword.**	
where:	Sec1 Sec2 . . . Sec36	Land use category for winds blowing toward sector 1 (10 degrees). Land use category for winds blowing toward sector 2 (20 degrees). Land use category for winds blowing toward sector 36 (360 degrees).
GDSEASON	Jan Feb ... Dec **The ALPHA option must be specified as a MODELOPT on the CO pathway to use the GDSEASON keyword.**	
where:	Jan .	Seasonal category for January: 1 = Midsummer/Lush vegetation; 2 = Autumn/Unharvested cropland;

Keyword	Parameters	
	. . . Dec	3 = Late autumn after harvest or Winter with no snow; 4 = Winter with continuous snow cover; or 5 = Transitional spring/partial green coverage/short annuals) Seasonal category for December.
LOW_WIND	SVmin (WSmin) or SVmin WSmin (FRANmax) or SVmin WSmin FRANmax (SWmin) or SVmin WSmin FRANmax SWmin (BigT) or SVmin WSmin FRANmax SWmin BigT (FRANmin) or SVmin WSmin FRANmax SWmin BigT FRANmin (PBAL) **The ALPHA option must be specified as a MODELOPT on the CO pathway to use the LOW_WIND keyword**	
where:	SVmin	Minimum value of sigma-v, within a range of 0.01 to 1.0 m/s.
	WSmin	Minimum value of wind speed, within a range of 0.01 to 1.0 m/s.
	FRANmax	Maximum value for meander factor, within a range of 0.0 to 1.0.
	SWmin	Minimum value of sigma-w, within a range of 0.0 to 3.0 m/s.
	BigT	Time period (BigT) used to calculate the time scale TRAN, within a range of 0.5 to 48.0 hours.
	FRANmin	Minimum value for meander factor, within a range of 0.0 to 1.0 but must be less than or equal to FRANmax.
	PBAL	Alternate momentum balance approach to determine plume meander which overrides the default energy balance approach.
AWMADWNW	AWMAUEFF and/or AWMAENTRAIN and/or ((AWMAUTURB or AWMAUTURBHX) w/wo STREAMLINE(D)) **The ALPHA option must be specified as a MODELOPT on the CO pathway to use the AWMADWNW keyword.**	
where:	AWMAUEFF	Redefines the height at which the wind speed is taken from the profile wind speed used in the calculation of concentrations from the primary plume.
	AWMAENTRAIN	Changes beta (B) entrainment coefficient for PRIME downwash from default value of 0.60 to 0.35.

Keyword	Parameters	
	AWMAUTURB	Uses alternative formulations for turbulence enhancement and velocity deficit calculations.
	AWMAUTURBHX	Uses distance-based plume rise at the downwind distance X for calculations.
	STREAMLINE	Reduces dispersion in the wake of streamlined structures such as storage tanks and cooling towers.
ORD_DWNW	ORDUEFF and/or ORDTURB and/or ORDCAV **The ALPHA option must be specified as a MODELOPT on the CO pathway to use the ORD_DWNW keyword.**	
where:	ORDUEFF	Redefines the height at which the wind speed is taken from the profile wind speed used in the calculation of concentrations from the primary plume.
	ORDTURB	Redefines the maximum value of the ambient turbulence intensity in the wake, reduced from 0.07 to 0.06.
	ORDCAV	Redefines the initial vertical dispersion, σz, of the re-emitted plume at the cavity boundary to equal the σz of the cavity plume.
NO2EQUIL	NO2Equil	
where:	NO2Equil	Equilibrium ratio of NO_2/NO_x for the PVMRM, OLM, and TTRM options; between 0.1 and 1.0, inclusive (default is 0.9).
NO2STACK	NO2Ratio	
where:	NO2Ratio	Default in-stack ratio of NO_2/NO_x for PVMRM, OLM, TTRM, and GRSM options, which may be overridden by the NO2RATIO keyword on SO pathway. NOTE: Beginning with version 11059, AERMOD no longer assumes a default in-stack ratio of 0.1 for the OLM option.
ARMRATIO	ARM2_Min ARM2_Max	For ARM2 Option
where:	ARM2_Min	Minimum ARM2 ambient ratio, with a default value of 0.50.
	ARM2_Max	Maximum ARM2 ambient ratio, with a default value of 0.90.
O3SECTOR	StartSect1 StartSect2 . . . StartSect*N*, where *N* is ≤ 6	
where:	StartSect1 StartSect2 .	Starting direction for the first sector. Starting direction for the second sector. .

Keyword	Parameters	
	. StartSect*N*	. Starting direction for the last sector. NOTE: The minimum sector width allowed is 30 degrees, and warning messages will be issued for sector widths less than 60 degrees. Sector-varying O_3 concentrations will be selected based on the flow vector, i.e., the downwind direction based on the wind direction specified in the surface meteorological data file.
OZONEFIL	O3FileName (O3Units) (O3Format) (without O3SECTORs) or SECT*x* O3FileName (O3Units) (O3Format) (with O3SECTORs)	
where:	SECT*x* O3FileName (O3Units) (O3Format)	Applicable sector (*x* = 1 to 6) defined on the CO O3SECTOR keyword, if specified. Filename for hourly ozone data file (YR, MN, DY, HR, O3Value). Units of ozone data (PPM, PPB, or UG/M3); default is UG/M3. Fortran format statement to read ozone file; default is FREE-format, i.e., comma or space-delimited data fields (Yr Mn Dy Hr O3Value). The O3Format parameter must include open and close parentheses, the date variables must be read as integers (Fortran I format), and the O3Value must be read as real (Fortran F, E, or D format), e.g., '(4I2,F8.3)'. The year may be specified as a 2-digit or 4-digit year, and the data period in the OZONEFIL must match the data period in the meteorological data files.
OZONEVAL	O3Value (O3Units) (without O3SECTORs) or SECT*x* O3Value (O3Units) (with O3SECTORs)	
where:	SECT*x* O3Value (O3Units)	Applicable sector (*x* = 1 to 6) defined on the CO O3SECTOR keyword, if specified. Background ozone concentration; also used to substitute for missing data in OZONEFIL. Units of ozone value (PPM, PPB, or UG/M3); default is UG/M3.
O3VALUES	O3Flag O3values(i), i=1, *n* (without O3SECTORs) or	

Keyword	Parameters	
	SECT*x* O3Flag O3values(i), i=1, *n* (with O3SECTORs)	
where:	SECT*x*	Applicable sector (*x* = 1 to 6) defined on the CO O3SECTOR keyword, if specified.
	O3Flag	Background ozone values flag: ANNUAL for annual; SEASON for seasonal; MONTH for monthly; HROFDY for hour-of-day; WSPEED for wind speed category; SEASHR for season-by-hour; HRDOW for emission rates vary by hour-of-day, and day-of-week [M-F, Sat, Sun]; HRDOW7 for emission rates vary by hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun]; SHRDOW for season by hour-of-day by day-of-week (M-F,Sat,Sun); SHRDOW7 for season by hour-of-day by day-of-week (M,Tu,W,Th,F,Sat,Sun); MHRDOW for month by hour-of-day by day-of-week (M-F,Sat,Sun); MHRDOW7 for month by hour-of-day by day-of-week (M,Tu,W,Th,F,Sat,Sun).
	O3values	Array of background concentrations, for: ANNUAL, *n*=1; SEASON, *n*=4; MONTH, *n*=12; HROFDY, *n*=24; WSPEED, *n*=6; SEASHR, *n*=96; HRDOW, *n*=72; HRDOW7, *n*=168; SHRDOW, *n*=288; SHRDOW7, *n*=672; MHRDOW, *n*=864; MHRDOW7, *n*=2016. NOTE: Background ozone values input through the O3VALUES keyword are assumed to be in units of PPB, unless modified by the OZONUNIT keyword.
OZONUNIT	OzoneUnits	
where:	OzoneUnits	Ozone concentration units for O3VALUES, specified as PPB for parts-per-billion, PPM for parts-per-million, or UG/M3 for micrograms/cubic-meter.
The following keywords: NOXSECTR, NOX_FILE, NOXVALUE, NOX_VALS, and NOX_UNIT, are only applicable to the GRSM NO-to-NO_2 Conversion Option.		
NOXSECTR	StartSect1 StartSect2 . . . StartSect*N*, where *N* is ≤ 6	
where:	StartSect1 StartSect2 . . StartSect*N*	Starting direction for the first sector. Starting direction for the second sector. . . Starting direction for the last sector.

Keyword	Parameters	
		NOTE: The minimum sector width allowed is 30 degrees, and warning messages will be issued for sector widths less than 60 degrees. Sector-varying NOX concentrations will be selected based on the flow vector, i.e., the downwind direction based on the wind direction specified in the surface meteorological data file.
NOX_FILE	NOXFileName (NOXUnits) (NOXFormat) (without NOXSECTRs) or SECT*x* NOXFileName (NOXUnits) (NOXFormat) (with NOXSECTRs)	
where:	SECT*x* NOXFileName (NOXUnits) (NOXFormat)	Applicable sector (*x* = 1 to 6) defined on the CO O3SECTOR keyword, if specified. Filename for hourly NOX data file (YR, MN, DY, HR, NOXValue). Units of NOX data (PPM, PPB, or UG/M3); default is UG/M3. Fortran format statement to read NOX file; default is FREE-format, i.e., comma or space-delimited data fields (Yr Mn Dy Hr NOXValue). The NOXFormat parameter must include open and close parentheses, the date variables must be read as integers (Fortran I format), and the NOXValue must be read as real (Fortran F, E, or D format), e.g., '(4I2,F8.3)'. The year may be specified as a 2-digit or 4-digit year, and the data period in the NOX_FILE must match the data period in the meteorological data files.
NOXVALUE	NOXValue (NOXUnits) (without NOXSECTRs) or SECT*x* NOXValue (NOXUnits) (with NOXSECTRs)	
where:	SECT*x* NOXValue (NOXUnits)	Applicable sector (*x* = 1 to 6) defined on the CO NOXSECTR keyword, if specified. Background ozone concentration; also used to substitute for missing data in OZONEFIL. Units of ozone value (PPM, PPB, or UG/M3); default is UG/M3.
NOX_VALS	NOXFlag NOXvalues(i), i=1, *n* (without NOXSECTRs) or	

Keyword	Parameters	
	SECT*x* NOXFlag NOXvalues(i), i=1, *n* (with NOXSECTRs)	
where:	SECT*x*	Applicable sector (*x* = 1 to 6) defined on the CO O3SECTOR keyword, if specified.
	NOXFlag	Background ozone values flag: ANNUAL for annual; SEASON for seasonal; MONTH for monthly; HROFDY for hour-of-day; WSPEED for wind speed category; SEASHR for season-by-hour; HRDOW for emission rates vary by hour-of-day, and day-of-week [M-F, Sat, Sun]; HRDOW7 for emission rates vary by hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun]; SHRDOW for season by hour-of-day by day-of-week (M-F,Sat,Sun); SHRDOW7 for season by hour-of-day by day-of-week (M,Tu,W,Th,F,Sat,Sun); MHRDOW for month by hour-of-day by day-of-week (M-F,Sat,Sun); MHRDOW7 for month by hour-of-day by day-of-week (M,Tu,W,Th,F,Sat,Sun).
	NOXvalues	Array of background concentrations, for: ANNUAL, *n*=1; SEASON, *n*=4; MONTH, *n*=12; HROFDY, *n*=24; WSPEED, *n*=6; SEASHR, *n*=96; HRDOW, *n*=72; HRDOW7, *n*=168; SHRDOW, *n*=288; SHRDOW7, *n*=672; MHRDOW, *n*=864; MHRDOW7, *n*=2016. NOTE: Background NOX values input through the NOXVALUES keyword are assumed to be in units of PPB, unless modified by the NOX_UNIT keyword.
NOX_UNIT	NOXUnits	
where:	NOXUnits	NOX concentration units for NOX_VALS, specified as PPB for parts-per-billion, PPM for parts-per-million, or UG/M3 for micrograms/cubic-meter.
FLAGPOLE	(Flagdf)	
where:	(Flagdf)	Default value for height of (flagpole) receptors above local ground, a default value of 0.0 m is used if this optional parameter is omitted.
ARCFTOPT	(AirportID)	
where:	(AirportID)	Optional alphanumeric character string to identify the airport where aircraft sources are located.

Keyword	Parameters	
RUNORNOT	RUN or NOT	
where:	RUN NOT	Indicates to run full model calculations. Indicates to process setup data and report errors, but do not run full model calculations.
EVENTFIL	(Evfile) (Evopt)	
where:	(Evfile) (Evopt)	Identifies the filename to be used to generate a file for input to EVENT model (Default=EVENTFIL.INP). Optional parameter to specify the level of output detail selected for the EVENT model: either SOCONT or DETAIL (default is DETAIL if this parameter is omitted).
SAVEFILE	(Savfil) (Dayinc) (Savfl2)	
where:	(Savfil) (Dayinc) (Savfl2)	Specifies name of disk file to be used for storing intermediate results (default = SAVE.FIL); file is overwritten after each dump. Number of days between dumps (optional: default is 1). Optional second disk filename to be used on alternate dumps - eliminates risk of system crash during the dump. If blank, file is overwritten each time.
INITFILE	(Inifil)	
where:	(Inifil)	Specifies name of disk file of intermediate results to be used for initializing run (default = SAVE.FIL).
MULTYEAR	(H6H) Savfil (Inifil)	
where:	(H6H) Savfil (Inifil)	Optional field formerly used to specify that High-Sixth-High is being calculated for use in PM10 processing; no longer required. Specifies name of file to be used for storing results at the end of the year. Optional name of file used for initializing the results arrays from previous year(s). The Inifil parameter is not used for the first year in the multi-year run.
DEBUGOPT	MODEL (Dbgfil) and/or METEOR (Dbmfil) and/or PRIME (Prmfil) and/or AWMADW (AwmaDwfil) and/or PLATFORM (PlatfmDbgFil) and/or DEPOS (Dbgfil) and/or	

Keyword	Parameters	
	[AREA (AreaDbFil) or LINE (LineDbFil)] and/or RLINE (RlineDbgFil) and/or BLPDBUG (BLPDbFil) and/or URBANDB (UrbanDbFil) and/or [PVMRM (Dbpvfil) (and TTRM2) or OLM (OLMfil) (and TTRM2) or ARM2 (ARM2fil) (and TTRM2) or TTRM (TTRMfil) or GRSM (GRSM fil)] and/or SWPOINT (SWfil) and/or HBPDBG (HBPfil) and/or AIRCRAFT (DbARCFTfil)	
where:	MODEL	Specifies that MODEL debugging output will be generated.
	(Dbgfil)	Optional filename for the model calculation debug file (a default filename of 'MODEL.DBG' will be used if omitted).
	METEOR	Specifies that METEORological profile data file will be generated.
	(Dbmfil)	Optional filename for the meteorological profile data file (a default filename of 'METEOR.DBG' will be used if omitted).
	PRIME	Specifies that PRIME debugging output will be generated.
	(Prmfil)	Optional filename for PRIME debug file (a default filename of 'PRIME.DBG' will be used if omitted).
	AWMADW	Specifies the debug out will be generated for AWMA Downwash options.
	(AwmaDwfil)	Optional filename for AWMADW debug file (a default filename of 'AWMADW.DBG' will be used if omitted).
	PLATFORM	Specifies the debug out will be generated for PLATFORM Downwash options.
	(PlatfmDbgfil)	Optional filename for PLATFORM downwash debug file. (a default filename of 'PLATFORM.DBG' will be used if omitted).

Keyword	Parameters	
	DEPOS	Specifies that DEPOSition debugging output will be generated, using default filenames of 'GDEP.DAT' for gas deposition and 'PDEP.DAT' for particle deposition.
	AREA or LINE	Specifies that AREA or LINE debugging output will be generated, including debugging outputs for OPENPIT sources, if included in the modeling.
	(AreaDbfil)	Optional filename for AREA debug file (a default filename of 'AREA.DBG' will be used if omitted).
	RLINE	Specifies that RLINE debugging output will be generated.
	(RLineDbgFil)	Optional filename for RLINE debug file (a default filename of 'RLINE.DBG' will be used if omitted).
	BLPDBUG	Debug information for the BUOYLINE source.
	(BLPDbFil)	Optional filename for BLPDBUG debug file (a default filename of 'BLPDBUG.DBG' will be used if omitted).
	URBANDB	Debug information from the URBANDB option. This will produce 3 output files, one for the surface meteorology and two for the profile meteorology.
	(UrbanDbFil)	Optional filename for URBANDB debug files This will produce three output files, one for the surface meteorology, two for the profile meteorology. If the filename is specified by the user, then the filename will be used for the surface meteorology debug file. The same name will be assigned for the two profile debug files with a "1" and "2" appended to the filename, respectively. Default filenames: URBDBUG.DBG, URBDBUG1.DBG, and URBDBUG2.DBG.
	PVMRM	Specifies that PVMRM debugging output will be generated
	(Dbpvfil)	Optional filename for PVMRM debug file (a default filename of 'PVMRM.DBG' will be used if omitted).
	OLM	Specifies that OLM debugging output will be generated
	(OLMfil)	Optional filename for OLM debug file (a default filename of 'OLM.DBG' will be used if omitted).
	ARM2	Specifies that ARM2 debugging output will be generated
	(ARM2fil)	Optional filename for ARM2 debug file (a default filename of 'ARM2.DBG' will be used if omitted).
	TTRM	Specifies that TTRM debugging output will be generated
	(TTRMfil)	Optional filename for TTRM debug file (a default filename of 'TTRM.DBG'will be used if omitted).
	TTRM2	Specifies that TTRM2 debugging output will be generated. TTRM2 can only be used with ARM2, PVMRM, or OLM and only if specified with the MODELOPT keyword along with one of those options.

Keyword	Parameters	
		A user-defined debug filename cannot be specified for the TTRM2 debug option.
	GRSM	Specifies that GRSM debugging output will be generated.
	(GRSM fil)	Optional filename for GRSM debug file (a default filename of 'GRSM.DBG' will be used if omitted).
	SWPOINT	Specifies debugging output for the SWPOINT (sidewash) source type will be generated.
	(SWfil)	Optional filename for SWPOINT debug file (a default filename of SWPOINT.DBG will be used if omitted).
		Note: The user can specify any of the applicable debug options for a particular model run, and the options can be specified in any order. However, the optional filenames must be specified immediately after the keyword option associated with the filename. Also note that debugging information that was written to the main 'aermod.out' file for the MODEL debug option prior to version 13350 is now written to the applicable debug file (either MODEL or PRIME) and beginning with version 14134 debug information for AREA/LINE/OPENPIT sources is written to the AREA debug file.
	HBPDBG	Specifies debugging output for the HBP (highly buoyant plume) sources will be generated.
	(HBPfil)	Optional filename for HBP debug file (a default filename of HBP_DEBUG.DBG will be used if omitted).
	AIRCRAFT	Specifies debugging output for AREA and VOLUME aircraft sources.
	(DbARCFTfil)	Optional filename for the AIRCRAFT debug file (a default filename of AIRCRAFT.DBG will be used if omitted).

ERRORFIL	(Errfil)	
where:	(Errfil)	Specifies name of detailed error listing file (default = ERRORS.LST).

Table A-3. Description of Source Pathway Keywords

SO Keywords	Type	Keyword Description
STARTING	M – N	Identifies the start of SOURCE pathway inputs
ELEVUNIT	O – N	Defines input units for source elevations (defaults to meters), must be first keyword after SO STARTING if used.
LOCATION	M – R	Identifies coordinates for particular source
RLEMCONV	O - N	Optional emission units conversion that changes the input units for the RLINE and RLINEXT sources to grams/hour/link
SRCPARAM	M – R	Identifies source parameters for a particular source
BUILDHGT	O – R	Building height values for each wind sector
BUILDLEN	O – R	Building projected length values for each wind sector
BUILDWID	O – R	Building projected width values for each wind sector
XBADJ	O – R	Along-flow distances from the stack to the center of the upwind face of the projected building
YBADJ	O – R	Across-flow distances from the stack to the center of the upwind face of the projected building
AREAVERT	M – R	Specifies location of vertices for an AREAPOLY source type (mandatory if AREAPOLY source is used)
RBARRIER	O - R	Specifies RLINEXT solid barrier source configuration. Individual segments are not considered continuous and are independent of one another. **The ALPHA option must be specified as a MODELOPT on the CO pathway to use the RBARRIER keyword.**
RDEPRESS	O - R	Specifies RLINEXT depressed roadway source configuration **The ALPHA option must be specified as a MODELOPT on the CO pathway to use the RDEPRESS keyword.**
SBARRIER	O-R	Specifies RLINEXT continuous solid barrier source configuration. Individual segments linked to the barrier ID are considered continuous, and the continuous solid barrier algorithm is applied. **The ALPHA option must be specified as a MODELOPT on the CO pathway to use the SBARRIER keyword.**
BLPINPUT	M - R	Buoyant line group parameters representative of the buoyant line group
URBANSRC	O – R	Identifies which sources to model with urban effects

SO Keywords	Type	Keyword Description
EMISFACT	O – R	Optional input for variable emission rate factors
EMISUNIT	O – N	Optional unit conversion factors for emissions, concentrations
CONCUNIT	O – N	Optional conversion factors for emissions and concentrations
DEPOUNIT	O – N	Optional conversion factors for emissions and depositions
PARTDIAM	O – R	Input variables for optional input of particle size (microns)
MASSFRAX	O – R	Optional input of mass fraction for each particle size category
PARTDENS	O – R	Optional input of particle density (g/cm^3) for each size category
METHOD_2	O – R	Optional input of parameters for METHOD_2 particle deposition **The ALPHA option must be specified as a MODELOPT on the CO pathway to use the METHOD_2 keyword.**
GASDEPOS	O – R	Optional input of gas deposition parameters **The ALPHA option must be specified as a MODELOPT on the CO pathway to use the GASDEPOS keyword.**
NO2RATIO	O – R	Option to specify in-stack NO2/NOx equilibrium ratio for OLM and PVMRM options by source
HOUREMIS	O – R	Option for specifying hourly emission rates in a separate file
BGSECTOR	O – N	Specifies optional wind sectors for use in varying background concentrations by wind direction for the pollutant being modeled, as specified on the BACKGRND keyword
BACKGRND	O – R	Option to specify temporally varying background concentrations
BACKUNIT	O – N	Option to specify units for background concentrations
INCLUDED	O – R	Option to include data from a separate file in the runstream
OLMGROUP	O – R	Specifies sources to combine for OLM option to account for merging plumes
BLPGROUP[2]	M - R	Associates individual buoyant lines with a buoyant line source group
PSDGROUP[1]	O – R	Specifies source groups for PSDCREDIT option with PVMRM
HBPSRCID	M – R	Identification of HBP (highly buoyant plume) sources. Mandatory when HBP option is used
ARCFTSRC	M - R	Identification of aircraft sources. Mandatory when the ARCFTOPT option is used
SRCGROUP[1]	M – R	Identification of source groups

SO Keywords	Type	Keyword Description
PLATFORM	O – R	Optional input for POINT and POINTHOR sources on a platform. **The ALPHA option must be specified as a MODELOPT on the CO pathway to use the PLATFORM keyword.**
FINISHED	M – N	Identifies the end of SOURCE pathway inputs

1) The PSDGROUP or SRCGROUP keywords must be the last keyword within the SO pathway before the FINISHED keyword. The SRCGROUP keyword is mandatory, unless the PSDCREDIT option is used, which requires the PSDGROUP option instead.

2) The BLPGROUP keyword(s) must be after the BLPINPUT keyword(s)

Table A-4. Description of Source Pathway Keywords and Parameters

Keyword	Parameters	
ELEVUNIT	METERS or FEET	
where:	METERS	Specifies input units for source base elevations of meters (default if ELEVUNIT is omitted).
	FEET	Specifies input units for source elevations of feet. Note: This keyword applies to source base elevations only.
LOCATION	SrcID Srctyp Xs Ys (Zs) [for all Srctyps except LINE, BUOYLINE, RLINE, and RLINEXT] or (FLAT) [for 'FLAT & ELEV' option] or SrcID Srctyp Xs1 Ys1 Xs2 Ys2 (Zs) [for LINE, RLINE, or BUOYLINE Srctyp] or (FLAT) [for 'FLAT & ELEV' option] or SrcID Srctyp Xs1 Ys1 Zs1 Xs2 Ys2 Zs2 (Zs) [for RLINEXT Srctyp] or (FLAT) [for 'FLAT & ELEV' option]	
where:	SrcID	Source identification code (unique alphanumeric string of up to 12 characters).
	Srctyp	Source type: POINT, POINTCAP, POINTHOR, VOLUME, AREA, AREAPOLY, AREACIRC, OPENPIT, LINE, BUOYLINE, RLINE, or RLINEXT.
	Xs	x-coord of source location, corner for AREA, AREAPOLY, and OPENPIT, center for AREACIRC (m).
	Ys	y-coord of source location, corner for AREA, AREAPOLY, and OPENPIT, center for AREACIRC (m).
	Xs1, Xs2	x-coords of midpoint for start and end of LINE, RLINE, RLINEXT, or BUOYLINE source (m).
	Ys1, Ys2	y-coords of midpoint for start and end of LINE, RLINE, RLINEXT, or BUOYLINE source (m).
	Zs1, Zs2	z-coords of midpoint for start and end of RLINEXT source (m).
	(Zs)	Optional z-coord of source location (elevation above mean sea level, defaults to 0.0 if omitted).
	(FLAT)	Optional keyword to indicate non-DFAULT option to specify source to model with FLAT terrain.
SRCPARAM	SrcID Ptemis Stkhgt Stktmp Stkvel Stkdia (POINT, POINTCAP, POINTHOR source)	

Keyword	Parameters	
	Vlemis Relhgt Syinit Szinit (VOLUME source) Aremis Relhgt Xinit (Yinit) (Angle) (Szinit) (AREA source) Aremis Relhgt Nverts (Szinit) (AREAPOLY source) Aremis Relhgt Radius (Nverts) (Szinit) (AREACIRC source) Lnemis Relhgt Width (Szinit) (LINE or RLINE source) Opemis Relhgt Xinit Yinit Pitvol (Angle) (OPENPIT source) Blemis Relhgt (BUOYLINE source) Rlemis DCL Width Szinit (RLINEXT source)	
where:	SrcID	Source identification code.
	Emis	Source emission rate: in g/s for Ptemis, Vlemis, and Blemis; g/(s-m^2) for Aremis, Lnemis, and Opemis; g/m/s for Rlemis.
	Hgt	Source physical release height above ground (center of height for VOLUME, height above base of pit for OPENPIT).
	Stktmp	Stack gas exit temperature (K).
	Stkvel	Stack gas exit velocity (m/s).
	Stkdia	Stack inside diameter (m).
	Syinit	Initial lateral dimension of VOLUME source (m).
	Szinit	Initial vertical dimension of VOLUME, AREA, LINE, RLINE, or RLINEXT source (m).
	Xinit	Length of side of AREA source in X-direction (m).
	Yinit	Length of side of AREA source in Y-direction (m) (optional parameter, assumed to be equal to Xinit if omitted).
	Angle	Orientation angle (deg) of AREA or OPENPIT source relative to N measured positive clockwise, rotated around the source location, (Xs,Ys) (optional parameter, assumed to be 0.0 if omitted).
	Nverts	Number of vertices used for AREAPOLY or AREACIRC source (optional for AREACIRC sources).
	Radius	Radius of circular area for AREACIRC source (m).
	Width	Width of LINE, RLINE, or RLINEXT source (m).
	Pitvol	Volume of OPENPIT source (m^3).
	Blemis	Buoyant line emission rate in g/(s) for the individual line of BUOYLINE source.
	DCL	Distance from roadway centerline for RLINEXT source (m).
BUILDHGT	SrcID (or SrcRange) Dsbh(i), i=1, 36	
where:	SrcID	Source identification code.
	SrcRange	Range of sources (inclusive) for which building dimensions apply, entered as two alphanumeric strings separated by a '-'.
	Dsbh	Array of direction-specific building heights (m) beginning with 10-degree flow vector and incrementing by 10 degrees clockwise.
BUILDLEN	SrcID (or SrcRange) Dsbl(i), i=1, 36	
where:	SrcID	Source identification code.

Keyword	Parameters	
	SrcRange Dsbl	Range of sources (inclusive) for which building dimensions apply. Array of direction-specific building lengths (m) beginning with 10 degree flow vector and incrementing by 10 degrees clockwise.
BUILDWID	SrcID (or SrcRange) Dsbw(i), i=1, 36	
where:	SrcID SrcRange Dsbw	Source identification code. Range of sources (inclusive) for which building dimensions apply. Array of direction-specific building widths (m) beginning with 10 degree flow vector and incrementing by 10 degrees clockwise.
XBADJ	SrcID (or SrcRange) Xbadj(i), i=1, 36	
where:	SrcID SrcRange Xbadj(i)	Source identification code. Range of sources (inclusive) for which XBADJ distances apply. Array of direction-specific along-wind distances beginning with 10 degree flow vector and incrementing by 10 degrees clockwise.
YBADJ	SrcID (or SrcRange) Ybadj(i), i=1, 36	
where:	SrcID SrcRange Ybadj(i)	Source identification code. Range of sources (inclusive) for which YBADJ distances apply. Array of direction-specific across-wind distances beginning with 10 degree flow vector and incrementing by 10 degrees clockwise.
AREAVERT	SrcID Xv(1) Yv(1) Xv(2) Yv(2) ... Xv(i) Yv(i)	
where:	SrcID Xv(1) Yv(1) Xv(i) Yv(i)	Source identification code. X-coordinate of the first vertex of an AREAPOLY source (must be the same as the value of Xs for that source defined on the SO LOCATION card). Y-coordinate of the first vertex of an AREAPOLY source (must be the same as the value of Ys for that source defined on the SO LOCATION card). X-coordinate for the i^{th} vertex of an AREAPOLY source. Y-coordinate for the i^{th} vertex of an AREAPOLY source.
RBARRIER	SrcID Htwall DCLwall (Htwall2 DCLwall2)	
where:	SrcID Htwall DCLwall Htwall2 DCLwall2	Source identification code. Height of the wall (or barrier 1) near roadway (m). Distance from the roadway centerline to the wall (m). Height of the second wall (or barrier 2) near roadway (m). Distance from the roadway centerline to the second wall (m).
RDEPRESS	SrcID Htwall DCLwall Depth Wtop Wbottom	
where:	SrcID Depth Wtop	Source identification code. Depth of the depression containing the roadway (m). Width of the top of the depression containing the roadway (m).

Keyword	Parameters	
	Wbottom	Width of the bottom of the depression containing the roadway (m).
SBARRIER	STA Numseg or Barid $X1_1$ $Y1_1$ $X2_1$ $Y2_1$ HT_1 Z_1 or Barid X1n Y1n X2n Y2n HTn Zn or Barid END	
where:	Barid STA Numseg $X1_1$, $Y1_1$ $X2_1$,$Y2_1$ HT_1 Z_1 $X1_n$, $Y1_n$ $X2_n$, $Y2_n$ HT_n Z_n END	Barrier identification code (up to 12 alphanumeric characters) STArt of SBARRIER inputs for specific BARID, repeated for each unique Barid Number of segments associated with BARID (integer, 50 segment limit) (n) Starting coordinate point of first segment (meters) Ending coordinate point of first segment (meters) Height of first barrier segment (meters) (>0) Elevation of first segment (meters) – Elevation currently ignored, Flat required (0m) Starting coordinate point of nth segment (meters) Ending coordinate point of nth segment (meters) Height of nth barrier segment (meters) (>0) Elevation of nth segment (meters) – Elevation currently ignored, Flat required (0m) Indicates the END of SBARRIER inputs for specific BARID, repeated for each unique Barid
BLPINPUT	(BLPGrpID) Blavgllen Blavgbhgt Blavgbwid Blavglwid Blavgbsep Blavgfprm	
where:	BLPGrpID Blavgllen Blavgbhgt Blavgbwid Blavglwid Blavgsep Blavgfprm	Buoyant line group ID following parameters apply to Average buoyant line length (m) Average building height (m) Average building width (m) Average buoyant line width (m) Average building separation (m) Average buoyancy parameter (m^4/s^3)
URBANSRC	<u>For multiple urban areas:</u> UrbanID SrcID's and/or SrcRng's <u>For single urban areas:</u> SrcID's and/or SrcRng's User may also specify 'ALL' for SrcID's to assign all sources as urban.	

Keyword	Parameters	
where:	UrbanID SrcID SrcRange	Specifies the alphanumeric urban ID (up to eight characters). Specifies which source(s) will be modeled with urban effects. Specifies a range of sources that will be modeled with urban effects.
EMISFACT	SrcID (or SrcRange) Qflag Qfact(i), i=1,n	
where:	SrcID SrcRange Qflag Qfact	Source identification code. Range of sources (inclusive) for which emission rate factors apply. Variable emission rate flag: SEASON for seasonal; MONTH for monthly; HROFDY for hour-of-day; WSPEED for wind speed category; SEASHR for season-by-hour; HRDOW for emission rates vary by hour-of-day, and day-of-week [M-F, Sat, Sun]; HRDOW7 for emission rates vary by hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun]; SHRDOW for season by hour-of-day by day-of-week (M-F,Sat,Sun); SHRDOW7 for season by hour-of-day by day-of-week (M,Tu,W,Th,F,Sat,Sun); MHRDOW for month by hour-of-day by day-of-week (M-F,Sat,Sun); MHRDOW7 for month by hour-of-day by day-of-week (M,Tu,W,Th,F,Sat,Sun). Array of scalar emission rate factors, for: SEASON, n=4; MONTH, n=12; HROFDY, n=24; WSPEED, n=6; SEASHR, n=96; HRDOW, n=72; HRDOW7, n=168; SHRDOW, n=288; SHRDOW7, n=672; MHRDOW, n=864; MHRDOW7, n=2016
EMISUNIT	Emifac Emilbl Outlbl	
where:	Emifac Emilbl Outlbl	Emission rate factor used to adjust units of output (default value is 1.0E06 for CONC for grams to micrograms; default value is 3600 for grams/sec to grams/m^2/hr for deposition). Label to use for emission units (default is grams/sec). Label to use for output units; applies to first output type if more than one output type is generated (default is micrograms/m**3 for concentration and grams/m**2 for deposition).
RLEMCONV	*No parameters or secondary keywords* Changes the expected emission units for the RLINE (Lemis) and RLEINXT (Rlemis)emissions to grams/hour/link.	
CONCUNIT	Emifac Emilbl Conlbl	
where:	Emifac Emilbl Conlbl	Emission rate factor used to adjust units of output (default value is 1.0E06 for concentration for grams to micrograms). Label to use for emission units (default is grams/sec). Label to use for concentrations (default is micrograms/m^3).

Keyword	Parameters	
DEPOUNIT	Emifac Emilbl Deplbl	
where:	Emifac	Emission rate factor used to adjust units of output for deposition (default value is 3600 for grams/sec to grams/m^2/hr).
	Emilbl	Label to use for emission units (default is grams/sec).
	Deplbl	Label to use for deposition (default is grams/m^2).
PARTDIAM	SrcID (or SrcRange) Pdiam(i), i=1,Npd	
where:	SrcID	Source identification code.
	SrcRange	Range of sources (inclusive) for which size categories apply.
	Pdiam	Array of particle diameters (microns).
MASSFRAX	SrcID (or SrcRange) Phi(i), i=1,Npd	
where:	SrcID	Source identification code.
	SrcRange	Range of sources (inclusive) for which mass fractions apply.
	Phi	Array of mass fractions for each particle size category.
PARTDENS	SrcID (or SrcRange) Pdens(i), i=1,Npd	
where:	SrcID	Source identification code.
	SrcRange	Range of sources (inclusive) for which particle densities apply.
	Pdens	Array of particle densities (g/cm^3) for each size category.
METHOD_2	SrcID (or SrcRange) FineMassFraction Dmm	
where:	SrcID	Source identification code.
	FineMassFraction	Fraction (between 0 and 1) of particle mass emitted in fine mode, less than 2.5 microns.
	Dmm	Representative mass mean particle diameter in microns.
GASDEPOS	SrcID (or SrcRange) Da Dw rcl Henry	
where:	SrcID	Source identification code.
	Da	Diffusivity in air for the pollutant being modeled (cm^2/s).
	Dw	Diffusivity in water for the pollutant being modeled (cm^2/s).
	rcl	Cuticular resistance to uptake by lipids for individual leaves (s/cm).
	Henry	Henry's Law constant (Pa m^3/mol).
NO2RATIO	SrcID (or SrcRange) NO2Ratio	
where:	SrcID	Source identification code.
	SrcRange	Source ID range for specified ratio.
	NO2Ratio	In-stack ratio of NO_2/NO_x.
HOUREMIS	Emifil SrcID's SrcRange's	
where:	Emifil	Specifies name of the hourly emission rate file.
	SrcID's	Discrete source IDs that are included in the hourly emission file.
	SrcRange's	Source ID ranges that are included in the hourly emission file.

Keyword	Parameters	
BGSECTOR	StartSect1 StartSect2 . . . StartSect*N*, where *N* is ≤ 6	
where:	StartSect1 StartSect2 . . StartSect*N*	Starting direction for the first sector. Starting direction for the second sector. . . Starting direction for the last sector. NOTE: The minimum sector width allowed is 30 degrees, and warning messages will be issued for sector widths less than 60 degrees. Sector-varying background concentrations will be selected based on the flow vector, i.e., the downwind direction, based on the wind direction specified in the surface meteorological data file.
BACKGRNd	BGflag BGvalue(i), i=1, *n* (without BGSECTORs) and/or HOURLY BGfilnam (BGformat) or SECT*x* BGflag BGvalue(i), i=1, *n* (with BGSECTORs) and/or SECT*x* HOURLY BGfilnam (BGformat)	
where:	SECT*x* BGflag BGvalue	Applicable sector (*x* = 1 to 6) defined on the SO BGSECTOR keyword, if specified. Variable background concentration flag: ANNUAL for annual; SEASON for seasonal; MONTH for monthly; HROFDY for hour-of-day; WSPEED for wind speed category; SEASHR for season-by-hour; HRDOW for emission rates vary by hour-of-day, and day-of-week [M-F, Sat, Sun]; HRDOW7 for emission rates vary by hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun]; SHRDOW for season by hour-of-day by day-of-week (M-F,Sat,Sun); SHRDOW7 for season by hour-of-day by day-of-week (M,Tu,W,Th,F,Sat,Sun); MHRDOW for month by hour-of-day by day-of-week (M-F,Sat,Sun); MHRDOW7 for month by hour-of-day by day-of-week (M,Tu,W,Th,F,Sat,Sun). Array of background concentrations; for: ANNUAL, *n*=1; SEASON, *n*=4; MONTH, *n*=12; HROFDY, *n*=24; WSPEED, *n*=6; SEASHR, *n*=96;

Keyword	Parameters	
		HRDOW, *n*=72; HRDOW7, *n*=168; SHRDOW, *n*=288; SHRDOW7, *n*=672; MHRDOW, *n*=864; MHRDOW7, *n*=2016
	HOURLY	Flag indicating that hourly background concentrations are specified in a separate data file; data period must match the meteorological data period being processed; no missing values are allowed in the hourly file, unless temporally varying background concentrations are also specified through the BGflag parameter, which are used to substitute for missing hourly values.
	BGfilnam	Filename for hourly background concentrations.
	(BGformat)	Optional Fortran format of hourly background concentration file; the default format is FREE format, i.e., comma or space-delimited data fields (Yr Mn Dy Hr BGvalue). The BGformat parameter must include open and close parentheses, the date variables must be read as integers (Fortran I format), and the BGvalue must be read as real (Fortran F, E, or D format), e.g., '(4I2,F8.3)'. The year may be specified as a 2-digit or 4-digit year, and the data period in the HOURLY background file must match the data period in the meteorological data files. The BGformat parameter cannot include any blank spaces, unless the field in enclosed by double quotes. NOTE: Background concentrations specified on the BACKGRND keyword are currently assumed to be in units of PPB for NO_2 and SO_2, PPM for CO, and UG/M3 for all other pollutants, unless otherwise specified on the SO BACKUNIT keyword. Background concentrations can be included with any source group, including group 'ALL', by including a "SrcID" of 'BACKGROUND' on the SRCGROUP keyword. **Note that background concentrations are automatically included with group ALL by default; however, background concentrations can be excluded from group ALL by including NOBACKGROUND (or NOBACKGRND) on the SRCGROUP ALL keyword.**
BACKUNIt	BGunits	
where:	BGunits	Background concentration units, specified as PPB for parts-per-billion, PPM for parts-per-million, or UG/M3 for micrograms/cubic-meter. Background concentrations input in units of PPB or PPM are converted to micrograms/cubic-meter

Keyword	Parameters	
		based on reference temperature (25 C) and pressure (1013.25 mb). Note: Units of PPB and PPM can only be used with the NO2, SO2, and CO POLLUTID.
INCLUDED	Incfil	
where:	SrcIncFile	Filename for the included source file, up to 200 characters in length; double quotes (“) may be used as delimiters for the filename to allow for embedded spaces; and quotes don’t count toward the limit of 200.
OLMGROUP	OLMGrpID SrcID's SrcRange's or ALL	
where:	OLMGrpID SrcID's SrcRange's	Group ID (Grpid = ALL specifies group including all sources). Discrete source IDs to be included in group. Source ID ranges to be included in group. Note: Card may be repeated with same Grpid if more space is needed to specify sources.
BLPGROUP	BLPGrpID SrcID’s SrcRange’s	
where:	BLPGrpID SrcID’s SrcRange’s	Buoyant line group ID. Discrete BUOYLINE source IDs to be included in group. BUOYLINE source ID ranges to be included in group.
PSDGROUP	PSDGrpID SrcID's SrcRange's	
where:	PSDGrpID SrcID's SrcRange's	PSD GrpID for PSDCREDIT option, must be one of the following: INCRCONS – increment-consuming sources, NONRBASE – non-retired baseline sources, or RETRBASE – retired (increment-expanding) baseline sources. Discrete source IDs to be included in group. Source ID ranges to be included in group. Note: Card may be repeated with same PSDGrpID if more space is needed to specify sources
HBPSRCID	SrcID's and/or SrcRange's or ALL	
where:	SrcID's SrcRange's	Discrete source IDs to be included. Source ID ranges to be included.

Keyword	Parameters	
	ALL	Note: Card may be repeated if more space is needed to specify sources. Includes all sources modeled that are source type POINT, POINTHOR, and POINTCAP.
ARCFTSRC	SrcID's and/or SrcRange's or ALL	
where:	SrcID's	Discrete source IDs to be included.
	SrcRange's	Source ID ranges to be included. Note: Card may be repeated if more space is needed to specify sources.
	ALL	Applies aircraft plume rise option (ARCFTOPT) to all AREA and VOLUME source types modeled.
SRCGROUP	SrcGrpID SrcID's SrcRange's	
where:	SrcGrpID	Group ID (Grpid = ALL specifies group including all sources).
	SrcID's	Discrete source IDs to be included in group; a "SrcID" of 'BACKGROUND' (or 'BACKGRND') can be used to include background concentrations, based on the BACKGRND keyword. Also note that background concentrations are automatically included with group ALL; however, background concentrations can be excluded from group ALL by specifying 'NOBACKGROUND' on the SRCGROUP ALL keyword.
	SrcRange's	Source ID ranges to be included in group. Note: Card may be repeated with same Grpid if more space is needed to specify sources.
BLPINPUT	Blavgblen Blavgbhgt Blavgbwid Blavglwid Blavgbsep Blavgfprm	
where:	Blavgblen	Average building length (m).
	Blavgbhgt	Average building height (m).
	Blavgbwid	Average building width (m).
	Blavglwid	Average line source width (m) (of the individual lines).
	Blavgbsep	Average building separation (m) (between the individual lines).
	Blavgfprm	Average buoyancy parameter (m4/s3).

Table A-5. Description of Receptor Pathway Keywords

RE Keywords	Type	Keyword Description
STARTING	M – N	Identifies the start of RECEPTOR pathway inputs
ELEVUNIT	O – N	Defines input units for receptor elevations (defaults to meters), must be first keyword after RE STARTING if used.
GRIDCART	O[1] – R	Defines a Cartesian grid receptor network
GRIDPOLR	O[1] – R	Defines a polar receptor network
DISCCART	O[1] – R	Defines the discretely placed receptor locations referenced to a Cartesian system
DISCPOLR	O[1] – R	Defines the discretely placed receptor locations referenced to a polar system
EVALCART	O[1] – R	Defines discrete Cartesian receptor locations for use with EVALFILE output option
INCLUDED	O – R	Identifies an external file containing receptor locations to be included in the inputs
FINISHED	M - N	Identifies the end of RECEPTOR pathway inputs

1) At least one of the following must be present: GRIDCART, GRIDPOLR, DISCCART, DISCPOLR, or EVALCART, unless the INCLUDED keyword is used to include receptor inputs from an external file. Multiple receptor networks can be specified in a single run, including both Cartesian and polar.

Table A-6. Description of Receptor Pathway Keywords and Parameters

Keyword	Parameters	
ELEVUNIT	METERS or FEET	
where:	METERS FEET	Specifies input units for receptor elevations of meters. Specifies input units for receptor elevations of feet. Note: This keyword applies to receptor elevations only.
GRIDCART	Netid STA XYINC Xinit Xnum Xdelta Yinit Ynum Ydelta or XPNTS Gridx1 Gridx2 Gridx3 .... GridxN, and YPNTS Gridy1 Gridy2 Gridy3 .... GridyN ELEV Row Zelev1 Zelev2 Zelev3 ... ZelevN HILL Row Zhill1 Zhill2 Zhill3 ... ZhillN FLAG Row Zflag1 Zflag2 Zflag3 ... ZflagN END	
where:	Netid STA XYINC Xinit Xnum Xdelta Yinit Ynum Ydelta XPNTS Gridx1 GridxN YPNTS Gridy1 GridyN ELEV Row Zelev HILL Row Zhill FLAG Row	Receptor network identification code (up to eight alphanumeric characters). Indicates STArt of GRIDCART subpathway, repeat for each new Netid. Keyword identifying grid network generated from x and y increments. Starting local x-axis grid location in meters. Number of x-axis receptors. Spacing in meters between x-axis receptors. Starting local y-axis grid location in meters. Number of y-axis receptors. Spacing in meters between y-axis receptors. Keyword identifying grid network defined by series of x and y coordinates. Value of first x-coordinate for Cartesian grid. Value of 'nth' x-coordinate for Cartesian grid. Keyword identifying grid network defined by series of x and y coordinates. Value of first y-coordinate for Cartesian grid. Value of 'nth' y-coordinate for Cartesian grid. Keyword to specify that receptor elevations follow. Indicates which row (y-coordinate fixed) is being input. An array of receptor terrain elevations for a particular Row. Keyword to specify that hill height scales follow. Indicates which row (y-coordinate fixed) is being input. An array of hill height scales for a particular Row. Keyword to specify that flagpole receptor heights follow. Indicates which row (y-coordinate fixed) is being input.

Keyword	Parameters	
	Zflag	An array of receptor heights above local terrain elevation for a particular Row (flagpole receptors).
	END	Indicates END of GRIDCART subpathway, repeat for each new Netid.
GRIDPOLR	Netid STA ORIG Xinit Yinit, or ORIG Srcid DIST Ring1 Ring2 Ring3 ... RingN DDIR Dir1 Dir2 Dir3 ... DirN, or GDIR Dirnum Dirini Dirinc ELEV Dir Zelev1 Zelev2 Zelev3 ... ZelevN HILL Dir Zhill1 Zhill2 Zhill3 ... ZhillN FLAG Dir Zflag1 Zflag2 Zflag3 ... ZflagN END	
where:	Netid	Receptor network identification code (up to eight alphanumeric characters).
	STA	Indicates STArt of GRIDPOLR subpathway, repeat for each new Netid
	ORIG	Optional keyword to specify the origin of the polar network (assumed to be at x=0, y=0 if omitted).
	Xinit	local x-coordinate for origin of polar network (m).
	Yinit	local y-coordinate for origin of polar network (m).
	Srcid	Source ID of source used as origin of polar network.
	DIST	Keyword to specify distances for the polar network.
	Ring1	Distance to the first ring of polar coordinates (m).
	RingN	Distance to the 'nth' ring of polar coordinates (m).
	DDIR	Keyword to specify discrete direction radials for the polar network.
	Dir1	First direction radial in degrees (1 to 360).
	DirN	The 'nth' direction radial in degrees (1 to 360).
	GDIR	Keyword to specify generated direction radials for the polar network.
	Dirnum	Number of directions used to define the polar system.
	Dirini	Starting direction of the polar system.
	Dirinc	Increment (in degrees) for defining directions.
	ELEV	Keyword to specify that receptor elevations follow.
	Dir	Indicates which direction is being input.
	Zelev	An array of receptor terrain elevations for a particular direction radial.
	HILL	Keyword to specify that hill height scales follow.
	Row	Indicates which row (y-coordinate fixed) is being input.
	Zhill	An array of hill height scales for a particular Row Keyword to specify that flagpole receptor heights follow.
	FLAG	Keyword to specify that flagpole receptor heights follow.

Keyword	Parameters	
	Dir	Indicates which direction or direction number is being input.
	Zflag	An array of receptor heights above local terrain elevation for a particular direction (flagpole receptors).
	END	Indicates END of GRIDPOLR subpathway, repeat for each new Netid.
DISCCART	Xcoord Ycoord (Zelev Zhill) (Zflag)	
where:	Xcoord	local x-coordinate for discrete receptor location (m).
	Ycoord	local y-coordinate for discrete receptor location (m).
	(Zelev)	Elevation above sea level for discrete receptor location (optional), used only for ELEV terrain.
	(Zhill)	Hill height scale (optional), used only for ELEV terrain.
	(Zflag)	Receptor height (flagpole) above local terrain (optional), used only with FLAGPOLE keyword.
DISCPOLR	Srcid Dist Direct (Zelev Zhill) (Zflag)	
where:	Srcid	Specifies source identification for which discrete polar receptor locations apply (used to define the origin for the discrete polar receptor).
	Dist	Downwind distance to receptor location (m).
	Direct	Direction to receptor location, in degrees clockwise from North.
	(Zelev)	Elevation above sea level for receptor location (optional), used only for ELEV terrain.
	(Zhill)	Hill height scale (optional).
	(Zflag)	Receptor height (flagpole) above local terrain (optional), used only with FLAGPOLE keyword.
EVALCART	Xcoord Ycoord Zelev Zhill Zflag Arcid (Name)	
where:	Xcoord	Local x-coordinate for discrete receptor location (m).
	Ycoord	Local y-coordinate for discrete receptor location (m).
	Zelev	Elevation above sea level for discrete receptor location, used only for ELEV terrain.
	Zhill	Hill height scale (m), used only for ELEV terrain.
	Zflag	Receptor height (flagpole) above local terrain, used only with FLAGPOLE keyword.
	Arcid	Receptor arc ID used to group receptors along an arc or other grouping (up to eight characters).
	(Name)	Optional name for receptor (up to eight characters).
INCLUDED	RecIncFile	
where:	RecIncFile	Identifies the filename for the included receptor file, up to 200 characters in length; double quotes (“) may be used as delimiters for the filename to allow for embedded spaces; quotes don’t count toward the limit of 200.

Table A-7. Description of Meteorology Pathway Keywords

ME Keywords	Type	Keyword Description
STARTING	M – N	Identifies the start of METEOROLOGY pathway inputs
SURFFILE	M – N	Describes input meteorological surface data file
PROFFILE	M – N	Describes input meteorological profile data file
SURFDATA	M – N	Describes surface meteorological station
UAIRDATA	M – N	Describes upper air meteorological station
SITEDATA	O – N	Describes on-site meteorological station
PROFBASE	M – N	Specifies the base elevation for the potential temperature profile
STARTEND	O – N	Specifies start and end dates to be read from input meteorological data file (default is to read entire file)
DAYRANGE	O – R	Specifies days or ranges of days to process (default is to process all data)
NOSA	O – N	Specifies to set σ_θ to missing for all hours in profile data file
NOSACO	O – N	Specifies to set σ_θ to missing for convective hours only in profile data file
NOSAST	O – N	Specifies to set σ_θ to missing for stable hours only in profile data file
NOSW	O – N	Specifies to set σ_w to missing for all hours in profile data file
NOSWCO	O – N	Specifies to set σ_w to missing for convective hours only in profile data file
NOSWST	O – N	Specifies to set σ_w to missing for stable hours only in profile data file
NOTURB	O – N	Specifies to set σ_θ and σ_w to missing for all hours in profile data file
NOTURBCO	O – N	Specifies to set σ_θ and σ_w to missing for convective hours only in profile data file
NOTURBST	O – N	Specifies to set σ_θ and σ_w to missing for stable hours only in profile data file
SCIMBYHR	O – N	Specifies the parameters for the SCIM (Sampled Chronological Input Model) option (see CO MODELOPT)
WDROTATE	O – N	May be used to correct for alignment problems of wind direction measurements, or to convert wind direction from to flow vector

WINDCATS	O – N	Input upper bounds of wind speed categories, five values input - sixth category is assumed to have no upper bound (used for WSPEED option on the EMISFACT keyword)
FINISHED	M – N	Identifies the end of METEOROLOGY pathway inputs

Table A-8. Description of Meteorology Pathway Keywords and Parameters

Keyword	Parameters	
SURFFILE	Sfcfil	
where:	Sfcfil	Specify filename for surface meteorological input file Note: FREE format is used for all SURFFILE reads beginning with version 09292.
PROFFILE	Profil	
where:	Profil	Specify filename for profile meteorological input file Note: FREE format is used for all PROFFILE reads beginning with version 09292.
SURFDATA	Stanum Year (Name) (Xcoord Ycoord)	
where:	Stanum Year (Name) (Xcoord) (Ycoord)	Station number, e.g., 5-digit WBAN number for NWS station. Year of data being processed (four digits). Station name (optional). x-coordinate of station location (m) (optional). y-coordinate of station location (m) (optional).
UAIRDATA	Stanum Year (Name) (Xcoord Ycoord)	
where:	Stanum Year (Name) (Xcoord) (Ycoord)	Station number, e.g., 5-digit WBAN number for NWS station. Year of data being processed (four digits). Station name (optional). x-coordinate of station location (m) (optional). y-coordinate of station location (m) (optional).
SITEDATA	Stanum Year (Name) (Xcoord Ycoord)	
where:	Stanum Year (Name) (Xcoord) (Ycoord)	Station number for on-site meteorological data station. Year of data being processed (four digits). Station name (optional). x-coordinate of station location (m) (optional). y-coordinate of station location (m) (optional).
PROFBASE	BaseElev (Units)	
where:	BaseElev (Units)	Base elevation (above MSL) for the potential temperature profile. Units of BaseElev: METERS or FEET (default is METERS).
STARTEND	Strtyr Strtmn Strtdy (Strthr) Endyr Endmn Enddy (Endhr)	
where:	Strtyr Strtmn Strtdy (Strthr)	Year of first record to be read. Month of first record to be read. Day of first record to be read. Hour of first record to be read (optional).

Keyword	Parameters	
	Endyr Endmn Enddy (Endhr)	Year of last record to be read. Month of last record to be read. Day of last record to be read. Hour of last record to be read (optional). Note: File read begins with hour 1 of the start date and ends with hour 24 of the end date if Stahr and Endhr are omitted.
DAYRANGE	Range1 Range2 Range3 ... Range*N*	
where:	Range1 Range*N*	First range of days to process, either as individual day (XXX) or as range (XXX-YYY); days may be input as Julian dates (XXX) or as month and day (XX/YY). The 'N-th' range of days to process.
NUMYEARS	NumYrs	
where:	NumYrs	Specifies the number of years of meteorological data being processed for purposes of allocating array storage for the OU MAXDCONT option. A default value of 5 years is assumed if the optional NUMYEARS keyword is omitted.
NOSA or NOSACO or NOSAST or NOSW or NOSWCO or NOSWST or NOTURB or NOTURBCO or NOTURBST	*No parameters or secondary keywords*	
SCIMBYHR	NRegStart NRegInt (SfcFilnam PflFilnam)	
where:	NRegStart NRegInt (SfcFilnam)	Specifies the first hour to be sampled with the SCIM option; required to have a value from 1 to 24. Specifies the sampling interval, in hours. Optional output file name to list the surface meteorological data for the sampled hours.

Keyword	Parameters	
	(PflFilnam)	Optional output file name to list the profile meteorological data for the sampled hours.
WDROTATE	Rotang	
where:	Rotang	Specifies angle (in degrees) to rotate wind direction measurements to correct for alignment problems; value of Rotang is subtracted from WD measurements, i.e., rotation is counterclockwise.
WINDCATS	Ws1 Ws2 Ws3 Ws4 Ws5	
where:	Ws1 Ws2 Ws3 Ws4 Ws5	Upper bound of first wind speed category (m/s). Upper bound of second wind speed category (m/s). Upper bound of third wind speed category (m/s). Upper bound of fourth wind speed category (m/s). Upper bound of fifth wind speed category (m/s). (sixth category is assumed to have no upper bound).

Table A-9. Description of Event Pathways and Keywords

EV Keywords	Type	Keyword Description
STARTING	M – N	Identifies the start of EVENT pathway inputs
EVENTPER	M – R	Describes data and averaging period for an event
EVENTLOC	M – R	Describes receptor location for an event
INCLUDED	O – R	Identifies an external file containing EVENT data to be included in the inputs
FINISHED	M – N	Identifies the end of EVENT pathway inputs

Table A-10. Description of Event Pathway Keywords and Parameters

Keyword	Parameters	
EVENTPER	Evname Aveper Grpid Date Conc	
where:	Name	Specify name of event to be processed (e.g., H002H24ALL), (up to ten alphanumeric characters).
	Grpid	Specify source group ID for event.
	Aveper	Specify averaging period for event.
	Date	Specify data period for event (ending YYMMDDHH for averaging period).
	Conc	Specifies the concentration value generated during the initial non-EVENT processing.
EVENTLOC	Evname XR= Xr YR= Yr (Zelev Zhill) (Zflag) or RNG= Rng DIR= Dir (Zelev Zhill) (Zflag)	
where:	Evname	Specify name of event to be processed (e.g., H002H24ALL), (up to ten alphanumeric characters).
	XR=	X-coordinate for event (discrete Cartesian receptor).
	YR=	Y-coordinate for event (discrete Cartesian receptor).
	RNG=	Distance range for event (discrete polar receptor).
	DIR=	Radial direction for event (discrete polar receptor).
	(Zelev)	Terrain elevation for event (optional).
	(Zhill)	Hill height scale (optional).
	(Zflag)	Receptor height above ground for event (optional).
INCLUDED	EventIncFile	
where:	EventIncFile	Identifies the filename for the included EVENT file, up to 200 characters in length; double quotes (“) may be used as delimiters for the filename to allow for embedded spaces; and quotes don’t count toward the limit of 200.

Note: EVENT locations can be input as either discrete Cartesian receptors (XR=, YR=) or as discrete polar receptors (RNG=, DIR=). Events that are specified in the file generated by the AERMOD model (CO EVENTFIL card) are always given as discrete Cartesian coordinates. Discrete polar receptors are assumed to be relative to an origin of (0,0).

Table A-11. Description of Output Pathway Keywords

OU Keywords	Type	Keyword Description
STARTING	M – N	Identifies the start of OUTPUT pathway inputs
RECTABLE	O – R	Option to specify value(s) by receptor for output
MAXTABLE	O – R	Option to summarize the overall maximum values
DAYTABLE	O – N	Option to print summaries for each averaging period for each day processed.
MAXIFILE	O – R	Option to list events exceeding a threshold value to file (if CO EVENTFIL option is used, these events are included in the input file generated for the EVENT model).
POSTFILE[1]	O – R	Option to write results to a mass storage file for postprocessing.
PLOTFILE[1]	O – R	Option to write certain results to a storage file suitable for input to plotting routines
TOXXFILE	O – R	Option to write results to a storage file suitable for input to the TOXX model component of TOXST or the RISK
RANKFILE	O – R	Option to output file of ranked values for Q-Q plots (must be used with the MAXTABLE keyword)
EVALFILE	O – R	Option to output file of normalized arc maxima from EVALCART receptors for model evaluation studies
SEASONHR	O – R	Option to output results by season and hour-of-day
MAXDAILY	O – R	Option to output file of daily maximum 1-hour values for each day processed; only applicable for 1-hour NO_2 and 1-hour SO_2 NAAQS
MXDYBYYR	O – R	Option to output file of daily maximum 1-hour values by year, for each year processed; only applicable for 1-hour NO_2 and 1-hour SO_2 NAAQS
MAXDCONT	O – R	Option to output contributions of each source group to ranked values averaged across years for a reference source group, paired in time and space; only applicable for 24-hour $PM_{2.5}$ 1-hour NO_2, and 1-hour SO_2 NAAQS
SUMMFILE	O – N	Option to output summary of high ranked values to separate file
FILEFORM	O – N	Specify fixed or exponential format for output results files
NOHEADER	O – N	Option to suppress file headers for output file options, e.g., POSTFILE, PLOTFILE, MAXDCONT, etc.
EVENTOUT	M – N	Specifies the level of output information provided for EVENT Processing [EVENT Only]

FINISHED	M – N	Identifies the end of OUTPUT pathway inputs

1) POSTFILE is used to output concurrent concentration values for particular source groups and averaging times across the receptor network suitable for postprocessing. PLOTFILE is used to output specific design values, such as second high concentrations, across the receptor network, suitable for plotting concentration contours.

Table A-12. Description of Output Pathway Keywords and Parameters

Keyword	Parameters	
RECTABLE	Aveper FIRST SECOND . . . SIXTH . . . TENTH and/or Aveper 1ST 2ND . . . 6TH . . . 10TH and/or Aveper 1 2 . . . 6 . . . 10 . . . *N* . . . 999	
where:	Aveper	Averaging period to summarize with high values (keyword ALLAVE specifies all short-term averaging periods).
	FIRST	Select summaries of FIRST highest values by receptor.
	SECOND	Select summaries of SECOND highest values by receptor.
	SIXTH	Select summaries of SIXTH highest values by receptor.
	1ST	Select summaries of 1ST highest values by receptor.
	2ND	Select summaries of 2ND highest values by receptor.
	6TH	Select summaries of 6TH highest values by receptor.
	N	Select summaries of *N*-th highest values by receptor (up to 999-th highest values). Note: If two parameters are input separated by a dash (e.g. FIRST-THIRD or 4-12), then summaries of all high ranked values within that range (inclusive) are provided. If the CO EVENTFIL keyword is exercised, then the events generated by the RECTABLE keyword are included in the input file for EVENT model. The range of ranks specified on the RECTABLE keyword (but not the individual ranks specified) also determines the range of ranks that may be considered with the MAXDCONT option.
MAXTABLE	Aveper Maxnum	
where:	Aveper	Averaging period to summarize with overall maximum values (keyword ALLAVE specifies all averaging periods).
	Maxnum	Specifies number of overall maximum values to summarize .
DAYTABLE	Avper1 Avper2 Avper3 . . .	
where:	Avper1	Averaging period, e.g., 24 for 24-hr averages, to summarize with values by receptor for each day of data processed (keyword ALLAVE for first parameter specifies all averaging periods).
MAXIFILE	Aveper GrpID Thresh Filnam (Funit)	
where:	Aveper	Specifies averaging period for list of values equal to or exceeding a threshold value.

Keyword	Parameters	
	GrpID Thresh Filnam Funit	Specifies source group to be output to file. Threshold value (e.g., NAAQS) for list of exceedances. Name of disk file to store maximum values. Optional parameter to specify the file unit. Note: If the CO EVENTFIL keyword is exercised, then the events generated by the MAXIFILE keyword are included in the input file for EVENT processing.
POSTFILE	Aveper GrpID Format Filnam (Funit)	
where:	Aveper GrpID Format Filnam Funit	Specifies averaging period to be output to file, e.g., 24 for 24-hr averages, PERIOD for period averages. Specifies source group to be output to file. Specifies format of file, either UNFORM for unformatted files or PLOT for formatted files for plotting. Specifies filename for output file. Optional parameter to specify the file unit.
PLOTFILE	Aveper GrpID Hivalu Filnam (Funit) (Short-Term values) Aveper GrpID Filnam (Funit) (PERIOD or ANNUAL averages)	
where:	Aveper GrpID Hivalu Filnam Funit	Specifies averaging period to be output to file, e.g., 24 for 24-hr averages, PERIOD for period averages, etc. Specifies source group to be output to file. Specifies rank to be included in high value summary (e.g., FIRST, SECOND, 1ST, 2ND, etc.) to be output to file (the rank must be included on the RECTABLE card). Specifies filename for output file. Optional parameter to specify the file unit.
TOXXFILE	Aveper Cutoff Filnam (Funit)	
where:	Aveper Cutoff Filnam Funit	Specifies averaging period to be output to file, e.g., 1 for 1-hr averages. Specifies cutoff (threshold) value in g/m^3 for outputting results for AERMOD model. Specifies filename for output file. Optional parameter to specify the file unit.
RANKFILE	Aveper Hinum Filnam (Funit)	
where:	Aveper Hinum Filnam Funit	Specifies averaging period to be output to file, e.g., 24 for 24-hr averages. Specifies the number of high values to be ranked. Specifies filename for output file. Optional parameter to specify the file unit.

Keyword	**Parameters**	
EVALFILE	SrcID Filnam (Funit)	
where:	SrcID Filnam Funit	Specifies the source ID to be output to file. Specifies filename for output file. Optional parameter to specify the file unit.
SEASONHR	GrpID FileName (FileUnit)	
where:	GrpID FileName (FileUnit)	Specifies the source group ID to be output to file. Specifies filename for output file. Optional parameter to specify file unit.
MAXDAILY	GrpID FileName (FileUnit)	
where:	GrpID FileName (FileUnit)	Specifies the source group ID to be output to file. Specifies filename for output file. Optional parameter to specify file unit.
MXDYBYYR	GrpID FileName (FileUnit)	
where:	GrpID FileName (FileUnit)	Specifies the source group ID to be output to file. Specifies filename for output file. Optional parameter to specify file unit.
MAXDCONT	GrpID UpperRank LowerRank FileName (FileUnit) or GrpID UpperRank THRESH ThreshValue FileName (FileUnit)	
where:	GrpID UpperRank LowerRank THRESH ThreshValue	Specifies the source group ID to be output to file. Upper bound of ranks to evaluate for contributions. Lower bound of ranks to evaluate for contributions (note that lower rank refers to lower concentrations and higher rank refers to higher concentrations). NOTE: The UpperRank and LowerRank values must be within the range of ranks specified on the RECTABLE keyword. AERMOD will analyze each rank within the range, regardless of whether the rank is specified explicitly on the RECTABLE keyword. Indicates that a threshold concentration (ThreshValue) will be specified as a limit on the lower bound rank to process. Lower threshold value for evaluating contributions; processing will stop after the first ranked value that is below ThreshValue NOTE: The ThreshValue analysis will be limited to the range of ranks specified on the RECTABLE keyword (but not the individual ranks that are specified). A warning message is generated if the ThreshValue is not reached within the range of ranks analyzed.

Keyword	Parameters	
	FileName (FileUnit)	Specifies filename for output file. Optional parameter to specify file unit. Note: The range of ranks specified on the RECTABLE keyword (but not the individual ranks specified) also determines the range of ranks that may be considered with the MAXDCONT option, even with the THRESH option.
SUMMFILE	SummFileName	
where:	SummFileName	Specifies filename of output summary file
FILEFORM	EXP or FIX	
where:	EXP FIX	Specifies that the output results files will use EXPonential-formatted values. **EXP cannot be used with the DFAULT model option (MODELOPT) when modeling a criteria pollutant. In this case, DFAULT should be omitted or AERMOD will reset FILEFORM to FIXed format.** Specifies that the output results files will use FIXed-formatted values (fixed-formatted values will be used if FILEFORM is omitted).
NOHEADER	FileType1 FileType2 FileType3 . . . FileType*N* or ALL	
where:	FileType*N* ALL	Specifies the output file type(s) for which header records will be suppressed; includes the following file types: POSTFILE, PLOTFILE, MAXIFILE, RANKFILE, SEASONHR, MAXDAILY, MXDYBYYR, and MAXDCONT. Specifies that header records will be suppressed for ALL applicable output file types.
EVENTOUT	SOCONT or DETAIL	[EVENT Only]
where:	SOCONT DETAIL	Provide source contribution information only in the event output. Include hourly concentrations for each source and hourly meteorological data in the event output

APPENDIX B. Explanation of error message codes

B.1 Introduction

Prior to AERMOD beginning the intensive processing to calculate predicted values specified by the user (e.g., concentrations, deposition), AERMOD runs a series of checks on the input control file to identify issues that would prevent AERMOD from completing successfully. Some of these checks include the control file structure and syntax, proper use or use of undefined keywords or parameters, missing required keywords, and conflicting options. Also, a great deal of effort has been made to eliminate the possibility of run time errors, such as "divide by zero" and to identify questionable input data.

Error messages are reported to the user in two ways. A summary of messages is provided in the main output result file. The user can also request a detailed message file.

Message Summary: Whether the user selects a detailed message file or not, the AERMOD model outputs a summary of messages within the output result file. This message table gives the number of messages of each type, together with a detailed list of all the fatal errors and warning messages. During setup processing, if no errors or warnings are generated, then the model simply reports to the user that "SETUP Finishes Successfully."

Detailed Message File: The AERMOD model provides the option of saving a detailed list of all messages generated by the model in a separate output file. The user can select this option by specifying the keyword "ERRORFIL" followed by a filename inside the COntrol pathway. For example, the following statements will save all the error messages to an ASCII text file named "errormsg.out":

```
CO  STARTING
    ERRORFIL  errormsg.out
CO  FINISHED
```

B.2 Output message summary

There are two message summaries provided in the standard output file of the AERMOD model. The first one is located after the echo of input control file options and before the input data summary. This summary will take one of two forms, depending on whether any fatal error or non-fatal warning messages were generated and depending on whether the option to RUN or NOT to run was selected on the CO RUNORNOT card. If there are no errors or warnings generated during the setup processing, and the RUN option was selected, then the model simply reports that "SETUP Finishes Successfully." If any fatal errors or warning messages were generated during the setup processing or if the option NOT to run was selected, then a more detailed summary is provided. This summary provides a message count for each type of message and a detailed listing of each fatal error and warning message generated. The second message summary table is located at the very end of the standard output result file, and it sums up the messages generated by the complete model run - both setup processing and run-time processing. An example of a setup processing message summary is shown in Figure B-1.

```
*** Message Summary For The AERMOD Model Setup ***


  --------- Summary of Total Messages ---------

A Total of 0 Fatal Error Message(s)

A Total of 0 Warning Message(s)

A Total of 0 Information Message(s)



   ******** FATAL ERROR MESSAGES ********

                ***  NONE  ***


   ********   WARNING MESSAGES   ********

                ***  NONE  ***

**********************************

*** SETUP Finishes Successfully ***

**********************************
```

Figure B-1. Example of an AERMOD Message Summary

B.3 Description of the message layout

Three types of messages can be produced by the model during the processing of input control file commands and during model calculations. These are described briefly below:

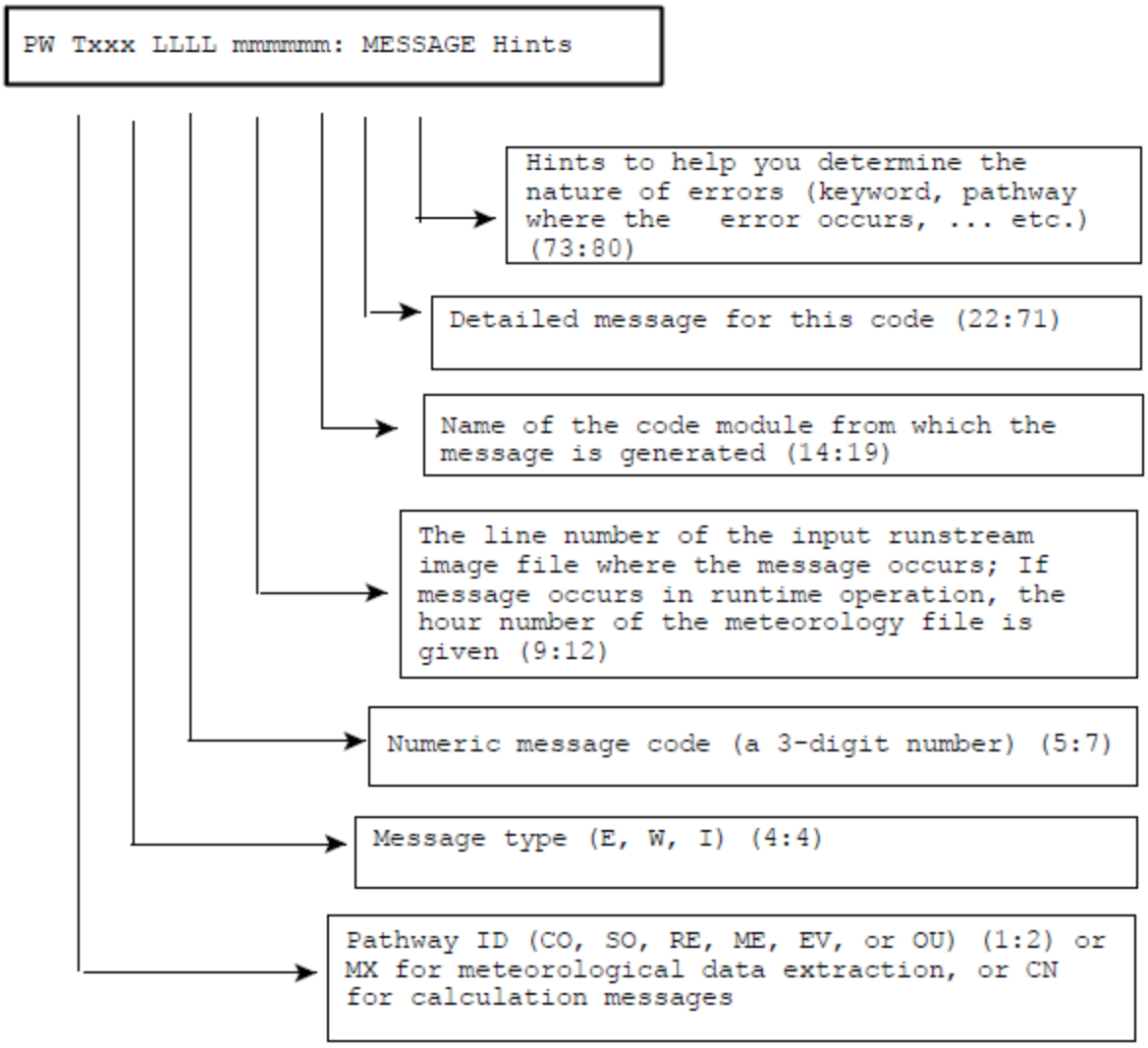
- Errors that will halt any further processing, except to identify additional error conditions (type E);
- Warnings that do not halt processing but indicate possible errors or suspect conditions (type W); and
- Informational messages that may be of interest to the user but have no direct bearing on the validity of the results (type I).

The messages have a consistent structure which contains the pathway ID, indicating which pathway the messages are generated from; the message type followed by a three-digit message number; the line number of the input control file command file for setup messages (or the meteorology hour number for runtime messages); the name of the module (e.g., the subroutine name) from which the message is generated; a detailed message corresponding to the message code; and an 8-character simple hint to help the user spot the possible source of the problem.

The following is an example of a detailed message generated from the CO pathway:

```
CO E1008 EXPATH: Invalid Pathway Specified. The Troubled Pathway is FF
```

The message syntax is explained in more detail below (values in parentheses give the column numbers within the message line for each element):



If an error occurs during processing of an included file (either SO INCLUDED or RE INCLUDED), the line number will represent the line number of the included file. The line number of the control file is saved before processing the included data, and then restored when processing returns to the main control file. The three message types are identified with the letters E (for errors), W (for warnings), and I (for informational messages).

APPENDIX C. Description of file formats

C.1 AERMET meteorological data

Two files are produced for input to the AERMOD dispersion model by the AERMET meteorological preprocessor. The surface OUTPUT contains observed and calculated surface variables, one record per hour. The PROFILE file contains the observations made at each level of an on-site tower, or the one level observations taken from NWS data, one record per level per hour. The contents and format of each of these files is described below:

SURFACE OUTPUT

Header record:

READ( ) *latitude, longitude, UA identifier, SF identifier, OS identifier, Version date, AERMET flags*

FORMAT (2(2X,A8), 8X,' UA_ID: ',A8, ' SF_ID: ',A8, ' OS_ID: ',A8, T85, 'VERSION:', A6)

where	*latitude*	=	latitude specified in Stage 1 for primary surface station
	longitude	=	longitude specified in Stage 1 for primary surface station
	UA identifier	=	station identifier for upper air data; usually the WBAN number used to extract the data from an archive data set
	SF identifier	=	station identifier for hourly surface observations; usually the WBAN number used in extracting the data
	OS identifier	=	site-specific identifier
	Version date	=	AERMET version date; this date also appears in the banner on each page of the summary reports
	AERMET flags	=	One or more of the following flags may be included in the header record after the version date, based on either the source of the data or option(s) used in AERMET to process the data for input to AERMOD: CCVR_Sub, TEMP_Sub, THRESH_1MIN *speed,* Adjust_u*, MMIF *version,* BULKRN, and COARE, where *speed* is the threshold wind speed and *version* is the MMIF version used. Refer to the AERMET User's Guide (EPA, 2026c) for information on each of these flags.

Note 1: The '*cc*_ID:' fields in the FORMAT statement above where *cc* can be UA for upper air, SF for surface, and OS for onsite or site-specific, include two spaces before the 2-character pathway ID and one space after the colon.

Note 2: The FORMAT statement above will read the header record through the version date. One or more flags may follow the version date to identify either the data source or option(s) used to preprocess the data with AERMET for input to AERMOD. The FORMAT statement will need to be revised with additional terms to read beyond the version date to retrieve the flags from the header record.

Data records:

READ( ) *year, month, day, j_day, hour, H, u_* , w_* , VPTG, Zic, Zim, L, z_o , B_o , r, W_s , W_d , z_{ref}, temp, z_{temp}, ipcode, pamt, rh, pres, ccvr, WSADJ*

FORMAT (3(I2,1X), I3,1X, I2,1X, F6.1,1X, 3(F6.3,1X), 2(F5.0,1X), F8.1,1X, F7.4,1X, 2(F6.2,1X), F7.2,1X, F5.0, 3(1X,F6.1), 1X,I5, 1X,F6.2, 2(1X, F6.0), 1X, I5, 1X, A7)

where

	j_day	=	Julian day
	H	=	sensible heat flux (W/m^2)
	u_*	=	surface friction velocity (m/s)
	w_*	=	convective velocity scale (m/s)
	VPTG	=	vertical potential temperature gradient above *Zic* (K/m)
	Zic	=	height of convectively-generated boundary layer (m)
	Zim	=	height of mechanically-generated boundary layer (m)
	L	=	Monin-Obukhov length (m)
	z_0	=	surface roughness length (m)
	B_0	=	Bowen ratio
	r	=	Albedo
	W_s	=	reference wind speed (m/s)
	W_d	=	reference wind direction (degrees)
	z_{ref}	=	reference height for wind (m)
	temp	=	reference temperature (K)
	z_{temp}	=	reference height for temperature (m)
	ipcode	=	precipitation type code (0=none, 11=liquid, 22=frozen, 99=missing)
	pamt	=	precipitation amount (mm/hr)
	rh	=	relative humidity (percent)
	pres	=	station pressure (mb)
	ccvr	=	cloud cover (tenths)
	WSADJ	=	wind speed adjustment and data source flag

When site-specific data are included in the data base, the definition of the reference height wind speed and direction are subject to the following restrictions:

- the wind speed, W_s, must be greater than or equal to the site-specific data threshold wind speed;
- the measurement height must be at or above $7*z_0$, where z_0 is the surface roughness length;
- the height must be less than or equal to 100 meters;

If AERMET is run only with NWS data, i.e., no site-specific data are in the data base, then the restrictions above do not apply and the reference winds are taken to be the NWS winds independent of the height at which the winds were measured.

Ambient air temperature is subject to a similar, but less restrictive, selection process:

- the measurement height must be above z_0; and
- the height must be less than or equal to 100 meters.

The sensible heat flux, Bowen ratio and albedo are not used by AERMOD, but are passed through by AERMET for information purposes only.

PROFILE OUTPUT

READ( ) *year, month, day , hour*, height, top, WD*nn*, WS*nn*, TT*nn*, SA*nn*, SW*nn*

FORMAT(4(I2,1X), F7.1,1X, I1,1X, F7.1,1X, F8.2,1X, F8.2,1X, F8.2,1X, F8.2)

where, height = measurement height (m)
top = 1, if this is the last (highest) level for this *hour*, or 0 otherwise
WD*nn* = wind direction at the current level (degrees)
WS*nn* = wind speed at the current level (m/s)
TT*nn* = temperature at the current level (°C)
SA*nn* = σ_θ (degrees)
SW*nn* = σ_w (m/s)

C.2 Threshold violation files (MAXIFILE option)

The OU MAXIFILE card for the AERMOD model allows the user the option to generate a file or files of threshold violations for specific source group and averaging period combinations. The file consists of several header records, each identified with an asterisk (*) in column one. The

header information includes the model name and version number, the first line of the title information for the run, the list of modeling option keywords applicable to the results, the averaging period and source group included in the file, and the threshold value. Any value equal to or exceeding the threshold value will be included in the file. The header also includes the format used for writing the data records, and column headers for the variables included in the file. The variables provided on each data record include the averaging period, the source group ID, the date (YYMMDDHH) for the end of averaging period, the X and Y coordinates of the receptor location, receptor terrain elevation, hill height scale, flagpole receptor height, and the concentration value that violated the threshold. The following example from a threshold file identifies the contents of the MAXIFILE:

```
* AERMOD ( 15181): A Simple Example Problem for the AERMOD-PRIME Model                    06/09/16
* AERMET ( 15181):                                                                       17:03:34
* MODELING OPTIONS USED:  NonDFAULT CONC      FLAT      RURAL
*         MAXI-FILE FOR  3-HR VALUES >= A THRESHOLD OF    50.00
*         FOR SOURCE GROUP: ALL
*         FORMAT: (1X,I3,1X,A8,1X,I8.8,2(1X,F13.5),3(1X,F7.2),1X,F13.5)
*AVE   GRP     DATE           X             Y        ZELEV   ZHILL   ZFLAG  AVERAGE CONC
*___ ________ ________  _____________  _____________  ______  ______  ______  _____________
   3 ALL      88030112     344.68271     -60.77686    0.00    0.00    0.00       71.36678
   3 ALL      88030112     492.40388     -86.82409    0.00    0.00    0.00       73.20689
   3 ALL      88030112     984.80775    -173.64818    0.00    0.00    0.00       50.65556
   3 ALL      88030112     164.44621     -59.85353    0.00    0.00    0.00      112.74896
```

C.3 Postprocessor files (POSTFILE option)

The OU POSTFILE card for the AERMOD model allows the user the option of creating output files of concurrent concentration values suitable for postprocessing. The model offers two options for the type of file generated - one is an unformatted file, and the other is a formatted file of X, Y, CONC values suitable for inputting to plotting programs.

The unformatted POSTFILE option generates a separate unformatted data record of concurrent values for each averaging period and source group specified. The averaging period and source group combinations may be written to separate files or combined into a single file. Each record begins with the date variable for the end of the averaging period (an integer variable of the form YYMMDDHH), the averaging period (e.g., an integer value of 3 for 3-hour averages), and the source group ID (eight characters). Following these three header variables, the record includes the concentration values for each receptor location, in the order in which the receptors are defined on the RE pathway. The results are output to the unformatted file or files as they are calculated by the model.

The formatted plot file option for the POSTFILE keyword includes several lines of header information, each identified with an asterisk (*) in column one. The header information includes the model name and version number, the first line of the title information for the run, the list of modeling option keywords applicable to the results, the averaging period and source group included in the file, and the number of receptors included. The header also includes the format used for writing the data records, and column headers for the variables included in the file. The variables provided on each data record include the X and Y coordinates of the receptor location, the concentration value for that location, receptor terrain elevation, hill height scale, flagpole receptor height, the averaging period, the source group ID, the date variable for the end of the averaging period (in the form of YYMMDDHH) for short-term averages or the number of hours in the period for PERIOD averages, and the receptor network ID. The following example from a formatted postprocessor file for PERIOD averages identifies the contents of the POSTFILE:

```
* AERMOD ( 15181): A Simple Example Problem for the AERMOD-PRIME Model                    06/09/16
* AERMET ( 15181):                                                                       16:58:19
* MODELING OPTIONS USED:  NonDFAULT CONC      FLAT      RURAL
*         POST/PLOT FILE OF PERIOD VALUES FOR SOURCE GROUP: ALL
*         FOR A TOTAL OF   144 RECEPTORS.
*         FORMAT: (3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)
*        X             Y      AVERAGE CONC    ZELEV    ZHILL    ZFLAG    AVE     GRP      NUM HRS   NET ID
* ____________  ____________  ____________   ______   ______   ______  ______  ________  ________  ________
      30.38843     172.34136       0.21576     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
      60.77686     344.68271       0.53162     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
      86.82409     492.40388       0.85993     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
     173.64818     984.80775       1.39778     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
      59.85353     164.44621       0.20861     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
     119.70705     328.89242       0.67388     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
     171.01007     469.84631       1.27452     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
     342.02014     939.69262       2.45702     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
      87.50000     151.55445       0.20576     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
     175.00000     303.10889       0.64322     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
     250.00000     433.01270       1.20422     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
     500.00000     866.02540       2.28880     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
     112.48783     134.05778       0.20172     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
     224.97566     268.11556       0.48027     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
     321.39380     383.02222       0.76067     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
     642.78761     766.04444       1.19405     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
```

C.4 High value results for plotting (PLOTFILE option)

The OU PLOTFILE card for the AERMOD model allows the user the option of creating output files of highest concentration values suitable for importing into graphics software to generate contour plots. The formatted plot files generated by the PLOTFILE include several lines of header information, each identified with an asterisk (*) in column one. The header information includes the model name and version number, the first line of the title information for the run, the list of modeling option keywords applicable to the results, the averaging period and source group included in the file, the high value (e.g., 2ND highest) included for plotting, and the number of receptors included. The header also includes the format used for writing the data records, and column

headers for the variables included in the file. The variables provided on each data record include the X and Y coordinates of the receptor location, the concentration value for that location, receptor terrain elevation, hill height scale, flagpole receptor height, averaging period, the source group ID, the high value included for short-term averages or the number of hours in the period for PERIOD averages, and the receptor network ID. For short-term averages, the PLOTFILE also includes the date variable for the end of the averaging period (in the form of YYMMDDHH). The PERIOD average PLOTFILE uses the same format for the data records as the PERIOD average formatted POSTFILE shown in the previous section. The following example from a plot file for high second highest 24-hour averages identifies the contents of the PLOTFILE:

```
* AERMOD ( 15181): A Simple Example Problem for the AERMOD-PRIME Model                    06/09/16
* AERMET ( 15181):                                                                        17:07:58
* MODELING OPTIONS USED:  NonDFAULT CONC      FLAT      RURAL
*         PLOT FILE OF  HIGH   2ND HIGH 24-HR VALUES FOR SOURCE GROUP: ALL
*         FOR A TOTAL OF   144 RECEPTORS.
*         FORMAT: (3(1X,F13.5),3(1X,F8.2),3X,A5,2X,A8,2X,A5,5X,A8,2X,I8)
*        X             Y      AVERAGE CONC    ZELEV    ZHILL    ZFLAG    AVE     GRP       RANK     NET ID   DATE(CONC)
* ____________  ____________  ____________   ______   ______   ______  ______  ________  ________  ________  ________
      30.38843     172.34136       0.34726     0.00     0.00     0.00   24-HR  ALL         2ND     POL1      88030324
      60.77686     344.68271       0.75187     0.00     0.00     0.00   24-HR  ALL         2ND     POL1      88030124
      86.82409     492.40388       1.18649     0.00     0.00     0.00   24-HR  ALL         2ND     POL1      88030124
     173.64818     984.80775       1.19837     0.00     0.00     0.00   24-HR  ALL         2ND     POL1      88030124
```

The PLOTFILE output also includes a flag ('**') identifying the receptor with the highest concentration. For short-term averages, the flag precedes the date field. For period averages, the flag precedes the field with the number of hours in the period.

C.5 TOXX model input files (TOXXFILE option)

The OU TOXXFILE card for the AERMOD model allows the user the option to generate an unformatted file or files of threshold violations for a specific averaging period for use with the TOXX model component of TOXST. The file consists of three header records, including the first line of the title information for the run, the number of source groups, receptors and averaging

periods, information on the type of receptor network, and the threshold cutoff value. Following the header records are pairs of records identifying the specific averaging period, source group and receptor location and corresponding concentration value for the values exceeding the user- specified threshold. If any source group exceeds the threshold for a given averaging period and receptor location, then the concentrations for all source groups are output for that period and receptor. The structure of the unformatted file for the AERMOD model TOXXFILE option is described below:

Record #	Description
1	Title (80 characters)
2	IYEAR, NUMGRP, NUMREC, NUMPER, ITAB, NXTOX, NYTOX, IDUM1, IDUM2, IDUM3
3	CUTOFF, RDUM1, ..., RDUM9

where:

TITLE	= First line of title (80 characters)
IYEAR	= Year of simulation
NUMGRP	= No. of source groups
NUMREC	= Total no. of receptors
NUMPER	= No. of averaging periods (e.g., number of hours in the year)
ITAB	= 1 for polar grid; 2 for Cartesian grid; 0 for discrete receptors or mixed grids
NXTOX	= No. of x-coordinates (or distances) in receptor network
NYTOX	= No. of y-coordinates (or directions) in receptor network
IDUM1	= dummy integer variable, arbitrarily set equal to zero
IDUM2	= dummy integer variable, arbitrarily set equal to zero
IDUM3	= dummy integer variable, arbitrarily set equal to zero
CUTOFF	= User-specified threshold for outputting results (g/m^3)
RDUM1	= Dummy real variables (nine), arbitrarily set equal to zero
.	
.	
.	
RDUM9	= Dummy real variables (nine), arbitrarily set equal to zero

Following the header records, the file consists of pairs of records including an ID variable identifying the data period, source group number and receptor number, and the corresponding concentration values. The number of values included in each record is controlled by the NPAIR PARAMETER, which is initially set at 100 in MODULE MAIN1. The identification variable is determined as follows:

IDCONC = IPER*100000 + IGRP*1000 + IREC

where: IPER = the hour number for the year corresponding to the concentration value
IGRP = the source group number (the order in which the group was defined on the SO pathway)
IREC = the receptor number (the order in which the receptor was defined on the RE pathway)

C.6 Maximum values by rank (RANKFILE option)

The OU RANKFILE card for the AERMOD model allows the user the option of creating output files of the maximum concentration values by rank, suitable for generating Q-Q or quantile plots. The data contained in the RANKFILE output is based on the MAXTABLE arrays, except that only one occurrence per data period is included. The formatted data files generated by the RANKFILE include several lines of header information, each identified with an asterisk (*) in column one. The header information includes the model name and version number, the first line of the title information for the run, the list of modeling option keywords applicable to the results, the averaging period included in the file, and the number of ranked values included. The header also includes the format used for writing the data records, and column headers for the variables included in the file. The variables provided on each data record include the rank, concentration value, X and Y coordinates of the receptor location, receptor terrain elevation, hill height scale, flagpole receptor height, and the source group ID. Each RANKFILE includes results for all of the source groups for a particular averaging period. Since the RANKFILE only include one occurrence per data period, the file may not include the number of ranked values requested, especially for evaluation data bases of limited duration. The following example identifies the contents of the RANKFILE:

```
* AERMOD ( 15181): A Simple Example Problem for the AERMOD-PRIME Model                    06/09/16
* AERMET ( 15181):                                                                       17:11:08
* MODELING OPTIONS USED:  NonDFAULT CONC      FLAT      RURAL
*         RANK-FILE OF UP TO    40 TOP  3-HR VALUES FOR     1 SOURCE GROUPS
*         INCLUDES OVERALL MAXIMUM VALUES WITH DUPLICATE DATA PERIODS REMOVED
*         FORMAT: (1X,I6,1X,F13.5,1X,I8.8,2(1X,F13.5),3(1X,F7.2),2X,A8)
*  RANK  AVERAGE CONC   DATE          X             Y        ZELEV   ZHILL   ZFLAG     GRP
*_______ _____________ ________  ____________  ____________  ______  ______  ______  ________
      1     329.96009 88030112     433.01270    -250.00000    0.00    0.00    0.00  ALL
      2     278.47891 88030115     469.84631    -171.01007    0.00    0.00    0.00  ALL
      3     124.30430 88030118     433.01270    -250.00000    0.00    0.00    0.00  ALL
```

C.7 Arc-maximum values for evaluation (EVALFIL option)

The OU EVALFILE card for the AERMOD model allows the user the option of creating output files of the arc-maximum concentration values for individual sources suitable for use in model evaluation studies. The data contained in the EVALFILE output is based on the maximum value along arcs of receptors, identified using the RE EVALCART card. Receptors may be grouped on arcs based on their distance from the source, or other logical grouping. The formatted EVALFILE output includes five records of information for each selected source and each hour of meteorological data. The information provided is as follows:

1. Source ID (12 characters)
2. Date (YYMMDDHH)
3. Arc ID (eight characters)
4. Arc maximum P/Q
5. Emission rate for arc maximum (including unit conversions)
6. Crosswind integrated concentration based on true centerline concentration
7. Normalized non-dimensional crosswind integrated concentration
8. Downwind distance corresponding to arc maximum (m)
9. Effective wind speed corresponding to arc maximum (m/s)
10. Effective F_v corresponding to arc maximum (m/s)
11. Effective F_w corresponding to arc maximum (m/s)

12. F_y corresponding to arc maximum (m)
13. Effective plume height corresponding to arc maximum (m)
14. Monin-Obukhov length for current hour (m)
15. Mixing height for current hour (m)
16. Surface friction velocity for current hour (m/s)
17. Convective velocity scale for current hour if unstable (m/s) or F_z for current hour if stable
18. Buoyancy flux for current hour (m^4/s^3)
19. Momentum flux for current hour (m^4/s^2)
20. Bowen ratio for current hour
21. Plume penetration factor for current hour
22. Centerline P/Q for direct plume
23. Centerline P/Q for indirect plume
24. Centerline P/Q for penetrated plume
25. Nondimensional downwind distance
26. Plume height/mixing height ratio
27. Non-dimensional buoyancy flux
28. Source release height (m)
29. Arc centerline P/Q
30. Developmental option settings place holder (string of 10 zeroes)
31. Flow vector for current hour (degrees)
32. Effective height for stable plume reflections (m)

The following Fortran WRITE and FORMAT statements are used to write the results to the EVALFILE output:

```
          WRITE(IELUNT(ISRC),9000) SRCID(ISRC), KURDAT, ARCID(I),
     &                     ARCMAX(I), QMAX(I), CWIC, CWICN,
     &                     DXMAX(I), UOUT, SVMAX(I),
     &                     SWMAX(I), SYOUT, HEMAX(I),
     &                     OBUOUT, ZI, USTAR, PWSTAR, FB, FM,
     &                     BOWEN, PPF, CHIDML(I), CHINML(I), CHI3ML(I),
     &                     XNDIM, HEOZI, FSTAR, AHS(ISRC), ARCCL(I),
     &                     AFV, HSBLMX(I)

9000  FORMAT(1X,A12,1X,I8.8,1X,A8,4(1X,G12.6),
     &       9X,6(1X,G12.4),9X,6(1X,G12.4),
     &       9X,6(1X,G12.4),9X,4(1X,G12.4),1X,'0000000000',
     &       1X,G12.4,1X,G12.4)
```

C.8 Results by season and hour-of-day (SEASONHR option)

The SEASONHR option is used to output a file containing the average results by season and hour-of-day. The formatted data files generated by the SEASONHR option include several lines of header information, each identified with an asterisk (*) in column one. The header information includes the model name and version number, the first line of the title information for the run, the list of modeling option keywords applicable to the results, the source group included in the file, and the number of receptors. The header also includes the format used for writing the data records, and column headers for the variables included in the file. The variables provided on each data record include the X and Y coordinates of the receptor location, the average concentration value, receptor terrain elevation, hill height scale, flagpole receptor height, source group ID, number of non-calm and non-missing hours used to calculate the season-by-hour-of-day averages (the NHRS column), season index (the SEAS column with 1 for winter, 2 for spring, 3 for summer, and 4 for fall), the hour-of-day for the concentration value, and the receptor network ID. A sample from a SEASONHR output file is shown below:

```
* AERMOD ( 15181): A Simple Example Problem for the AERMOD-PRIME Model                    06/09/16
* AERMET ( 14134):                                                                        17:27:43
* MODELING OPTIONS USED:  NonDFAULT CONC      FLAT      RURAL
*         FILE OF SEASON/HOUR VALUES FOR SOURCE GROUP: ALL
*         FOR A TOTAL OF   144 RECEPTORS.
*         FORMAT: (2(1X,F13.5),1(1X,F13.8),3(1X,F7.2),2X,A8,2X,3(I4,2X),A8)
*        X             Y      AVERAGE CONC   ZELEV   ZHILL   ZFLAG    GRP     NHRS  SEAS  HOUR   NET ID
* _____________  _____________  _____________  ______  ______  ______  ________  ____  ____  ____  ________
      30.38843     172.34136   34.14568783    0.00    0.00    0.00  ALL         65     1     1  POL1
      60.77686     344.68271   39.19676801    0.00    0.00    0.00  ALL         65     1     1  POL1
      86.82409     492.40388   34.59785413    0.00    0.00    0.00  ALL         65     1     1  POL1
     173.64818     984.80775   16.14253303    0.00    0.00    0.00  ALL         65     1     1  POL1
      59.85353     164.44621   32.93762092    0.00    0.00    0.00  ALL         65     1     1  POL1
     119.70705     328.89242   41.97750583    0.00    0.00    0.00  ALL         65     1     1  POL1
```

C.9 Source group contribution for ranked averaged maximum daily values (MAXDCONT)

The OU MAXDCONT card of the AERMOD model allows the user to create output files that provide source contributions for the 24-hour PM2.5, 1-hour NO_2 and 1-hour SO_2 standards in which the design value is based on averages of ranked values across multiple years. Ranked concentrations and source contributions are based on a target source group specified by the user. The user can define the ranks to include or a range of ranks and an optional minimum threshold concentration value. The MAXDCONT output file includes several lines of header information, each identified with an asterisk (*) in column one, including: the model name and version number, the first line of the title information, the list of modeling option keywords, the highest rank specified, the averaging period, target source group, and threshold value if applicable. The header also includes the total number of receptors and source groups and the Fortran format statement used to write the data records. The variables provided on each data record include the X and Y coordinates of the receptor location, the concentration value for the target source group at the receptor location, receptor terrain elevation, hill height scale, flagpole receptor height, averaging period, the source group ID, rank, receptor network ID, and the source contribution for each source modeled. The data records are grouped by rank in ascending order. Concentrations are displayed for all receptors for the highest rank, then the next highest rank, etc. The following example is a partial MAXDCONT file with a minimum threshold value of 35 $\mu g/m^3$ was specified for ranks 1 through 50. Results for the first two ranks are displayed for four the source groups that were modeled.

* AERMOD (15181): PM-2.5 Test Case for the AERMOD Model using single met file 07/30/15

* AERMET (13350): 13:50:57

* MODELING OPTIONS USED: NonDFAULT CONC FLAT RURAL

* MAXDCONT FILE OF 1ST-HIGHEST 24-HR VALUES AVERAGED OVER 5 YEARS FOR SOURCE GROUP: ALL ; ABOVE THRESH = 35.00000

* FOR A TOTAL OF 16 RECEPTORS AND 3 SOURCE GROUPS; WITH CONTRIBUTIONS FROM OTHER SOURCE GROUPS PAIRED IN TIME & SPACE

* FORMAT: (3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,A5,5X,A8,2X, 3(F13.5,2X:))

X	Y	AVERAGE CONC	ZELEV	ZHILL	ZFLAG	AVE	GRP	RANK	NET ID	CONT STACK1	CONT STACK2	CONT ALL
200.00000	0.00000	9.76902	0.00	0.00	0.00	24-HR	ALL	1ST	POL1	0.00000	0.00000	0.00000
500.00000	0.00000	25.61401	0.00	0.00	0.00	24-HR	ALL	1ST	POL1	0.00000	0.00000	0.00000
1000.00000	0.00000	26.86548	0.00	0.00	0.00	24-HR	ALL	1ST	POL1	0.00000	0.00000	0.00000
3000.00000	0.00000	8.85979	0.00	0.00	0.00	24-HR	ALL	1ST	POL1	0.00000	0.00000	0.00000
0.00000	-200.00000	20.50162	0.00	0.00	0.00	24-HR	ALL	1ST	POL1	0.00000	0.00000	0.00000
0.00000	-500.00000	51.65594	0.00	0.00	0.00	24-HR	ALL	1ST	POL1	21.15838	30.49757	51.65594
0.00000	-1000.00000	52.82753	0.00	0.00	0.00	24-HR	ALL	1ST	POL1	13.99357	38.83396	52.82753
0.00000	-3000.00000	19.91409	0.00	0.00	0.00	24-HR	ALL	1ST	POL1	0.00000	0.00000	0.00000
-200.00000	-0.00000	8.64428	0.00	0.00	0.00	24-HR	ALL	1ST	POL1	0.00000	0.00000	0.00000
-500.00000	-0.00000	14.58084	0.00	0.00	0.00	24-HR	ALL	1ST	POL1	0.00000	0.00000	0.00000
-1000.00000	-0.00000	11.59131	0.00	0.00	0.00	24-HR	ALL	1ST	POL1	0.00000	0.00000	0.00000
-3000.00000	-0.00000	12.28970	0.00	0.00	0.00	24-HR	ALL	1ST	POL1	0.00000	0.00000	0.00000
-0.00000	200.00000	67.53734	0.00	0.00	0.00	24-HR	ALL	1ST	POL1	67.53733	0.00002	67.53734
-0.00000	500.00000	67.83252	0.00	0.00	0.00	24-HR	ALL	1ST	POL1	64.45844	3.37408	67.83252
-0.00000	1000.00000	52.28291	0.00	0.00	0.00	24-HR	ALL	1ST	POL1	28.94476	23.33815	52.28291
-0.00000	3000.00000	29.08609	0.00	0.00	0.00	24-HR	ALL	1ST	POL1	0.00000	0.00000	0.00000

* AERMOD (15181): PM-2.5 Test Case for the AERMOD Model using single met file 07/30/15

* AERMET (13350): 13:50:57

* MODELING OPTIONS USED: NonDFAULT CONC FLAT RURAL

* MAXDCONT FILE OF 2ND-HIGHEST 24-HR VALUES AVERAGED OVER 5 YEARS FOR SOURCE GROUP: ALL ; ABOVE THRESH = 35.00000

* FOR A TOTAL OF 16 RECEPTORS AND 3 SOURCE GROUPS; WITH CONTRIBUTIONS FROM OTHER SOURCE GROUPS PAIRED IN TIME & SPACE

* FORMAT: (3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,A5,5X,A8,2X, 3(F13.5,2X:))

* X	Y	AVERAGE CONC	ZELEV	ZHILL	ZFLAG	AVE	GRP	RANK	NET ID	CONT STACK1	CONT STACK2	CONT ALL
200.00000	0.00000	7.91782	0.00	0.00	0.00	24-HR	ALL	2ND	POL1	0.00000	0.00000	0.00000
500.00000	0.00000	22.53064	0.00	0.00	0.00	24-HR	ALL	2ND	POL1	0.00000	0.00000	0.00000
1000.00000	0.00000	24.26451	0.00	0.00	0.00	24-HR	ALL	2ND	POL1	0.00000	0.00000	0.00000
3000.00000	0.00000	8.10584	0.00	0.00	0.00	24-HR	ALL	2ND	POL1	0.00000	0.00000	0.00000
0.00000	-200.00000	16.96505	0.00	0.00	0.00	24-HR	ALL	2ND	POL1	0.00000	0.00000	0.00000
0.00000	-500.00000	43.25276	0.00	0.00	0.00	24-HR	ALL	2ND	POL1	14.36197	28.89079	43.25276
0.00000	-1000.00000	43.82672	0.00	0.00	0.00	24-HR	ALL	2ND	POL1	10.92254	32.90417	43.82672
0.00000	-3000.00000	17.32480	0.00	0.00	0.00	24-HR	ALL	2ND	POL1	0.00000	0.00000	0.00000
-200.00000	-0.00000	6.77421	0.00	0.00	0.00	24-HR	ALL	2ND	POL1	0.00000	0.00000	0.00000
-500.00000	-0.00000	11.56687	0.00	0.00	0.00	24-HR	ALL	2ND	POL1	0.00000	0.00000	0.00000
-1000.00000	-0.00000	9.72229	0.00	0.00	0.00	24-HR	ALL	2ND	POL1	0.00000	0.00000	0.00000
-3000.00000	-0.00000	8.03098	0.00	0.00	0.00	24-HR	ALL	2ND	POL1	0.00000	0.00000	0.00000
-0.00000	200.00000	51.19765	0.00	0.00	0.00	24-HR	ALL	2ND	POL1	51.19763	0.00002	51.19765
-0.00000	500.00000	59.15581	0.00	0.00	0.00	24-HR	ALL	2ND	POL1	57.67153	1.48428	59.15581
-0.00000	1000.00000	41.49519	0.00	0.00	0.00	24-HR	ALL	2ND	POL1	18.49276	23.00243	41.49519
-0.00000	3000.00000	23.24160	0.00	0.00	0.00	24-HR	ALL	2ND	POL1	0.00000	0.00000	0.00000

C.10 Daily maximum 1-hour values (MAXDAILY)

The OU MAXDAILY card of the AERMOD model generates a file of daily maximum 1-hour concentrations for a specified source group, useful for analyzing the 1-hour NO_2 and SO_2 NAAQS. The MAXDAILY file includes several lines of header information, each identified with an asterisk (*) in column one, including: the model name and version number, the first line of the title information, the list of modeling option keywords, and the source group. The header also includes the total number of receptors and the Fortran format statement used to write the data records. The variables provided on each data record include the X and Y coordinates of the receptor location, the concentration value for the target source group at the receptor location, receptor terrain elevation, hill height scale, flagpole receptor height, averaging period, the source group ID, day of the year, hour, date, and receptor network ID. The following example is a sample from a MAXDAILY output file.

* AERMOD (15181): AERMOD OLM/OLMGROUP ALL Test Case, with BACKGROUND 07/30/15

* AERMET (13350): 13:50:48

* MODELING OPTIONS USED: NonDFAULT CONC FLAT OLM RURAL

* MAXDAILY FILE OF DAILY MAXIMUM 1-HR VALUES BY DAY FOR SOURCE GROUP: ALL

* FOR A TOTAL OF 16 RECEPTORS.

* FORMAT: (3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I4,2X,I3,2X,I8.8,2X,A8)

* X	Y	AVERAGE CONC	ZELEV	ZHILL	ZFLAG	AVE	GRP	JDAY	HR	DATE	NET ID
100.00000	0.00000	50.00000	35.00	35.00	0.00	1-HR	ALL	1	13	99010113	POL1
300.00000	0.00000	50.00159	35.00	35.00	0.00	1-HR	ALL	1	13	99010113	POL1
1000.00000	0.00000	50.20117	35.00	35.00	0.00	1-HR	ALL	1	13	99010113	POL1
3000.00000	0.00000	50.12314	35.00	35.00	0.00	1-HR	ALL	1	13	99010113	POL1
0.00000	-100.00000	50.00000	35.00	35.00	0.00	1-HR	ALL	1	13	99010113	POL1
0.00000	-300.00000	50.00259	35.00	35.00	0.00	1-HR	ALL	1	13	99010113	POL1
0.00000	-1000.00000	50.22100	35.00	35.00	0.00	1-HR	ALL	1	13	99010113	POL1
0.00000	-3000.00000	68.29389	35.00	35.00	0.00	1-HR	ALL	1	7	99010107	POL1
-100.00000	-0.00000	50.00000	35.00	35.00	0.00	1-HR	ALL	1	13	99010113	POL1
-300.00000	-0.00000	50.00258	35.00	35.00	0.00	1-HR	ALL	1	13	99010113	POL1
-1000.00000	-0.00000	50.20079	35.00	35.00	0.00	1-HR	ALL	1	13	99010113	POL1
-3000.00000	-0.00000	50.12262	35.00	35.00	0.00	1-HR	ALL	1	13	99010113	POL1
-0.00000	100.00000	50.00000	35.00	35.00	0.00	1-HR	ALL	1	13	99010113	POL1
-0.00000	300.00000	50.00159	35.00	35.00	0.00	1-HR	ALL	1	13	99010113	POL1
-0.00000	1000.00000	50.20117	35.00	35.00	0.00	1-HR	ALL	1	13	99010113	POL1
-0.00000	3000.00000	50.12314	35.00	35.00	0.00	1-HR	ALL	1	13	99010113	POL1
100.00000	0.00000	50.00000	35.00	35.00	0.00	1-HR	ALL	2	13	99010213	POL1
300.00000	0.00000	50.00001	35.00	35.00	0.00	1-HR	ALL	2	13	99010213	POL1
1000.00000	0.00000	50.00008	35.00	35.00	0.00	1-HR	ALL	2	13	99010213	POL1
3000.00000	0.00000	50.00280	35.00	35.00	0.00	1-HR	ALL	2	13	99010213	POL1
0.00000	-100.00000	50.00000	35.00	35.00	0.00	1-HR	ALL	2	13	99010213	POL1
0.00000	-300.00000	50.00001	35.00	35.00	0.00	1-HR	ALL	2	13	99010213	POL1
0.00000	-1000.00000	50.00009	35.00	35.00	0.00	1-HR	ALL	2	13	99010213	POL1
0.00000	-3000.00000	50.00285	35.00	35.00	0.00	1-HR	ALL	2	13	99010213	POL1
-100.00000	-0.00000	50.00000	35.00	35.00	0.00	1-HR	ALL	2	13	99010213	POL1

C.11 Maximum daily 1-hour concentration by year (MAXDYBYYR)

The OU MAXDYBYYR card of the AERMOD model generates a file with a summary of daily maximum 1-hour concentrations by year for each rank specified on the RECTABLE keyword for a specified source group. This is another output file type that is applicable to the 1-hour NO_2 and 1-hour SO_2 NAAQS. The ranks included in the MXDYBYYR file are the ranks used in the MAXDCONT postprocessing option. The MAXDYBYYR file includes several lines of header information, each identified with an asterisk (*) in column one, including: the model name and version number, the first line of the title information, the list of modeling option keywords, and the source group. The header also includes the total number of receptors and the Fortran format statement used to write the data records. The variables provided on each data record include the X and Y coordinates of the receptor location, the concentration value for the target source group at the receptor location, receptor terrain elevation, hill height scale, flagpole receptor height, rank, the source group ID, day of the year, hour, date, and receptor network ID. The data records are grouped by rank in ascending order. Concentrations are displayed for all receptors for the highest rank, then the next highest rank, etc. The following example is a sample from a MAXDAILY output file for which ranks 4, 8 12, and 50 were specified on the MAXDCONT keyword.

* AERMOD (15181): AERMOD OLM/OLMGROUP ALL Test Case, with BACKGROUND 07/30/15

* AERMET (13350): 13:50:48

* MODELING OPTIONS USED: NonDFAULT CONC FLAT OLM RURAL

* MXDYBYYR FILE OF RANKED DAILY MAXIMUM 1-HR VALUES BY YEAR FOR SOURCE GROUP: ALL

* FOR A TOTAL OF 16 RECEPTORS.

* FORMAT: (3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I4,2X,I3,2X,I8.8,2X,A8)

* X	Y	AVERAGE CONC	ZELEV	ZHILL	ZFLAG	RANK	GRP	JDAY	HR	DATE	NET ID
100.00000	0.00000	76.74205	35.00	35.00	0.00	4TH	ALL	236	14	99082414	POL1
300.00000	0.00000	174.62886	35.00	35.00	0.00	4TH	ALL	136	14	99051614	POL1
1000.00000	0.00000	146.90191	35.00	35.00	0.00	4TH	ALL	147	14	99052714	POL1
3000.00000	0.00000	91.97719	35.00	35.00	0.00	4TH	ALL	104	13	99041413	POL1
0.00000	-100.00000	99.52361	35.00	35.00	0.00	4TH	ALL	252	15	99090915	POL1
0.00000	-300.00000	171.76063	35.00	35.00	0.00	4TH	ALL	107	11	99041711	POL1
0.00000	-1000.00000	152.93801	35.00	35.00	0.00	4TH	ALL	65	13	99030613	POL1
0.00000	-3000.00000	111.73167	35.00	35.00	0.00	4TH	ALL	293	16	99102016	POL1
-100.00000	-0.00000	91.59388	35.00	35.00	0.00	4TH	ALL	62	14	99030314	POL1
-300.00000	-0.00000	154.65265	35.00	35.00	0.00	4TH	ALL	62	15	99030315	POL1
-1000.00000	-0.00000	131.73020	35.00	35.00	0.00	4TH	ALL	360	13	99122613	POL1
-3000.00000	-0.00000	86.11262	35.00	35.00	0.00	4TH	ALL	312	16	99110816	POL1
-0.00000	100.00000	80.06381	35.00	35.00	0.00	4TH	ALL	203	8	99072208	POL1
-0.00000	300.00000	166.86210	35.00	35.00	0.00	4TH	ALL	139	16	99051916	POL1
-0.00000	1000.00000	156.54681	35.00	35.00	0.00	4TH	ALL	110	15	99042015	POL1
-0.00000	3000.00000	102.04635	35.00	35.00	0.00	4TH	ALL	23	15	99012315	POL1
100.00000	0.00000	65.46639	35.00	35.00	0.00	8TH	ALL	250	17	99090717	POL1
300.00000	0.00000	164.95260	35.00	35.00	0.00	8TH	ALL	147	14	99052714	POL1
1000.00000	0.00000	137.02622	35.00	35.00	0.00	8TH	ALL	145	16	99052516	POL1
3000.00000	0.00000	79.71649	35.00	35.00	0.00	8TH	ALL	102	19	99041219	POL1
0.00000	-100.00000	90.20572	35.00	35.00	0.00	8TH	ALL	175	9	99062409	POL1
0.00000	-300.00000	167.99537	35.00	35.00	0.00	8TH	ALL	81	14	99032214	POL1
0.00000	-1000.00000	147.76997	35.00	35.00	0.00	8TH	ALL	107	18	99041718	POL1
0.00000	-3000.00000	108.50074	35.00	35.00	0.00	8TH	ALL	272	17	99092917	POL1
-100.00000	-0.00000	86.21569	35.00	35.00	0.00	8TH	ALL	251	12	99090812	POL1
-300.00000	-0.00000	147.43347	35.00	35.00	0.00	8TH	ALL	63	13	99030413	POL1
-1000.00000	-0.00000	113.23071	35.00	35.00	0.00	8TH	ALL	144	8	99052408	POL1
-3000.00000	-0.00000	80.46493	35.00	35.00	0.00	8TH	ALL	251	12	99090812	POL1
-0.00000	100.00000	62.77470	35.00	35.00	0.00	8TH	ALL	213	15	99080115	POL1
-0.00000	300.00000	164.12251	35.00	35.00	0.00	8TH	ALL	212	12	99073112	POL1
-0.00000	1000.00000	147.60345	35.00	35.00	0.00	8TH	ALL	84	15	99032515	POL1

-0.00000	3000.00000	92.37244	35.00	35.00	0.00	8TH	ALL	264	19	99092119	POL1
100.00000	0.00000	63.04954	35.00	35.00	0.00	12TH	ALL	213	15	99080115	POL1
300.00000	0.00000	158.05318	35.00	35.00	0.00	12TH	ALL	182	15	99070115	POL1
1000.00000	0.00000	132.45210	35.00	35.00	0.00	12TH	ALL	123	15	99050315	POL1
3000.00000	0.00000	75.06520	35.00	35.00	0.00	12TH	ALL	56	14	99022514	POL1
0.00000	-100.00000	81.79820	35.00	35.00	0.00	12TH	ALL	230	14	99081814	POL1
0.00000	-300.00000	163.58691	35.00	35.00	0.00	12TH	ALL	150	13	99053013	POL1
0.00000	-1000.00000	143.66477	35.00	35.00	0.00	12TH	ALL	63	11	99030411	POL1
0.00000	-3000.00000	103.84510	35.00	35.00	0.00	12TH	ALL	359	10	99122510	POL1
-100.00000	-0.00000	66.87945	35.00	35.00	0.00	12TH	ALL	210	13	99072913	POL1
-300.00000	-0.00000	134.34226	35.00	35.00	0.00	12TH	ALL	192	11	99071111	POL1
-1000.00000	-0.00000	112.42027	35.00	35.00	0.00	12TH	ALL	90	10	99033110	POL1
-3000.00000	-0.00000	69.14045	35.00	35.00	0.00	12TH	ALL	70	12	99031112	POL1
-0.00000	100.00000	57.29793	35.00	35.00	0.00	12TH	ALL	80	13	99032113	POL1
-0.00000	300.00000	161.46688	35.00	35.00	0.00	12TH	ALL	46	12	99021512	POL1
-0.00000	1000.00000	141.04997	35.00	35.00	0.00	12TH	ALL	165	14	99061414	POL1
-0.00000	3000.00000	89.51271	35.00	35.00	0.00	12TH	ALL	109	19	99041919	POL1
100.00000	0.00000	51.04396	35.00	35.00	0.00	50TH	ALL	132	13	99051213	POL1
300.00000	0.00000	126.14782	35.00	35.00	0.00	50TH	ALL	175	15	99062415	POL1
1000.00000	0.00000	105.50261	35.00	35.00	0.00	50TH	ALL	267	17	99092417	POL1
3000.00000	0.00000	56.90880	35.00	35.00	0.00	50TH	ALL	236	14	99082414	POL1
0.00000	-100.00000	56.69467	35.00	35.00	0.00	50TH	ALL	287	13	99101413	POL1
0.00000	-300.00000	137.18380	35.00	35.00	0.00	50TH	ALL	204	13	99072313	POL1
0.00000	-1000.00000	120.65746	35.00	35.00	0.00	50TH	ALL	268	13	99092513	POL1
0.00000	-3000.00000	85.42463	35.00	35.00	0.00	50TH	ALL	156	1	99060501	POL1
-100.00000	-0.00000	51.20790	35.00	35.00	0.00	50TH	ALL	169	14	99061814	POL1
-300.00000	-0.00000	72.61516	35.00	35.00	0.00	50TH	ALL	32	13	99020113	POL1
-1000.00000	-0.00000	72.14476	35.00	35.00	0.00	50TH	ALL	270	10	99092710	POL1
-3000.00000	-0.00000	52.15505	35.00	35.00	0.00	50TH	ALL	265	13	99092213	POL1
-0.00000	100.00000	50.39602	35.00	35.00	0.00	50TH	ALL	180	14	99062914	POL1
-0.00000	300.00000	125.74471	35.00	35.00	0.00	50TH	ALL	247	14	99090414	POL1
-0.00000	1000.00000	117.67662	35.00	35.00	0.00	50TH	ALL	143	1	99052301	POL1
-0.00000	3000.00000	70.84420	35.00	35.00	0.00	50TH	ALL	127	2	99050702	POL1

APPENDIX D. Overview of AERMOD revisions in version 26135

Model Change Bulletin (MCB) 19
AERMOD version 26135 (May 15, 2026)

Changes are listed by type and with each change are the affected pollutants and source types:

Bug Fixes

Item	Modification	Pollutants	Source Types
1	Correction when using restart capability with MAXIFILE. MAXIFILE would sometimes include duplicate records with different concentrations.	ALL	ALL
2	Correction in Tier 3 OLM option that produced a fatal error when using sector-varying background ozone concentrations (O3SECTOR keyword).	NO2	ALL
3	Correction to limitation on number of debug options that can be specified with the DEBUGOPT keyword.	ALL	ALL
4	Correction when program error encountered in some situations when the year specified on the SURFDATA keyword did not match the year of the first data record in the surface meteorological data file.	ALL	ALL
5	Correction in standard output file. Options summary did not print both ALPHA and BETA as options specified when both were used in the same AERMOD run.	ALL	ALL
6	Correction to erroneous error indicating there was a record out of sequence in one of the meteorological input data files.	ALL	ALL
7	Correction to print format statement in urban debug procedure.	ALL	ALL

8	Correction in GRSM Tier 3 NO2 conversion option when generating a MAXDCONT file to determine source contributions for 1-hour NO2 MAXDCONT. Individual source group contributions did not sum up to the ALL source group total.	NO2	ALL
9	Correction in subroutines O3VAL and NOXVAL in coset.f to correctly read the OZONEVAL and NOXVALUE concentrations when no units are specified for sector varying concentrations	NO2	ALL
10	Correction if STARTEND is March 1 through February 28, AERMOD does not see that as a full year for MAXDCONT, MULTYEAR, and ANNUAL averages. Code would issue an erroneous error and stop processing.	ALL	ALL
11	Update code to generate an error message when negative emission rate is specified. Negative emission rates to credit sources cannot be used with ARM2 due to non-linear dependence of concentrations on emissions.	NO2	ALL
12	GRSM - Logic added to maintain original formulation behavior in cases where NOX and/or NO2 inputs are missing or non-missing.	NO2	ALL
13	Correction in POINT_CONC to reset variable UEFF to a non-zero number.	ALL	RLINE, RLINEXT
14	Correction in POINT_CONC to use the absolute value of XD as an argument to REFL_HT	ALL	RLINE, RLINEXT
15	Correction using MULTYR in which first hour of each year processed after the first year was missing from the POSTFILE results.	ALL	ALL

16	Aircraft plume rise - Math expressions in arise.f were updated to be consistent with the formulation, and NENG was removed from the formulation calculations. calc1.f/ADISY fix for 'SY = DSQRT(SYB*SYB + SYAMB*SYAMB + VSIGY*VSIGY)'. Calc1.f/f2int function updated to call VDIS or ADIS for aircraft sources.	ALL	Aircraft
17	Add code to initialize file arrays and loop to close all open files at end of processing.	ALL	ALL
18	GRSM - In cases where very low NOX impacts occur, GRSM post-chemistry results could result in negative NO concentrations which results in NO2Frac conversion factors > 1.0. Following chemistry calculations, set NO2Frac to the lesser of 1 and NO2/(NO2+NO).	NO2	ALL

Enhancements

Item	Modification	Pollutants	Source Types
1	Reconfigured code for opening debug files with error checking on file unit and file name. Updated DEBUGOPT keyword. DEBUGOPT is now repeatable.	ALL	ALL
2	Added capability to use multiple hourly emission rate files.	ALL	ALL
3	Reconfigured source code and mechanism for assigning file units when not specified by the user.	ALL	ALL
4	Add ALPHA options for RLINEXT to model solid continuous barriers, solid barrier edge effects (account for influence zone at end of barrier), and vegetative barriers.	ALL	RLINEXT
5	Plume rise formulation update for aircraft sources. (Characterization as an aircraft source is an ALPHA option.)	ALL	Aircraft

APPENDIX E. Glossary

AERMAP -- AMS/EPA Regulatory Model (AERMOD) Terrain Preprocessor.
AERMET -- AMS/EPA Regulatory Model (AERMOD) Meteorological Preprocessor.
AERMOD -- AMS/EPA Regulatory Model.
ASCII -- American Standard Code for Information Interchange, a standard set of codes used by computers and communication devices. Sometimes used to refer to files containing only such standard codes, without any application-specific codes such as might be present in a document file from a word processor program.

Card -- A single input record within the input control file.

CO -- **CO**ntrol, the 2-character pathway ID for input control file commands used to specify overall job control options.

CO Pathway -- Collective term for the group of input control file commands used to specify the overall job control options, including titles, dispersion options, terrain options, etc.

Directory -- A logical subdivision of a disk used to organize files stored on a disk.

Dispersion Model -- A group of related mathematical algorithms used to estimate (model) the dispersion of pollutants in the atmosphere due to transport by the mean (average) wind and small scale turbulence.

DOS -- Disk Operating System. Software that manages applications software and provides an interface between applications and the system hardware components, such as the disk drive, terminal, and keyboard.

Echo of inputs -- By default, the AERMOD model will echo the input control file commands, character by character, into the main printed output file. This serves as a record of the inputs as originally entered by the user, without any rounding of the numerical values. The echoing can be suppressed with the NO ECHO option.

EOF -- End-of-File.

EPA -- U. S. Environmental Protection Agency.

Error message -- A message written by the model to the error/message file whenever an error is encountered that will inhibit data processing.

Error/Message File -- A file used for storage of messages written by the model.

EV -- **EV**ent, the 2-character pathway ID for input control file commands used to specify event inputs for the Short-Term EVENT model.

EV Pathway -- Collective term for the group of input control file commands used to specify the event periods and location for the Short-Term EVENT model.

EVENT Processing -- An option in the AERMOD model specifically designed to provide source contribution (culpability) information for specific events of interest, e.g., design values or threshold violations.

Extended Memory -- Additional memory on 80386 and 80486 PCs that allows programs to address memory beyond the 640 KB limit of DOS. Special software is required to utilize this extra memory.

Fatal Error -- Any error which inhibits further processing of data by the model. Model continues to read input images to check for errors during setup and will continue to read input meteorological data during calculation phase.

Flow Vector -- The direction towards which the wind is blowing.

GMT -- Greenwich Mean Time, the time at the 0° meridian.

Informational Message -- Any message written to the error/message file that may be of interest to the user, but which have no direct bearing on the validity of the results, and do not affect processing.

Input Image -- User supplied input, read through the default input device, controlling the model options and data input. A single card or record from the input control file. Each input image consists of a pathway ID (may be blank indicating a continuation of the previous pathway), a keyword (may also be blank for continuation of a keyword), and possibly one or more parameter fields.

Input control file -- The basic input file to the AERMOD model controlling the modeling options, source data, receptor locations, meteorological data file specifications, and output options. Consists of a series of input images grouped into functional pathways.

Julian Day -- The number of the day in the year, i.e., Julian Day = 1 for January 1 and 365 (or 366 for leap years) for December 31.

KB -- Kilobyte, 1000 bytes, a unit of storage on a disk

Keyword -- The 8-character codes that follow immediately after the pathway ID in the input run stream data.

LST -- Local Standard Time.

Math Co-processor -- A computer chip used to speed up floating point arithmetic in a personal computer.

MB -- Megabyte, one million bytes, a unit of storage on a disk

ME -- **ME**teorology, the 2-character pathway ID for input control file commands used to specify meteorological data options

ME Pathway -- Collective term for the group of input control file commands used to specify the input meteorological data file and other meteorological variables, including the period to process from the meteorological file for the AERMOD model.

Meteorological Data File -- Any file containing meteorological data, whether it be mixing heights, surface observations or on-site data.

Missing Value -- Alphanumeric character(s) that represent breaks in the temporal or spatial record of an atmospheric variable.

Mixing Height -- The depth through which atmospheric pollutants are typically mixed by dispersive processes.

NCDC -- National Climatic Data Center, the federal agency responsible for distribution of the National Weather Service upper air, mixing height and surface observation data.

NO ECHO -- Option to suppress echoing of the control file commands to the main printed output file.

NWS -- National Weather Service.

On-site Data -- Data collected from a meteorological measurement program operated in the vicinity of the site to be modeled in the dispersion analysis.

OU -- **OU**tput, the 2-character pathway ID for input control file commands used to specify output options.

OU Pathway -- Collective term for the group of input control file commands used to specify the output options for a particular run.

Overlay -- One or more subprograms that reside on disk and are loaded into memory only when needed.

Pasquill Stability Categories -- A classification of the dispersive capacity of the atmosphere, originally defined using surface wind speed, solar insolation (daytime) and cloudiness (nighttime). They have since been reinterpreted using various other meteorological variables.

Pathway -- One of the six major functional divisions in the input control file for the AERMOD model. These are **CO**ntrol, **SO**urce, **RE**ceptor, **ME**teorology, **EV**ent, and **OU**tput (see these entries in this section for a description).

PC -- Personal Computer, a wide-ranging class of computers designed for personal use, typically small enough to fit on a desktop.

Quality Assessment -- Judgment of the quality of the data.

Quality Assessment Check -- Determining if the reported value of a variable is reasonable (see also Range Check).

Quality Assessment Message -- Message written to the error/message file when a data value is determined to be suspect.

Quality Assessment Violation -- Occurrences when data values are determined to be suspect (see also Range Check Violation).

RAM -- Random Access Memory on a personal computer.

RAMMET -- Meteorological processor program used for regulatory applications capable of processing twice-daily mixing heights and hourly surface weather observations for use in dispersion models such as AERMOD, CRSTER, MPTER and RAM.

Range Check -- Determining if a variable falls within predefined upper and lower bounds.

Range Check Violation -- Determination that the value of a variable is outside range defined by upper and lower bound values (see also Quality Assessment Violation).

RE -- **RE**ceptor, the 2-character pathway ID for input control file commands used to specify receptor locations.

RE Pathway -- Collective term for the group of input control file commands used to specify the receptor locations for a particular run.

Regulatory Applications -- Dispersion modeling involving regulatory decision-making as described in the Guideline on Air Quality Models, which is published as Appendix W of 40 CFR Part 51 (as revised).

Regulatory Model -- A dispersion model that has been approved for use by the regulatory offices of the EPA, specifically one that is included in Appendix A of the Guideline on Air Quality Models, (as revised), such as the AERMOD model.

R-LINE – Research LINE-source dispersion model for near surface releases.

Control file -- Collectively, all input images required to process input options and input data for the AERMOD model.

SCRAM -- Support Center for Regulatory Air Models - part of EPA's website on the internet, used by EPA for disseminating air quality dispersion models, modeling guidance, and related information.

Secondary Keyword -- A descriptive alphabetical keyword used as a parameter for one of the main control file keywords to specify a particular option.

SO -- **SO**urce, the 2-character pathway ID for input control file commands used to specify input source parameters and source groups.

SO Pathway -- Collective term for the group of input control file commands used to specify the source input parameters and source group information.

Station Identification -- An integer or character string used to uniquely identify a station or site as provided in the upper air, mixing height, and surface weather data formats available from NCDC. There are no standard station numbers for on-site data or card image/screening data, and the user may include any integer string

Subdirectory -- A directory below the root, or highest level, directory or another subdirectory, used for organization of files on a storage medium such as a PC hard disk.

Surface Weather Observations -- A collection of atmospheric data on the state of the atmosphere as observed from the earth's surface. In the U.S. the National Weather Service collect these data on a regular basis at selected locations.

Surface Roughness Length -- Height at which the wind speed extrapolated from a near-surface wind speed profile becomes zero.

Syntax -- The order, structure and arrangement of the inputs that make of the input control file, specifically, the rules governing the placement of the various input elements including pathway IDs, keywords, and parameters.

Unformatted File -- A file written without the use of a FORTRAN FORMAT statement, sometimes referred to as a binary file.

Upper Air Data (or soundings) -- Meteorological data obtained from balloon- borne instrumentation that provides information on pressure, temperature, humidity, and wind away from the surface of the earth.

Vertical Potential Temperature Gradient -- The change of potential temperature with height, used in modeling the plume rise through a stable layer, and indicates the strength of the stable temperature inversion. A positive value means that potential temperature increases with height above ground and indicates a stable atmosphere.

Warning Message -- A message written by the model to the error/message file whenever a problem arises that may reflect an erroneous condition but does not inhibit further processing.

APPENDIX F. SBARRIER, BAREDGE, and VBARRIER Examples

The following examples are provided to show the user simplistic cases. These cases highlight some of the errors/warnings that the code will check as it tries to associate barriers with sources. The following cases are shown below with source (SO) parameters as follows:

1. Barrier smaller than the source
2. Barrier segments not all parallel to the source
3. Barrier segments with a gap
4. Barrier with overlapping segments
5. Edge Effects (BAREDGE)
6. Vegetative Barriers (VBARRIER)

Example cases 1-4 use the same RLINEXT source, as shown here:

```
SO LOCATION LLANE RLINEXT 1 1 1.5 15 1 1.5
SO SRCPARAM LLANE 2.16e-02 0 3.3 1.5
```

F.1 Barrier smaller than the source.

Input:



Barrier: SBARRIER BAR1 STA 1

SBARRIER BAR1 1 11 3 11 5 0

SBARRIER BAR1 END

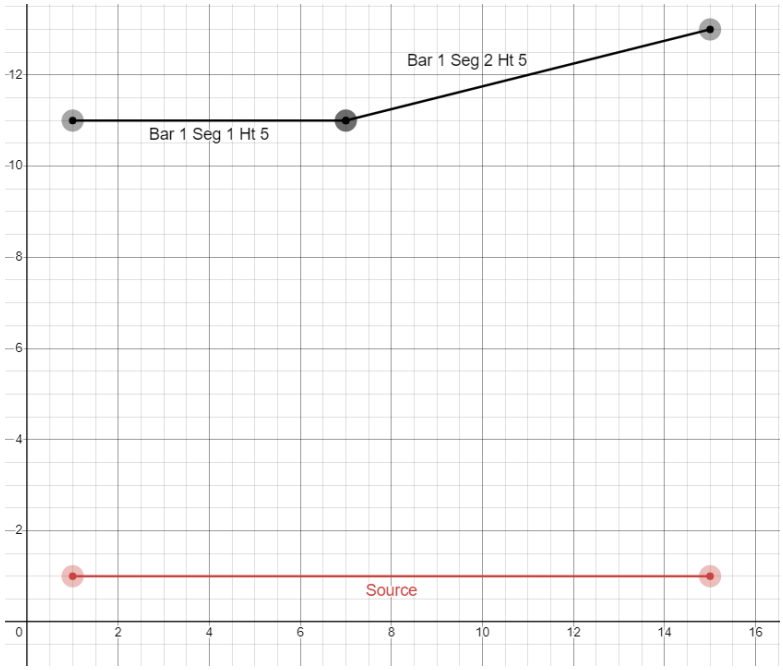
Output: **NO BARRIER**

Warning Message: W308 Barrier does not meet overlap threshold.

Explanation: Barrier is ignored because the barrier segment overlaps the source by < 90%.

F.2 *Barrier segments are not all parallel to the source*

Input:



Barrier:

```
SBARRIER BAR1 STA 2
SBARRIER BAR1 1 11  7 11 5 0
SBARRIER BAR1 7 11 15 13 5 0
SBARRIER BAR1 END
```

Output: **Single continuous barrier with skewed DCL**

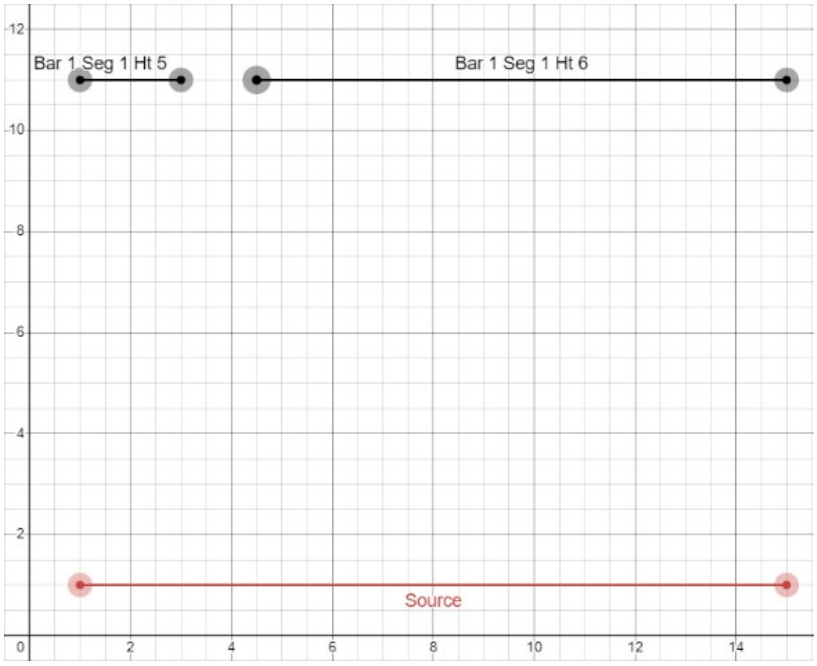
Warning Message: W307 SBAR_DCL: Segment(s) not parallel.

SOURCE ID	BARRIER ID1	BARRIER HTWALL (METERS)	BARRIER DCLWALL (METERS)	BARRIER ID2	BARRIER HTWALL2 (METERS)	BARRIER DCLWALL2 (METERS)
LLANE	BAR1	5.00	10.57	NOBARID	0.00	0.00

Explanation: Barrier DCL is still calculated (so long as it also meets the overlap criteria) and is treated as a single continuous barrier with DCL.

F.3 *Barrier segments with gap*

Input:



Barrier:

```
SBARRIER BAR1 STA 2
SBARRIER BAR1   1 11  3 11 5 0
SBARRIER BAR1 4.5 11 15 11 6 0
SBARRIER BAR1 END
```

Output: **Single continuous barrier with skewed DCL**

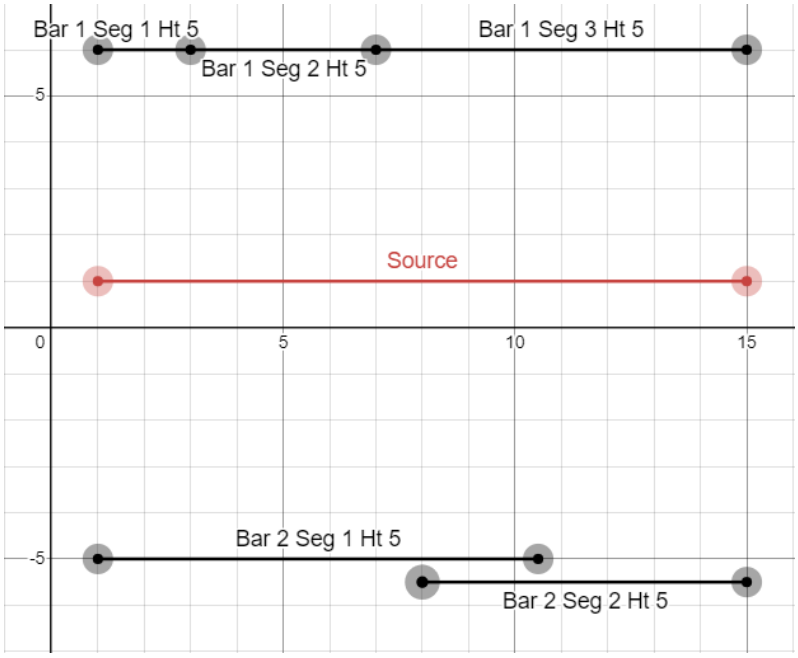
Warning Message: W304 SBAR_DCL: Gap >1m between barrier segments.

SOURCE ID	BARRIER ID1	BARRIER HTWALL (METERS)	BARRIER DCLWALL (METERS)	BARRIER ID2	BARRIER HTWALL2 (METERS)	BARRIER DCLWALL2 (METERS)
LLANE	BAR1	5.84	10.00	NOBARID	0.00	0.00

Explanation: Barrier DCL is still calculated (so long as it also meets the overlap criteria) and is treated as a single continuous barrier.

F.4 *Barrier with overlapping segments*

Input:



Barrier:

```
SBARRIER BAR1 STA 3
SBARRIER BAR1 1 6  3 6 5 0
SBARRIER BAR1 3 6  7 6 5 0
SBARRIER BAR1 7 6 15 6 5 0
SBARRIER BAR1 END

SBARRIER BAR2 STA 2
SBARRIER BAR2 1 -5   10.5 -5   5 0
SBARRIER BAR2 8 -5.5 15   -5.5 5 0
SBARRIER BAR2 END
```

Output: **Two continuous barriers, BAR2 with skewed DCL due to segment overlap**

SOURCE ID	BARRIER ID1	BARRIER HTWALL (METERS)	BARRIER DCLWALL (METERS)	BARRIER ID2	BARRIER HTWALL2 (METERS)	BARRIER DCLWALL2 (METERS)
LLANE	BAR1	5.00	5.00	BAR2	5.00	-6.21

Explanation: The perpendicular distance between the segments of barrier BAR2 is considered a gap. Barrier DCL is calculated based on total overlap of the

barrier and source, segment-to-segment overlap is removed. Total barrier must still meet source overlap threshold or will be ignored.

F.5 *Barrier Edge Effects*

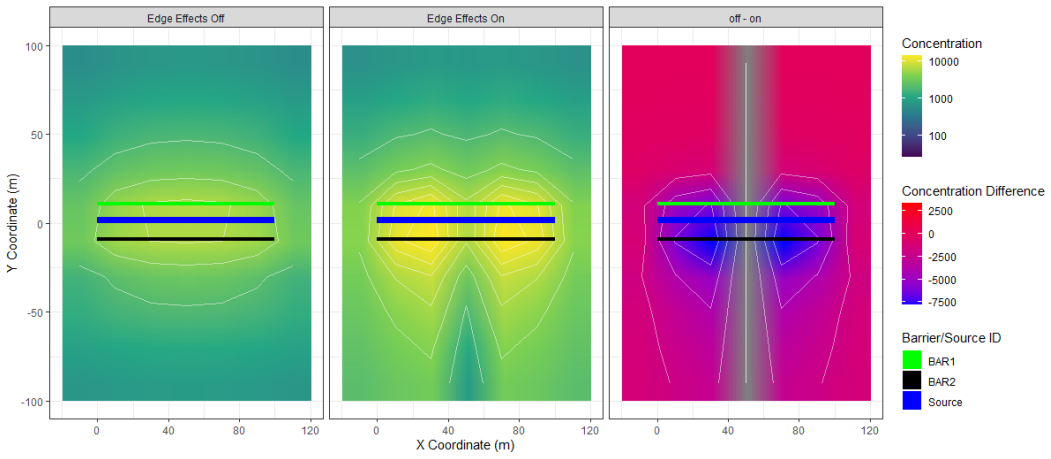
Input: MODELOPT FLAT CONC WARNCHKD ALPHA **BAREDGE**

Barrier:

```
SBARRIER BAR1 STA 2
SBARRIER BAR1 0  10  50 10 5 0
SBARRIER BAR1 50 10 100 10 5 0
SBARRIER BAR1 END

SBARRIER BAR2 STA 2
SBARRIER BAR2 0  -10  50 -10 5 0
SBARRIER BAR2 50 -10 100 -10 5 0
SBARRIER BAR2 END
```

Output:



Explanation The BAREDGE keyword changes concentrations within zones near barrier edges

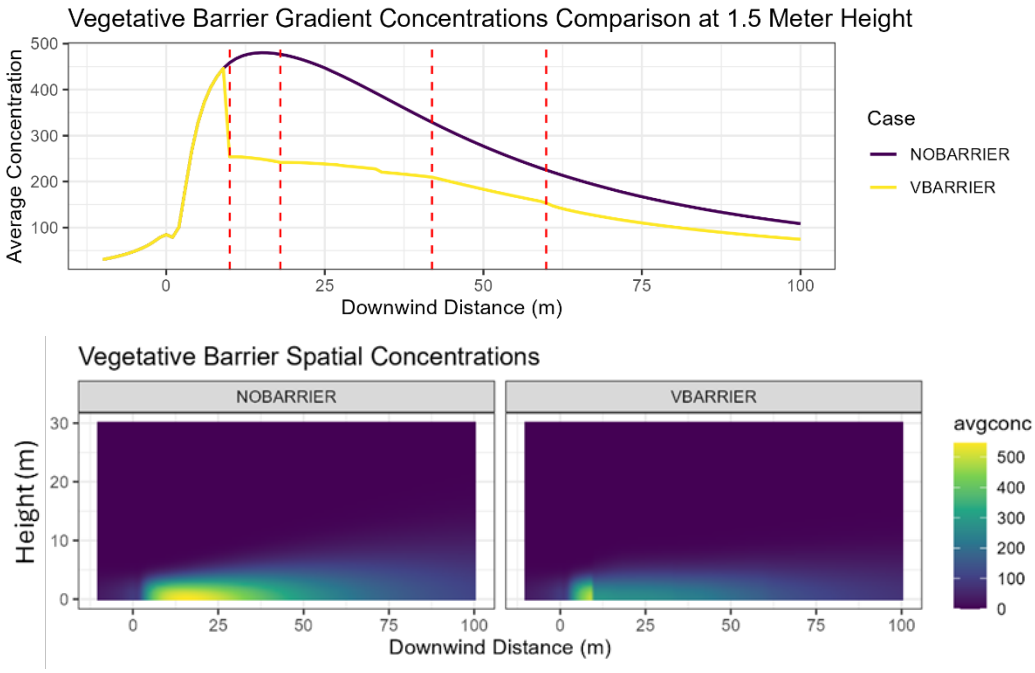
F.6 Vegetative Barrier segments

Input: ***MODELOPT FLAT CONC WARNCHKD ALPHA***

Barrier:

```
LOCATION LLANE RLINEXT 1 0 1.5 15 0 1.5
** VBARRIER SRCID HT WT DCL LAI LAD
   VBARRIER LLANE  6  8  10   7 1.6
```

Output:



Explanation: *The output concentrations with the vegetative barrier are noticeably reduced after the plume encounters the barrier (downwind distance of 10 m). Before the plume encounters the barrier, the concentrations of the no barrier case and the vegetative barrier case match. The dashed vertical lines (top, red) indicate the start of each region as used by the vegetative barrier algorithm.*

United States Environmental Protection Agency	Office of State Air Partnerships Air Quality Assessment Division Research Triangle Park, NC	Publication No. EPA-454/B-26-001 July 2026