ADDENDUM

USER'S GUIDE FOR THE AMS/EPA REGULATORY MODEL - AERMOD (EPA-454/B-03-001, September 2004)

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Air Quality Assessment Division
Research Triangle Park, North Carolina 27711

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PREFACE

This document provides updated user instructions for the AERMOD dispersion model, including modifications introduced with version 06341 and later. This addendum supplements and updates the information contained in the current AERMOD User's Guide (EPA, 2004a).

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1.0 INTRODUCTION

1.1 OVERVIEW OF AERMOD REVISIONS

This document provides user instructions for revisions to the AERMOD dispersion model. The discussion provided here supplements and updates the information contained in the current AERMOD User's Guide (EPA, 2004a), and it is assumed that the reader is already familiar with the contents of that document. Note that portions of the current AERMOD User's Guide (EPA, 2004a) are no longer valid or applicable.

Four sets of AERMOD revisions are included in this Addendum:

1. The first set of revisions, first introduced with version 03273 of AERMOD, includes dry and wet deposition algorithms for both particulate and gaseous emissions (see Sections 1.2 and 2.2 for more details), and the OPENPIT source option, originally incorporated in the ISCST3 model (EPA, 1995a), for modeling particulate emissions from open pit (below grade) sources, such as surface coal mines and rock quarries;
2. The second set of revisions, first introduced with version 04300 of AERMOD, includes two non-DFAULT options for modeling conversion of NO to NO_2: 1) the Plume Volume Molar Ratio Method (PVMRM) (Hanrahan, 1999a and 1999b); and 2) the Ozone Limiting Method (OLM);
3. The third set of revisions, first introduced with version 06341 of AERMOD, includes the following (additional information is provided in Model Change Bulletin (MCB) #1 provided on the SCRAM AERMOD webpage):
    a. A new "BETA" option on the CO MODELOPT card to allow for new features to be added to AERMOD that are still in BETA-test status;
    b. A BETA option for incorporating NO/NO_2 chemistry for NO_2 increment consumption calculations with PSD credits using the PVMRM option;
    c. BETA options for capped and horizontal stack releases;
    d. An option to specify an initial default in-stack NO_2/NO_x ratio for the PVMRM and OLM options;
    e. New options for varying emissions by month, hour-of-day, and day-of-week (MHRDOW and MHRDOW7);
    f. An option to allow multiple urban areas to be defined in a single model run;

g. Updated processing to support modeling demonstrations for the National Ambient Air Quality Standards (NAAQS) for PM, including the 24-hour average design value for PM-2.5 impacts; and

h. Use of dynamic array allocation for AREAPOLY sources to allocate array limits for the maximum number of vertices at model runtime, replacing the previous fixed array limit of 20 vertices.

4. The fourth set of revisions, first introduced with version 09292 of AERMOD, includes the following (additional information is provided in MCB#3 provided on the SCRAM AERMOD webpage):

a. New options for varying emissions by hour-of-day and day-of-week (HRDOW and HRDOW7);

b. Modification of the regulatory default option (DFAULT) on the CO MODELOPT card to impose a restriction on the urban roughness length parameter to be 1 meter for regulatory default applications. Any value other than 1 meter for the urban roughness length option on the CO URBANOPT card will be treated as a non-DFAULT option;

c. Removal of the TOXICS option from the MODELOPT keyword. Options formerly associated with the TOXICS option are still considered non-DFAULT options within AERMOD. The area source optimizations formerly associated with the TOXICS option are now selected using the new non-DFAULT FASTAREA option on the MODELOPT keyword;

d. A new non-DFAULT option for optimizing runtime for POINT and VOLUME sources based on an alternative implementation of the horizontal meander algorithm has been incorporated through the FASTALL option on the MODELOPT keyword. The FASTALL option also includes the FASTAREA optimizations if area sources are included in the model inputs;

e. The option for specifying hourly emissions from a separate file through the HOUREMIS keyword has been enhanced to allow the use of hourly varying release heights and initial dispersion coefficients for VOLUME and AREA/AREAPOLY/AREACIRC sources;

f. The OPENPIT source option has been modified to allow for use of the OPENPIT source for gaseous (non-particulate) emissions and with METHOD_2 for particulate emissions;

g. The non-DFAULT option of FLAT terrain can now be specified on a source-by-source basis, allowing both FLAT and ELEV terrain treatments within the same model run (see Section 4.1 of the *AERMOD Implementation Guide* regarding modeling of sources with terrain-following plumes in sloped terrain);

h. A non-DFAULT option for a user-specified dry deposition velocity for gaseous emissions has been added under the GASDEPVD keyword on the CO pathway;

i. A new SUMMFILE option has been included on the OU pathway to output the summary of high ranked values to a separate file;

j. An option to use scientific notation for output result files has been added through the FILEFORM keyword on the OU pathway. The FILEFORM option is applicable to PLOTFILEs, plot-formatted POSTFILEs, MAXIFILEs, RANKFILEs, and SEASONHR files;

k. An option (WARNCHKD) has been added to the MODELOPT keyword to allow issuing of warning messages rather than fatal errors for non-sequential meteorological data files, in order to allow use of multi-year meteorological data files that may contain gaps between years of data under the DFAULT option; and

l. The maximum length of filenames specified in the 'aermod.inp' file has been increased to 200 (controlled by the ILEN_FLD parameter in modules.f), and the maximum input string length to 512 (controlled by the ISTRG parameter in modules.f). Double quotes (") are also allowed as field delimiters in the 'aermod.inp' file to support filenames with embedded spaces.

5. The fifth set of revisions, first introduced with version 11059 of AERMOD, includes the following (additional information is provided in MCB#4 provided on the SCRAM AERMOD webpage):

a. Revisions to the processing options available for 24-hour averages of PM2.5 to support implementation of recommendations regarding appropriate modeling procedures for demonstrating compliance the PM2.5 NAAQS;

b. Enhancements to support processing for the 1-hour NO_2 and SO_2 NAAQS, based on the annual distribution of maximum daily 1-hour values, averaged across the number of years processed, including three new output file options, MAXDAILY, MXDYBYYR, and MAXDCONT, and revisions to the RECTABLE keyword to support user-specified ranks up the 999^{th} highest value to support significant contribution analyses;

c. A new option to specify uniform or temporally-varying background concentrations, using the BACKGRND keyword on the SO pathway;

d. A new option to specify temporally-varying background ozone concentrations, using the O3VALUES keyword on the CO pathway;

e. Incorporation of the default equilibrium ratio 0.90 for NO2/NOx for the OLM option, which was previously associated only with the PVMRM option (the CO NO2EQUIL option can also be used to specify a non-default equilibrium ratio for the OLM option);

f. An option to suppress file headers for formatted output files, using the NOHEADER keyword on the OU pathway;

g. A modification to the urban option to address issues with the transition from the nighttime urban boundary layer to the daytime convective boundary layer (a non-DFAULT option has been included to revert to original implementation); and

h. Corrections to several bugs related to the PVMRM algorithm and modifications to the DEBUGOPT keyword to allow user to specify only PVMRM or deposition (DEPOS) debug output, without the MODEL debug file, which can be very large.

1.2 BACKGROUND ON DEPOSITION ALGORITHMS

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 (EPA, 2003).

The deposition algorithms based on the ANL report were initially implemented in the AERMOD model under the non-DFAULT TOXICS option, which was selected by including the TOXICS keyword on the CO MODELOPT card. Beginning with version 09292 of AERMOD, the TOXICS option has been removed from the model. Those options in AERMOD that were formerly associated with the TOXICS option are still considered non-DFAULT options but no longer require the specification of the TOXICS option to allow their use. The other changes to the AERMOD model inputs associated with the deposition algorithms are limited to the CO (control) pathway and the SO (source) pathway. For gaseous dry deposition based on the ANL algorithms, the user must define the seasonal categories based on the ANL report for each of the calendar months, and must also define the land use category and three pollutant-specific physical parameters that are provided in the appendices of the ANL report. 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 and are described below in Section 2.2. 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, which are also provided for selected pollutants in Appendix B of the ANL report. The

keywords used to define these inputs and the meteorological data requirements for deposition are described in Section 2.2.

Consistent with Section 7.2.7(b) of the *Guideline on Air Quality Models* (40 CFR Part 51, Appendix W), the use of "Method 1" for particle deposition in AERMOD is allowed under the regulatory DFAULT option. However, use of the "Method 1" particle deposition algorithms require quantification of the particle size distribution and should be done in coordination with the appropriate reviewing authority. Use of the "Method 2" option for particle deposition and the gas deposition algorithms (both dry and wet) are considered non-DFAULT options in AERMOD. Table 1-1 summarizes the required keywords for the various deposition options within AERMOD and whether they are allowed under the DFAULT option.

Table 1-1. Summary of Deposition Options in AERMOD

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
Gaseous	CONC w/wet depletion WDEP	SO GASDEPOS	No
Gaseous	CONC w/dry & wet depletion DEPOS	CO GDSEASON, CO GDLANUSE, and SO GASDEPOS	No
Particulate ("Method 1")	CONC w/dry and/or wet depletion DEPOS DDEP WDEP	SO PARTDIAM, SO PARTDENS, and SO MASSFRAX	Yes
Particulate ("Method 2")	CONC w/dry and/or wet depletion DEPOS DDEP WDEP	SO METHOD_2	No

2.0 USER INSTRUCTIONS

2.1 DISPERSION MODELING OPTIONS

2.1.1 Modification to Urban Option for Morning Transition

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 the most recent 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 has increased with the recent promulgation of the 1-hour NO_2 and 1-hour SO_2 NAAQS.

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, 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 Appendix E.

While the urban option has been modified under the regulatory default mode beginning with version 11059, a non-DFAULT option to revert to the urban option as implemented prior to

version 11059 has been included on the CO MODELOPT keyword (see Section 2.1.2). As with other non-DFAULT options in AERMOD, use of this option in regulatory modeling applications would require justification and approval on a case-by-case basis.

2.1.2 MODELOPT Keyword

The dispersion options are controlled by the MODELOPT keyword on the CO pathway. The syntax, type, and order of the MODELOPT keyword are summarized below:

Syntax: CO MODELOPT [DFAULT] [BETA] [CONC / DEPOS / DDEP / WDEP (and/or)] [AREADPLT] [FLAT (and/or ELEV)] [NOSTD] [NOCHKD (or WARNCHKD)] [NOWARN] [SCREEN] [SCIM] [PVMRM (or OLM)] [PSDCREDIT] [FASTALL (or FASTAREA)] [DRYDPLT (or NODRYDPLT)] [WETDPLT (or NOWETDPLT)] [NOURBTRAN]	
Type:	Mandatory, Non-repeatable
Order:	Must precede POLLUTID, HALFLIFE and DCAYCOEF

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);

BETA - Non-DFAULT option that allows for draft, "Beta" test options to be used; currently includes the PSDCREDIT option and options for capped and horizontal stack releases (see Section 2.1.2 for more details);

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-DFAULT method for optimized plume depletion due to dry removal mechanisms will be included in calculations for area sources;

FLAT - Specifies that the non-DFAULT 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-DFAULT 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;

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-DFAULT FLAT terrain option on a source-by-source basis;

NOSTD - Specifies that the non-DFAULT option of no stack-tip downwash will be used;

NOCHKD - Specifies that the non-DFAULT option of suspending date checking will be used for non-sequential meteorological data files;

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 - Specifies that the non-DFAULT option for running AERMOD in a screening mode will be used;

SCIM - Sampled Chronological Input Model - 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;

PVMRM - Specifies that the non-DFAULT Plume Volume Molar Ratio Method (PVMRM) for NO_2 conversion will be used;

OLM - Specifies that the non-DFAULT Ozone Limiting Method (OLM) for NO_2 conversion will be used;

PSDCREDIT - Specifies that the non-DFAULT BETA test option will be used to calculate the increment consumption with PSD credits using the PVMRM option;

FASTALL - Non-DFAULT option to optimize model runtime through use of alternative implementation of horizontal meander for POINT and VOLUME sources; also optimizes model runtime for AREA/ AREAPOLY/AREACIRC and OPENPIT sources through hybrid approach (formerly associated with TOXICS option, now controlled by FASTAREA option);

FASTAREA - Non-DFAULT option to optimize model runtime through hybrid approach for AREA/ AREAPOLY/AREACIRC and OPENPIT sources (formerly associated with TOXICS option);

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;

NODRYDPLT - Option to disable dry depletion (removal) processes associated with dry deposition algorithms;

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;

NOWETDPLT - Option to disable wet depletion (removal) processes associated with wet deposition algorithms; and

NOURBTRAN - Non-DFAULT 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).

The DFAULT option has been modified beginning with version 09292 to impose a restriction on the optional urban roughness length parameter to be 1 meter for regulatory default applications.

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 1.2 and 2.2 for more details).

Beginning with version 04300, the dry and/or 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 Section 2.2, 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 the effect of 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.

The PVMRM and OLM options for modeling NO_2 conversion are non-DFAULT options, and only one of these options can be specified for a given model run. Both options require that the pollutant ID be specified as 'NO2' on the CO POLLUTID card (see Section 3.2.5 of the AERMOD User's Guide). These options have additional input requirements as described in Section 2.4.

Beginning with version 09292, the TOXICS option in no longer used in AERMOD and the FASTAREA option on the MODELOPT is now used to select the non-DFAULT option to optimize model runtime for AREA sources (including AREA, AREAPOLY, AREACIRC and OPENPIT source types). When the FASTAREA option 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. Also beginning with version 09292, a non-DFAULT option to optimize model runtime for POINT and VOLUME sources has been included, which is selected by the FASTALL option on the MODELOPT keyword. Specification of the FASTALL option also activates the FASTAREA option if AREA sources are including in the model inputs. Both FASTALL and FASTAREA skip receptors that are more than 80 kilometers from the source.

The FASTALL option for POINT 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 based on 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 overprediction for the FASTALL option. However, the range of ratios for high ranked values shows both overpredictions and underpredictions relative the DFAULT option, and differences at specific receptors may be much larger.

The new NOURBTRAN non-DFAULT 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. As with other non-DFAULT options in AERMOD, use of the NOURBTRAN option in regulatory modeling applications would require justification and approval on a case-by-case basis.

2.1.2 BETA Test Options

A 'BETA' test option switch is included on the CO MODELOPT keyword to identify and allow for new features to be added to the model that are still in a draft BETA-test status. The BETA option is a non-DFAULT option, and will result in a fatal error if the DFAULT option is also specified. Two draft enhancements are included in AERMOD under the BETA option, beginning with version 06341:

1) Options for capped stacks (source type = POINTCAP) and for horizontal releases (source type = POINTHOR); and

2) The PSDCREDIT option for PVMRM to account for NO/NO_2 chemistry of combined plumes in the computation of increment consumption with PSD credits.

Inclusion of these draft BETA-test options does not imply any endorsement of their use for regulatory or non-regulatory applications of the model. In addition, the designation of BETA-test to these draft enhancements does not imply that these options have completed rigorous internal ("Alpha") testing prior to being included in a public release of the model. More details regarding the POINTCAP and POINTHOR options are provided in Section 2.1.5, and more details regarding the PSDCREDIT option are provided in Section 2.4.6.

2.1.3 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 . . . TimeN MONTH PERIOD or ANNUAL
Type:	Mandatory, Non-repeatable

where the parameters Time1 . . . TimeN 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, the PERIOD and ANNUAL keywords produce the same results for a single year data file. 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 (see Section 2.1.4 below for a description of the MULTYEAR option).

2.1.4 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. Since the multiple year option makes use of the model re-start capabilities described in the Section 3.2.10 of the AERMOD User's Guide (2004a), 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 setup 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 runstream file for the first year with all of 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 of the AERMOD User's Guide (2004a)).

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 is primarily intended 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.

2.1.5 Processing for Particulate Matter (PM) NAAQS

2.1.5.1 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 has issued recommendations (EPA, 2010) regarding appropriate modeling procedures for use in modeling demonstrations of compliance with the

PM2.5 NAAQS, which include a recommendation to use 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, as well as 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 on Air Quality Models* (40 CFR Part 51, Appendix W) 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 these EPA 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 first-highest (H1H) 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 first-highest concentrations at each receptor, if more than one year of meteorological data is input to the model. In other words, the model calculates the first-highest 24-hour concentration at each receptor for each year modeled, averages those first-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 first-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. In order for the PM-2.5 processing to work correctly for multiple year periods, the yearly meteorological data files must be concatenated into

a single multi-year file for input into the model. (NOTE: The MULTYEAR option with separate yearly meteorological data files may also be used to determine the modeled design values, but the OU MAXDCONT option to determine contributions from other source groups to the cumulative modeled design value will not work with separate meteorological data files for each year.) Multi-year meteorological data files can also be generated by processing multi-year inputs in AERMET, the meteorological processor for AERMOD. There is no requirement to remove the header records between concatenated surface meteorological data files prior to running the model. 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.

In order to comply with these processing requirements, the following restrictions are applied to the PM-2.5 NAAQS processing whenever a pollutant ID of 'PM25', '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. Specifying another high value rank on the RECTABLE card will result in a non-fatal warning message being generated and should not be used as the basis for modeled contribution to a NAAQS compliance demonstration for PM2.5. Selection of ranks lower than the 1ST 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 card 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 separate meteorological data files. 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 incompatible with the EVENT processor. If the MAXIFILE option is used to output 24-hour average threshold violations, these 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.

2.1.5.2 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 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) 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 2.1.4; or 2) 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.

2.1.6 Processing for 1-hour NO2 and SO2 NAAQS

New 1-hour NAAQS for NO2 and SO2 were promulgated in February 2010 and June 2010, respectively. The form of these new 1-hour standards is similar, based on a percentile rank from the annual distribution of maximum daily 1-hour values, averaged across the number of

years processed. For the 1-hour NO2 standard the modeled design value is based on the 98th-percentile of the maximum daily 1-hour values, which is represented by the eighth-highest of the maximum daily 1-hour values across the year. The 1-hour SO2 modeled design value is based on the 99th-percentile, or fourth-highest, of the maximum daily 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 for NO2, or fourth-highest values for SO2.

The form of these new 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 2.7.1.

2.1.7 Specifying Multiple Urban Areas

The AERMOD model (beginning with the version dated 06341) includes the option to specify multiple urban areas within the same model run. This option 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 multiple urban areas are defined using multiple CO URBANOPT cards. The syntax of the modified URBANOPT keyword is as follows:

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-DFAULT 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 the previous version of AERMOD, so that existing input files will not require modification.

The syntax of the URBANSRC keyword on the SO pathway has also been modified to allow for the option of specifying multiple urban areas. The syntax of the modified URBANSRC keyword is as follows:

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
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 3.3.3 of the AERMOD User's Guide (EPA, 2004a). 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.

2.1.8 BETA Options for Capped and Horizontal Stack Releases

Draft BETA test options are included in AERMOD (beginning with the version dated 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, included in Appendix A of this Addendum. 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 for 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 in order 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 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; use of an effective diameter adjusted to maintain flow rate is not appropriate and could produce unrealistic results. For PRIME downwash sources modeled using the BETA 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, have been adapted for the PRIME numerical plume rise formulation. However, this adaptation of the Model Clearinghouse procedure to PRIME downwash sources has not been validated by field tracer or wind tunnel data.

The user selects the BETA 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, respectively, of the AERMOD User's Guide (EPA, 2004a), and is also summarized in Appendix B of this Addendum. 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-downwashed sources, the user-specified exit velocity for horizontal releases is treated initially as horizontal momentum in the downwind direction. More details regarding the BETA options for capped and horizontal releases will be provided later, as warranted based on further testing and evaluation.

2.2 DEPOSITION ALGORITHM INPUTS AND OPTIONS

The AERMOD model includes algorithms for both dry and wet deposition of both particulate and gaseous emissions. Based on the guidance provided for application of the AERMOD model in Appendix W, and based on the history of 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 under the regulatory default option. This option 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 considered to be non-DFAULT options in AERMOD, and the model will issue a fatal error message and abort processing if the DFAULT option is specified with the gas deposition or Method 2 particle deposition options. As discussed above in Section 1.2, the TOXICS option formerly associated with the options for gas deposition and Method 2 for particle deposition is no longer used in the AERMOD model. No additional

option switches are required to allow use of these non-DFAULT options. Table 1-1 in Section 1.2 summarizes the required keywords and regulatory status of various deposition options within AERMOD. The remainder of this section provides a detailed description of the model input parameters associated with the deposition algorithms.

2.2.1 Definition of Seasons for Gas Dry Deposition

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

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 2.2.5. 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.

2.2.2 Definition of Land Use Categories for Gas Dry Deposition

The gas deposition algorithms include some gas deposition resistance terms based on five seasonal categories, defined above, and nine land use categories as follows (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.

2.2.3 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).

2.2.4 Specifying Source Parameters for Gas Deposition (Dry and/or Wet)

The input of 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).

2.2.5 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.

2.2.6 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 Sections 1.2 and 2.2, use of the Method 2 option is considered non-DFAULT.

2.2.6.1 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.

2.2.6.2 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).

2.2.7 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 3.3.6 of the AERMOD User's Guide (EPA, 2004a)) 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 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.

2.2.8 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 3.2.13 of the AERMOD User's Guide

(EPA, 2004a). 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.

2.2.9 Meteorological Data for Deposition Algorithms

The AERMET meteorological processor was modified (beginning with the version dated 04300) to output additional meteorological parameters needed for the deposition algorithms in AERMOD. The additional variables include the precipitation code, precipitation rate, relative humidity, surface pressure, and cloud cover. These additional variables are automatically included after the standard variables for each hour, and do not require any additional user input. The precipitation data needed for wet deposition calculations in AERMOD can be obtained from the SAMSON, HUSWO or ISHD (TD-3505) formats currently supported by AERMET (EPA, 2004b).

The input meteorological data file consists of a header record that includes the latitude and longitude, surface station ID (e.g., WBAN number), upper air station ID, the on-site station ID, and the AERMET version date (see Section D.1 of the AERMOD model user's guide (EPA, 2004a)). The meteorological data file for the deposition algorithms is read as a free format file, i.e., each field on a record is separated from adjacent fields by a comma or by one or more spaces. The subsequent data records contain the following variables in the order listed:

Variable Description	Format
Year	Integer
Month	Integer
Day of Month	Integer
Julian Day (Day of Year)	Integer
Hour of Day	Integer
Heat Flux (W/m^2)	Real
Surface Friction Velocity, u_* (m/s)	Real
Convective Velocity Scale, w_* (m/s)	Real
Lapse Rate above Mixing Height (K/m)	Real
Convective Mixing Height (m)	Real
Mechanical Mixing Height (m)	Real
Monin-Obukhov Length, L (m)	Real
Surface Roughness Length, z_o (m)	Real
Bowen Ratio	Real
Albedo	Real
Reference Wind Speed (m/s)	Real
Reference Wind Direction (degrees)	Real
Reference Height for Wind (m)	Real
Ambient Temperature (K)	Real
Reference Height for Temperature (m)	Real
Precipitation Code (0-45)	Integer
Precipitation Amount (mm)	Real
Relative Humidity (%)	Real
Surface Pressure (mb)	Real
Cloud Cover (tenths)	Integer

2.3 OPEN PIT SOURCE OPTION

The open pit source option is invoked by specifying a source type of OPENPIT on the source location (SO LOCATION) card. The OPENPIT source algorithm can be used to model particulate or gaseous emissions from open pits, such as surface coal mines and rock quarries. If particulate emissions are modeled, the user must specify the particle size information through the appropriate keywords described in Section 2.2. 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).

The AERMOD model accepts rectangular pits with an optional rotation angle specified relative to a north-south orientation. The rotation angle 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 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, which 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.

2.4 SPECIFYING BACKGROUND CONCENTRATIONS

Beginning with version 11059, users can specify uniform or temporally varying background concentrations using the BACKGRND keyword on the SO pathway, which 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. The syntax of the BACKGRND keyword is as follows:

Syntax:	SO BACKGRND BGflag BGvalue(i), i=1,n 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). Note that AERMOD does not allow any missing data with the HOURLY background file option is used. BGflag 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.). The wind speed categories used with the WSPEED option may be defined using the ME WINDCATS keyword. 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.

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). If the BACKUNIT keyword is omitted, default units of PPB are assumed for background NO2 and SO2, 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).

Background concentrations specified with the BACKGRND keyword are combined with source impacts on a temporally-paired basis to estimate cumulative ambient impacts. To include background concentrations with a particular source group, the reserved "source ID" of BACKGROUND can be included on the SRCGROUP keyword, including source group ALL. The contribution of background concentrations can 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.**

2.5 PVMRM AND OLM OPTIONS FOR MODELING NO_2

This section provides a description of the inputs related to the non-DFAULT PVMRM and OLM options for modeling the conversion of NO_x to NO_2. A technical description of the PVMRM algorithm is provided in an Addendum to the AERMOD Model Formulation Document (Cimorelli, *et al.*, 2004). Background on the original development of the PVMRM option is provided by Hanrahan (1999a and 1999b).

The PVMRM and OLM algorithms have been implemented as non-DFAULT options, which means that the PVMRM and OLM options cannot be used if the DFAULT keyword is included on the CO MODELOPT card. As described in Section 2.1.1, a BETA-test draft model option, PSDCREDIT, has been added for use when an application is for increment consumption with PSD credits using PVMRM. The special source grouping required for the PSDCREDIT option is described below in Section 2.4.6.1.

2.5.1 Specifying Ozone Concentrations for PVMRM and OLM Options

The background ozone concentrations for the PVMRM and OLM options can be input as a single value through the OZONEVAL keyword on the CO pathway, as temporally-varying values through the O3VALUES keyword on the CO pathway, or as hourly values from a

separate data file specified through the OZONEFIL keyword on the CO pathway. The user must specify background ozone concentrations through the OZONEVAL, O3VALUES, or OZONEFIL keyword in order to use the PVMRM or OLM options. The OZONEVAL or O3VALUES keyword may also be specified 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.

The syntax of the OZONEVAL keyword is as follows:

Syntax:	CO OZONEVAL O3Value (O3Units)
Type:	Optional, Non-repeatable

where the O3Value parameter is the background ozone concentration in the units specified by the optional O3Units parameter (PPM, PPB, or UG/M3). 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). The OZONEVAL keyword word is optional and non-repeatable.

Ozone concentrations specified on the O3VALUES keyword are currently assumed to be in units of PPB, and the model will convert the concentrations to micrograms/cubic-meter based on reference temperature (25 C) and pressure (1013.25 mb). The syntax of the O3VALUES keyword is as follows, and is similar to the EMISFACT keyword on the SO pathway for specifying temporally-varying emission rates:

Syntax:	CO O3VALUES O3Flag O3values(i), i=1,n
Type:	Optional, Repeatable

where 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 is shown 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. 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 2.6.1 below includes an example illustrating the order of inputs for these options for the EMISFACT keyword.

The syntax of the OZONEFIL keyword is as follows:

Syntax:	CO OZONEFIL O3FileName (O3Units) (Format)
Type:	Optional, Non-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 Format parameter specifies the Fortran FORMAT to read the ozone data. 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. If the optional Format parameter is missing, then the model will read the ozone data using a Fortran free format, i.e., assuming that commas or spaces separate the data fields. The contents of the ozone data file must include the year (2-digits), month, day, hour and ozone value in that order (unless specified differently through the Format parameter). 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).

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 a background ozone value has been

specified using the OZONEVAL keyword, then that value will be used to substitute for missing ozone data from the ozone file. If no OZONEVAL keyword is used, then the model will assume full conversion for hours with missing ozone data.

2.5.2 Specifying the Ambient Equilibrium NO2/NOx Ratio for PVMRM and OLM

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. A NO_2/NO_x equilibrium ratio other than 0.90 can be specified for either the PVMRM or OLM 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.

2.5.3 Specifying the Default In-stack NO2/NOx Ratio for PVMRM and OLM

The PVMRM and OLM 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, regarding the 1-hour NO_2NAAQS, 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 option.

The in-stack NO_2/NO_x ratio can be specified for the PVMRM or OLM options by using either the CO NO2STACK card to specify a default value to be used for all sources, or by using the SO NO2RATIO card to specify a value on a source-by-source basis. The SO NO2RATIO

card can also be used to override the default value if the CO NO2STACK card 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 card (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 and PVMRM 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 cards (described in Section 2.4.4), or both.

2.5.4 Specifying In-stack NO2/NOx Ratios by Source for PVMRM and OLM

As noted above, the PVMRM and OLM 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 option requires the user to specify an in-stack NO_2/NO_x ratio for each source, using either the CO NO2STACK (described in Section 2.4.3) or SO NO2RATIO cards, or both.

2.5.5 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. Sources which are not specified for modeling as combined plumes will be modeled as individual plumes. 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
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

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 card, and if more than one input card is needed to define the sources for a particular OLM group, then additional cards 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 an OLM group unless the same group of sources is also identified on a SRCGROUP card. Another constraint is that a source cannot be included in more than one OLM group.

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 model, 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.

2.5.6 Modeling NO2 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 draft PSDCREDIT option allows modeling PSD increment credits for NO_2 when the PVMRM option is specified. The PSDCREDIT option is currently implemented as a BETA-test option, and requires that the PVMRM and BETA options be specified. The PSDCREDIT option utilizes a new PSDGROUP keyword, described below, to identify which sources consume or expand increment. This option is not valid if the OLM option is specified, and no comparable option is available for modeling increment credits with the OLM option. 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 BETA-test PSDCREDIT option for PVMRM.

2.5.6.1 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 standards exist for three pollutants: SO_2 (3-hr, 24-hr, and annual averages), NO_2 (annual average), and PM-10 (24-hr and annual average). 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.

2.5.6.2 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

$$[(\mathbf{A}+\mathbf{B}) - (\mathbf{B})] - [(\mathbf{B}+\mathbf{C}) - (\mathbf{B})] \quad (1)$$

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:

$$[(\mathbf{A}+\mathbf{B})] - [(\mathbf{B}+\mathbf{C})] \quad (2)$$

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. In order 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.

2.5.6.3 Specifying Source Groups under the PSDCREDIT Option

The PSDCREDIT option introduces limitations on grouping sources in order 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 under 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 use with the SRCGROUP keyword cannot be used with the PSDGROUP keyword. As with the SRCGROUP keyword for non-PSDCREDIT applications,

the group ID's 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 3.3.3 of the AERMOD User's Guide (EPA, 2004a), 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.

2.5.6.4 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 2.4.6.2. The

results reported under the 'PSDINC' source group label are based on the expression presented above in Equation 2.

2.6 VARIABLE EMISSION RATES

2.6.1 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 3.3.3 of the AERMOD User's Guide).

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.). The wind speed categories used with the WSPEED option may be defined using the ME WINDCATS keyword. 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:

```
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
```

2.6.2 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. AERMOD currently allows for a single hourly emission file to be used with each 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 3.3.3 of the AERMOD User’s Guide (EPA, 2004a), are input as two source IDs separated by a dash, e.g., STACK1-STACK10. The user may include more than one HOUREMIS card in a runstream file, if needed to specify additional sources, but there can be only one hourly emissions file, and therefore the filename must be the same on all HOUREMIS cards.

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 sources, the stack gas exit temperature (K), and stack gas exit velocity (m/s) are also specified. Beginning with version 09292, the release heights and initial dispersion coefficients can also be varied on an hourly basis for AREA, AREAPOLY, AREACIRC, and VOLUME sources using the HOUREMIS option. 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.

The hourly emissions file is processed using the same routines used to process the runstream input 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, and also for a source ID mismatch. 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 of the AERMOD User's Guide) 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 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.

2.7 OUTPUT OPTIONS

A number of enhancements have been incorporated in AERMOD, beginning with version 11059, to more fully support the form of the new 1-hour NO2 and SO2 standards, as well as the 24-hour PM2.5 standard. The form of these NAAQS are similar in that they are based on a ranked percentile value averaged over the number of years processed. In order to support 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 also restricted the rank for the 24-hour PM2.5 NAAQS to the 8th highest value (corresponding to the 98th percentile of daily values during a year).

2.7.1 Output Options for 1-hour NO2 and SO2 Standards

Three new output options have been incorporated on the OU pathway to support these standards, especially the analyses that may be required to determine a source's contributions (or group of sources) 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 NO2 and SO2 standards which are based on ranked values from the distribution of maximum daily 1-hour averages.

The new MAXDCONT option, applicable to 24-hour PM2.5, 1-hour NO2 and 1-hour SO2 standards, can be used to determine the contribution of each user-defined source group to the high ranked values for a target 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 NO2 (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. 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. Since the MAXDCONT option extracts

meteorological variables stored in memory to optimize runtime, the MAXDCONT option cannot be used with the model "re-start" option using the INITFILE and SAVEFILE keywords on the CO pathway.

The MAXDAILY option, applicable to 1-hour NO2 and 1-hour SO2 NAAQS, generates a file of maximum daily 1-hour concentrations for a specified source group, for each day in the data period processed. 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 maximum daily 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.

Another option introduced with version 11059, the MXDYBYYR keyword, generates a summary of maximum daily 1-hour concentrations by year for each rank specified on the RECTABLE keyword. The syntax, type and order of the optional MAXDAILY keyword are summarized below:

Syntax:	OU MXDYBYYR GrpID FileName (FileUnit)
Type:	Optional, Non-repeatable

where GrpID is the source group selected for maximum daily 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.

2.7.2 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. The format specified on this optional keyword is applicable to PLOTFILEs, plot-formatted POSTFILEs, MAXIFILEs, RANKFILEs, and SEASONHR files, but will not affect the format of results in the standard 'aermod.out' file or the optional SUMMFILE. The FILEFORM optional may be useful to preserve precision in applications with relatively small impacts, especially for the purpose of post-processing hourly concentrations using the POSTFILE option. 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.

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 includes 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.

2.8 MODEL STORAGE LIMITS

The AERMOD model has been designed using a dynamic storage allocation approach, where the model allocates data storage as needed based on the number of sources, receptors, source groups, and input requirements, up to the maximum amount of memory available on the computer being used. The AERMOD model uses dynamic arrays to allocate data storage at model runtime rather than at compile time. The AERMOD model preprocesses the model runstream input file to determine the data storage requirements for a particular model run, and

then allocates the input data arrays before processing the setup data. Once the setup processing is completed, the model allocates storage for the result arrays. When allocating data storage, the AERMOD model traps for errors, e.g., not enough memory available to allocate. If the allocation is unsuccessful, then an error message is generated by the model and further processing is prevented. If the CO RUNORNOT NOT option is selected, the model will still go through all array allocations so that the user can determine if sufficient memory is available to complete the run. Also, a rough estimate of the total amount of memory needed for a particular run is printed out as part of the first page of printed output.

The storage parameters that are established at model runtime are as follows:

NSRC =	Number of Sources
NREC =	Number of Receptors
NGRP =	Number of Source Groups
NOLM =	Number of OLM Groups (OLMGROUP Keyword)
NAVE =	Number of Short Term Averaging Periods
NVAL =	Number of High Values by Receptor (RECTABLE Keyword)
NTYP =	Number of Output Types (CONC currently is the only output type)
NMAX =	Number of Overall Maximum Values (MAXTABLE Keyword)
NQF =	Number of Variable Emission Rate Factors per Source
NPDMAX =	Number of Particle Diameter Categories per Source
NVMAX =	Number of Vertices for Area Sources (including AREA, AREACIRC, and AREAPOLY source types) and/or OPENPIT Sources
NSEC =	Number of Sectors for Building Downwash Parameters (set to 36 if downwash sources are included)
NURB =	Number of Urban Areas (URBANOPT Keyword)
NNET =	Number of Cartesian and/or Polar Receptor Networks
IXM =	Number of X-coord (Distance) Values per Receptor Network
IYM =	Number of Y-coord (Direction) Values per Receptor Network
NARC =	Number of Receptor Arcs Used with EVALCART Keyword
NEVE =	Number of Events for EVENT processing

3.0 REFERENCES

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Note: All references listed here, with the exception of Hanrahan (1999a and 1999b) and EPA (2008), can be found on the U.S. EPA SCRAM website at the following url:
http://www.epa.gov/scram001/

APPENDIX A. ALPHABETICAL KEYWORD REFERENCE

This appendix provides an alphabetical listing of all of the keywords used by the AERMOD model. Each keyword is identified as to the pathway for which it applies, the keyword type (either mandatory or optional, and either repeatable or non-repeatable), and with a brief description of the function of the keyword. For a more complete description of the keywords, including a list of associated parameters, refer to Section 2.0 of this Addendum, the Functional Keyword/Parameter Reference in Appendix B of this Addendum, and/or the Detailed Keyword Reference in Section 3 of the AERMOD User's Guide (EPA, 2004a).

Keyword	Path	Type	Keyword Description
AREAVERT	SO	M – R	Specifies location of vertices for an AREAPOLY source type (mandatory if AREAPOLY source is used)
AVERTIME	CO	M – N	Averaging time(s) to process
BACKGRND	SO	O – R	Option to specify temporally varying background concentrations
BACKUNIT	SO	O – N	Option to specify units for background concentrations
BUILDHGT	SO	O – R	Building height values for each wind sector
BUILDLEN	SO	O – R	Building projected length values for each wind sector
BUILDWID	SO	O – R	Building projected width values for each wind sector
CONCUNIT	CO	O – N	Optional conversion factors for emission input units and concentration output units
DAYRANGE	ME	O – R	Specifies days or ranges of days to process (default is to process all data)
DAYTABLE	OU	O – N	Option to provide summaries for each averaging period for each day processed.
DCAYCOEF	CO	O – N	Optional decay coefficient for exponential decay
DEBUGOPT	CO	O – N	Option to generate detailed result and meteorology files for debugging purposes
DEPOUNIT	SO	O – N	Optional conversion factors for emission input units and deposition output units
DISCCART	RE	O – R	Defines discretely placed receptors referenced to a Cartesian system
DISCPOLR	RE	O – R	Defines discretely placed receptors referenced to a polar system
ELEVUNIT	SO RE	O – N O – N	Defines input units for receptor elevations (RE path), or source elevations (SO path) (defaults to meters)
EMISFACT	SO	O – R	Optional input for variable emission rate factors
EMISUNIT	SO	O – N	Optional conversion factors for emission units and concentration units
ERRORFIL	CO	O – N	Option to generate detailed error listing file (error file is mandatory for CO RUNORNOT NOT case)
EVALCART	RE	O – R	Defines discretely placed receptor locations referenced to a Cartesian system, grouped by arc for use with the EVALFILE output option
EVALFILE	OU	O – R	Option to output file of normalized arc maxima for model evaluation studies
EVENTFIL	CO	O – N	Specifies whether to generate an input file for EVENT model
EVENTLOC	EV	M – R	Describes receptor location for an event
EVENTOUT	OU	M – N	Specifies level of output information provided by the EVENT model

Keyword	Path	Type	Keyword Description
EVENTPER	EV	M – R	Describes data and averaging period for an event
FILEFORM	OU	O – N	Specify fixed or exponential format for output results files
FINISHED	ALL	M – N	Identifies the end of inputs for a particular pathway
FLAGPOLE	CO	O – N	Specifies whether to accept receptor heights above local terrain (m) for use with flagpole receptors, and allows for a default flagpole height to be specified
GASDEPDF	CO	O – N	Option to override default parameters for gas dry deposition
GASDEPOS	SO	O – R	Specify source parameters for gas deposition algorithms
GASDEPVD	CO	O – N	Option to specify deposition velocity for gas dry deposition
GDLANUSE	CO	O – N	Specify land use categories by sector for gas dry deposition
GDSEASON	CO	O – N	Specify seasonal definitions for gas dry deposition
GRIDCART	RE	O – R	Defines a Cartesian grid receptor network
GRIDPOLR	RE	O – R	Defines a polar receptor network
HALFLIFE	CO	O – N	Optional half-life for exponential decay
HOUREMIS	SO	O – R	Option for specifying hourly emission rates in a separate file
INCLUDED	SO, RE, EV	O – R	Option to include input data from a separate file in the runstream for the SO and/or RE pathways, or for the EV pathway for EVENTs
INITFILE	CO	O – N	Option to initialize model from file of intermediate results generated by SAVEFILE option
LOCATION	SO	M – R	Identifies coordinates for particular source location
MASSFRAX	SO	O – R	Optional input of mass fraction for each particle size category
MAXDAILY	OU	O – R	Option to output file of maximum daily 1-hour values for each day processed; only applicable for 1-hour NO2 and 1-hour SO2 NAAQS
MAXDCONT	OU	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 PM2.5, 1-hour NO2, and 1-hour SO2 NAAQS
MAXIFILE	OU	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)
MAXTABLE	OU	O – R	Option to summarize the overall maximum values
METHOD_2	SO	O – R	Specify optional source parameters for METHOD_2 option for particle deposition
MODELOPT	CO	M – N	Job control and dispersion options
MULTYEAR	CO	O – N	Specifies that run is part of a multi-year run, e.g., for PM-10 H6H in five years

Keyword	Path	Type	Keyword Description
MXDYBYYR	OU	O – R	Option to output file of maximum daily 1-hour values by year, for each year processed; only applicable for 1-hour NO2 and 1-hour SO2 NAAQS
NOHEADER	OU	O – N	Option to suppress file headers for output file options, e.g., POSTFILE, PLOTFILE, MAXDCONT, etc
NO2EQUIL	CO	O – N	Option to override default NO2/NOx equilibrium ratio for PVMRM
NO2RATIO	SO	O – R	Option to specify in-stack NO2/NOx equilibrium ratio for OLM and PVMRM options by source
NO2STACK	CO	O – N	Option to specify default in-stack NO2/NOx equilibrium ratio for OLM and PVMRM options; may be overridden by NO2RATIO
OLMGROUP	SO	O – R	Specifies sources to combine for OLM option for merging plumes
OZONEFIL	CO	O – N	Specifies hourly ozone file for OLM and PVMRM options
OZONEVAL	CO	O – N	Specifies background value of ozone for OLM and PVMRM options
O3VALUES	CO	O – R	Option to specify temporally varying ozone concentrations for use with OLM and PVMRM options for estimating NO2
PARTDENS	SO	O – R	Specifies particle density by size category for particle deposition
PARTDIAM	SO	O – R	Specifies particle diameters by size category for particle deposition
PLOTFILE	OU	O – R	Option to write certain results to a storage file suitable for input to plotting routines
POLLUTID	CO	M – N	Identifies pollutant being modeled
POSTFILE	OU	O – R	Option to write results to a mass storage file for postprocessing
PROFBASE	ME	M – N	Specifies the base elevation for the potential temperature profile
PROFFILE	ME	M – N	Describes input profile meteorological data file
PSDGROUP	SO	O – R	Specifies source groups for PSDCREDIT option with PVMRM
RANKFILE	OU	O – R	Option to produce output file of ranked values for Q-Q plots
RECTABLE	OU	O – R	Option to output high ranked value(s) by receptor
RUNORNOT	CO	M – N	Identifies whether to run model or process setup information only
SAVEFILE	CO	O – N	Option to store intermediate results for later restart of the model after user or system interrupt
SCIMBYHR	ME	O – N	Specifies sampling parameters for the SCIM option
SEASONHR	OU	O – R	Option to output values by season and hour-of-day
SITEDATA	ME	O – N	Describes on-site meteorological station
SRCGROUP	SO	M – R	Identification of source groups
SRCPARAM	SO	M – R	Identifies source parameters for a particular source

Keyword	Path	Type	Keyword Description
STARTEND	ME	O – N	Specifies start and end dates to be read from input meteorological data file (default is to read entire file)
STARTING	ALL	M – N	Identifies the start of inputs for a particular pathway
SUMMFILE	OU	O – N	Option to output summary of high ranked values to separate file
SURFDATA	ME	M – N	Surface meteorological station
SURFFILE	ME	M – N	Describes input surface meteorological data file
TITLEONE	CO	M – N	First line of title for output
TITLETWO	CO	O – N	Optional second line of output title
TOXXFILE	OU	O – R	Creates output file for use with TOXX model component of TOXST
UAIRDATA	ME	M – N	Upper air meteorological station
URBANOPT	CO	O – R	Option to specify population for urban option
URBANSRC	SO	O – R	Option to specify use of urban option by source
WDROTATE	ME	O – N	Wind direction rotation adjustment
WINDCATS	ME	O – N	Upper bound of wind speed categories
XBADJ	SO	O – R	Along-flow distances from the stack to the center of the upwind face of the projected building
YBADJ	SO	O – R	Across-flow distances from the stack to the center of the upwind face of the projected building

APPENDIX B. FUNCTIONAL KEYWORD/PARAMETER REFERENCE

This appendix provides a functional reference for the keywords and parameters used by the input runstream files for the AERMOD model. The keywords are organized by functional pathway, and within each pathway the order of the keywords is based on the function of the keyword within the preprocessor. The pathways used by the preprocessor are as follows, in the order in which they appear in the runstream file and in the tables that follow:

CO - for specifying overall job **CO**ntrol options; and
SO - for specifying **SO**urce location information (optional);
RE - for specifying **RE**ceptor information; and
ME - for specifying **ME**teorology information and options;
EV - for specifying **EV**ent information and options;
OU - for specifying **OU**tput file information.

The pathways and keywords are presented in the same order as in the Detailed Keyword Reference in Section 3 of the AERMOD User's Guide (EPA, 2004a), and in the Quick Reference at the end of the manual, with the exception of new keywords that are not reflected in the original user's guide.

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 presents the parameters for each keyword, in the order in which they should appear in the runstream 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 AERMAP 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

preprocessor 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 B-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
NO2EQUIL	O – N	Option to override default NO2/NOx equilibrium ratio for PVMRM
NO2STACK	O – N	Option to specify default in-stack NO2/NOx equilibrium ratio for OLM and PVMRM options; may be overridden by NO2RATIO option on SO pathway
OZONEFIL	O – N	Specifies filename for hourly ozone file for use with OLM and PVMRM options
OZONEVAL	O – N	Specifies background value of ozone for use with OLM and PVMRM options
O3VALUES	O – R	Option to specify temporally varying ozone concentrations for use with OLM and PVMRM options for estimating NO2
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
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 N – Non-Repeatable
O – Optional 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 or not 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 runstream 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 B-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
TITLETWO	Title2	
where:	Title2	Optional second line of title for output, character string of up to 68 characters
MODELOPT	DFAULT BETA CONC DEPOS DDEP and/or WDEP AREADPLT FLAT and/or ELEV NOSTD NOCHKD or WARNCHKD NOWARN SCREEN SCIM PVMRM or OLM PSDCREDIT FASTALL or FASTAREA DRYDPLT or NODRYDPLT WETDPLT or NOWETDPLT URBTRANS	
where:	DFAULT	Specifies that regulatory default options will be used; specification of DFAULT option will override non-DFAULT options that may be specified
	BETA	Non-DFAULT option that allows for draft, "Beta" test options to be used; includes PSDCREDIT option and capped and horizontal stack releases
	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
	AREADPLT	Specifies use of non-DFAULT method for optimized plume depletion due to dry removal mechanisms for area sources
	FLAT	Non-DFAULT option of assuming flat terrain will be used
	ELEV	Default option of assuming elevated terrain will be used; Note: Both FLAT and ELEV may be specified in the same model run to allow specifying the non-DFAULT FLAT terrain option on a source-by-source basis (see the SO LOCATION keyword for specifying FLAT sources)
	NOSTD	Non-DFAULT option of no stack-tip downwash will be used
	NOCHKD	Non-DFAULT option of suspending date checking will be used for non-sequential meteorological data files, also implemented when SCREEN option is specified
	WARNCHKD	Specifies option for issuing warning messages rather than fatal errors for non-sequential meteorological data files
	NOWARN	Option to suppress detailed listing of warning messages in the main output file will be used

Keyword	Parameters	
	SCREEN	Non-DFAULT option for running AERMOD in a screening mode for AERSCREEN will be used
	SCIM	Non-DFAULT Sampled Chronological Input Model (SCIM) option; applies to ANNUAL averages only; SCIM sampling parameters must be specified on the ME pathway
	PVMRM	Non-DFAULT Plume Volume Molar Ratio Method (PVMRM) for NO_2 conversion will be used
	OLM	Non-DFAULT Ozone Limiting Method (OLM) for NO_2 conversion will be used
	PSDCREDIT	Non-DFAULT BETA test option to calculate the increment consumption with PSD credits using the PVMRM option
	FASTALL	Non-DFAULT option to optimize model runtime for POINT, VOLUME and AREA sources (AREA optimizations formerly associated with TOXICS option)
	FASTAREA	Non-DFAULT option to optimize model runtime for AREA sources (formerly associated with TOXICS option)
	DRYDPLT	Option to incorporate dry depletion (removal) processes associated with dry deposition algorithms; dry depletion will be used by default if dry deposition algorithms are invoked
	NODRYDPLT	Option to disable dry depletion (removal) processes
	WETDPLT	Option to incorporate wet depletion (removal) processes associated with wet deposition algorithms; wet depletion will be used by default if wet deposition algorithms are invoked
	NOWETDPLT	Option to disable wet depletion (removal) processes.
	NOURBTRAN	Non-DFAULT option to revert to the urban option as implemented prior to version 11059 (see Section 2.1.1).
AVERTIME	Time1 Time2 . . . TimeN MONTH PERIOD or ANNUAL	
where:	TimeN	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 areas: Urbpop (Urbname) (UrbRoughness)	
where:	UrbanID	Specifies the alphanumeric urban ID (up to eight characters)

Keyword	Parameters	
	UrbPop (UrbName) (UrbRoughness)	Specifies the population of the urban area Specifies the name of the urban area (optional) Specifies the urban surface roughness length, meters (optional, defaults to 1.0m; value other than 1.0m treated as non-DFAULT)
POLLUTID	Pollut	
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 2.1.5.1). Use of NO2 or SO2 triggers special processing for their respective 1-hr NAAQS based on maximum daily 1-hour concentrations, averaged across the number of years processed, if the CO AVERTIME keyword includes 1-hour averages. Use of NO2 is required in order to use the OLM and PVMRM options for simulating conversion of NO to NO2. Use of SO2 also triggers the use of a 4-hour half-life for SO2 decay for urban applications under the regulatory default option.
HALFLIFE	Haflif	
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)	
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	
where:	Uservd	User-specified dry deposition velocity (m/s) for gaseous pollutants
GDLANUSE	Sec1 Sec2 ... Sec36	

Keyword	Parameters	
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	
where:	Jan . . . . Dec	Seasonal category for January: 1 = Midsummer/Lush vegetation; 2 = Autumn/Unharvested cropland; 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
NO2EQUIL	NO2Equil	
where:	NO2Equil	Equilibrium ratio for PVMRM and OLM options (default is 0.9)
NO2STACK	NO2Ratio	
where:	NO2Ratio	Default in-stack ratio of NO2/NOx for PVMRM and OLM options, which may be overridden by 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.
OZONEFIL	O3FileName (O3Units) (Format)	
where:	O3FileName (O3Units) (Format)	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 Value).
OZONEVAL	O3Value (O3Units)	
where:	O3Value (O3Units)	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	
where:	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);

Keyword	Parameters	
		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.
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
RUNORNOT	RUN or NOT	
where:	RUN NOT	Indicates to run full model calculations Indicates to process setup data and report errors, but to 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

Keyword	Parameters	
		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 PVMRM (Dbpvfil) and/or DEPOS	
where:	MODEL (Dbgfil) METEOR (Dbmfil) PVMRM (Dbpvfil) DEPOS	Specifies that MODEL debugging output will be generated Optional filename for the model calculation debug file (a default filename of 'MODEL.DBG' will be used if omitted) Specifies that METEORological profile data file will be generated Optional filename for the meteorological profile data file (a default filename of 'METEOR.DBG' will be used if omitted) Specifies that PVMRM debugging output will be generated Optional filename for PVMRM debug file (a default filename of 'PVMRM.DBG' will be used if omitted) Specifies that DEPOSition debugging output will be generated, using default filenames of 'GDEP.DAT' for gas deposition and 'PDEP.DAT' for particle deposition. 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 some debugging information is written to the main 'aermod.out' file for the MODEL and DEPOS debug options.
ERRORFIL	(Errfil)	
where:	(Errfil)	Specifies name of detailed error listing file (default = ERRORS.LST)

TABLE B-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
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)
URBANSRC	O – R	Identifies which sources to model with urban effects
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
GASDEPOS	O – R	Optional input of gas deposition parameters
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
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

SO Keywords	Type	Keyword Description
OLMGROUP	O – R	Specifies sources to combine for OLM option to account for merging plumes
PSDGROUP[1]	O – R	Specifies source groups for PSDCREDIT option with PVMRM
SRCGROUP[1]	M – R	Identification of source groups
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.

TABLE B-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) 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
	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)
	(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 for identifying sources to model as FLAT terrain
SRCPARAM	SrcID Ptemis Stkhgt Stktmp Stkvel Stkdia (POINT, POINTCAP, POINTHOR source) 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) Opemis Relhgt Xinit Yinit Pitvol (Angle) (OPENPIT source)	
where:	SrcID	Source identification code
	__Emis	Source emission rate: in g/s for Ptemis and Vlemis; g/(s-m^2) for Aremis and Opemis
	___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 or AREA 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)

Keyword	Parameters	
	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)
	Pitvol	Volume of OPENPIT source (m^3)
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
	SrcRange	Range of sources (inclusive) for which building dimensions apply
	Dsbl	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	Source identification code
	SrcRange	Range of sources (inclusive) for which building dimensions apply
	Dsbw	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	Source identification code
	SrcRange	Range of sources (inclusive) for which XBADJ distances apply
	Xbadj(i)	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	Source identification code
	SrcRange	Range of sources (inclusive) for which YBADJ distances apply
	Ybadj(i)	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	Source identification code
	Xv(1)	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)
	Yv(1)	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)

Keyword	Parameters	
	Xv(i) Yv(i)	X-coordinate for the i^{th} vertex of an AREAPOLY source Y-coordinate for the i^{th} vertex of an AREAPOLY source
URBANSRC	For multiple urban areas: UrbanID SrcID's and/or SrcRng's For single urban areas: SrcID's and/or SrcRng's	
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)
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 Emilbl Deplbl	Emission rate factor used to adjust units of output for deposition (default value is 3600 for grams/sec to grams/m^2/hr) Label to use for emission units (default is grams/sec) Label to use for deposition (default is grams/m^2)
PARTDIAM	SrcID (or SrcRange) Pdiam(i), i=1,Npd	
where:	SrcID SrcRange Pdiam	Source identification code Range of sources (inclusive) for which size categories apply Array of particle diameters (microns)
MASSFRAX	SrcID (or SrcRange) Phi(i), i=1,Npd	
where:	SrcID SrcRange Phi	Source identification code Range of sources (inclusive) for which mass fractions apply Array of mass fractions for each particle size category
PARTDENS	SrcID (or SrcRange) Pdens(i), i=1,Npd	
where:	SrcID SrcRange Pdens	Source identification code Range of sources (inclusive) for which particle densities apply Array of particle densities (g/cm^3) for each size category
METHOD_2	SrcID (or SrcRange) FineMassFraction Dmm	
where:	SrcID FineMassFractio n Dmm	Source identification code Fraction (between 0 and 1) of particle mass emitted in fine mode, less than 2.5 microns Representative mass mean particle diameter in microns
GASDEPOS	SrcID (or SrcRange) Da Dw rcl Henry	
where:	SrcID Da Dw rcl Henry	Source identification code Diffusivity in air for the pollutant being modeled (cm^2/s) Diffusivity in water for the pollutant being modeled (cm^2/s) Cuticular resistance to uptake by lipids for individual leaves (s/cm) Henry's Law constant (Pa m^3/mol)
NO2RATIO	SrcID (or SrcRange) NO2Ratio	
where:	SrcID SrcRange NO2Ratio	Source identification code Source ID range for specified ratio In-stack ratio of NO2/NOx
HOUREMIS	Emifil SrcID's SrcRange's	
where:	Emifil SrcID's SrcRange's	Specifies name of the hourly emission rate file Discrete source IDs that are included in the hourly emission file Source ID ranges that are included in the hourly emission file
BACKGRND	BGflag BGvalue(i), i=1,n or	

Keyword	Parameters	
	HOURLY BGfilnam (BGformat)	
where:	BGflag	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)
	BGvalue	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
	HOURLY	Flag indicating that hourly background concentrations are specified in a separate data file; data period must match the meteorological data period being processed, and no missing values are allowed
	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 Value). NOTE: Background concentrations specified on the BACKGRND keyword are currently assumed to be in units of PPB for NO2 and SO2, PPM for CO, and UG/M3 for all other pollutants, unless otherwise specified on the BACKUNIT keyword. Background concentrations can be included with any source group, including group 'ALL', by including a "SrcID" of 'BACKGROUND' on the SRCGROUP 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.
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

Keyword	Parameters	
OLMGROUP	OLMGrpID SrcID's SrcRange's	
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
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
SRCGROUP	SrcGrpID SrcID's SrcRange's	
where:	SrcGrpID SrcID's SrcRange's	Group ID (Grpid = ALL specifies group including all sources) Discrete source IDs to be included in group; a "SrcID" of 'BACKGROUND' can be used to include background concentrations, based on the BACKGRND keyword Source ID ranges to be included in group Note: Card may be repeated with same Grpid if more space is needed to specify sources

TABLE B-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 B-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 Zflag END	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 An array of receptor heights above local terrain elevation for a particular Row (flagpole receptors) Indicates END of GRIDCART subpathway, repeat for each new Netid

Keyword	Parameters	
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
	Dir	Indicates which direction 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)

Keyword	Parameters	
	(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 (optional), used only for ELEV terrain
	Zhill	Hill height scale (m)
	Zflag	Receptor height (flagpole) above local terrain (optional), 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 B-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)
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 B-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) Endyr	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) Year of last record to be read

Keyword	Parameters	
	Endmn Enddy (Endhr)	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 ... RangeN	
where:	Range1 RangeN	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
SCIMBYHR	NRegStart NRegInt (SfcFilnam PflFilnam)	
where:	NRegStart NRegInt (SfcFilnam) (PflFilnam)	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 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 B-9

DESCRIPTION OF EVENT PATHWAY 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 B-10

DESCRIPTION OF EVENT PATHWAY KEYWORDS AND PARAMETERS

Keyword	**Parameters**	
EVENTPER	Evname Aveper Grpid Date	
where:	Name Grpid Aveper Date	Specify name of event to be processed (e.g. H2H24ALL), (up to eight alphanumeric characters) Specify source group ID for event Specify averaging period for event Specify data period for event (ending YYMMDDHH for averaging period)
EVENTLOC	Evname XR= Xr YR= Yr (Zelev Zhill) (Zflag) or RNG= Rng DIR= Dir (Zelev Zhill) (Zflag)	
where:	Evname XR= YR= RNG= DIR= (Zelev) (Zhill) (Zflag)	Specify name of event to be processed (e.g. H2H24ALL), (up to eight alphanumeric characters) X-coordinate for event (discrete Cartesian receptor) Y-coordinate for event (discrete Cartesian receptor) Distance range for event (discrete polar receptor) Radial direction for event (discrete polar receptor) Terrain elevation for event (optional) Hill height scale (optional) 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 B-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 maximum daily 1-hour values for each day processed; only applicable for 1-hour NO2 and 1-hour SO2 NAAQS
MXDYBYYR	O – R	Option to output file of maximum daily 1-hour values by year, for each year processed; only applicable for 1-hour NO2 and 1-hour SO2 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 PM2.5, 1-hour NO2, and 1-hour SO2 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 B-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
EVALFILE	SrcID Filnam (Funit)	
where:	SrcID	Specifies the source ID to be output to file

Keyword	Parameters	
	Filnam Funit	Specifies filename for output file Optional parameter to specify the file unit
SEASONHR	GrpID FileName (FileUnit)	
	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)	
	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)	
	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)	
	GrpID UpperRank LowerRank THRESH ThreshValue FileName (FileUnit)	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. Specifies filename for output file Optional parameter to specify file unit
SUMMFILE	SummFileName	
	SummFileName	Specifies filename of output summary file
FILEFORM	EXP or FIX	

Keyword	Parameters	
	EXP	Specifies that the output results files will use EXPonential-formatted values
	FIX	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	
	FileType*N*	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
	ALL	Specifies that header records will be suppressed for ALL applicable output file types
EVENTOUT	SOCONT or DETAIL	[EVENT Only]
where:	SOCONT	Provide source contribution information only in the event output
	DETAIL	Include hourly concentrations for each source and hourly meteorological data in the event output

APPENDIX C. LIST OF ERROR/WARNING MESSAGES

This appendix provides a list of error, warning and informational messages used in the current version of the AERMOD model. Three types of messages can be produced by the model during processing of model inputs and during model calculations. These are described below:

- **Fatal 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).

A more detailed explanation of the error handling and reporting procedures used in AERMOD is provided in Appendix C of the AERMOD User's Guide (EPA, 2004a). The three message types are identified with the letters E (errors), W (warnings), and I (informational messages). The 3-digit message numbers are generally grouped into categories corresponding to the different stages of the processing, although these distinctions may not always be obvious. Theses categories are:

100 - 199	Input Runstream Image Structure Processing
200 - 299	Parameter Setup Processing
300 - 399	Data and Quality Assurance Processing
400 - 499	Run Time Message Processing
500 - 599	Input/Output Message Processing

The list provided below includes the message number, the main message text, and the "hint" field that may include additional details regarding the message. Note that the listing of messages in the AERMOD User's Guide (EPA, 2004a) is not up-to-date. Several additional messages have been added to AERMOD since that time, and the numbering of some messages may have changed.

Message Number	Error/Warning Message	Hint
100	Invalid Pathway Specified. The Troubled Pathway is	Path
105	Invalid Keyword Specified. The Troubled Keyword is	Keyword
110	Keyword is Not Valid for This Pathway. Keyword is	Path
115	STARTING or FINISHED Out of Sequence: Pathway =	Path
120	Pathway is Out of Sequence: Pathway =	Path
125	Missing FINISHED-Runstream File Incomplete: ISTAT=	
130	Missing Mandatory Keyword. The Missing Keyword is	Keyword
135	Nonrepeatable Keyword or Recursed INCLUDED: Keywrd	Keyword
140	Invalid Order of Keyword. The Troubled Keyword is	Keyword
141	Conflicting Options: PVMRM and OLM both specified	
142	Following Keyword Invalid Without PVMRM or OLM:	Keyword
143	Following Keyword Invalid Without PVMRM Option:	Keyword
144	Following Keyword Invalid Without OLM Option:	Keyword
145	Conflicting Options: MULTYEAR and Re-Start Option	Keyword
146	PSDGROUP Keyword Specified without PSDCREDIT Opt.	Keyword
147	Following Option is Invalid with PSDCREDIT Option:	Option
149	Conflicting options specified on MODELOPT keyword:	Option
150	Conflicting Options: MULTYEAR for Wrong Pollutant	Keyword
152	ELEVUNIT card must be first for this Pathway:	Path
154	Conflicting options: SCIM cannot be used with	ST AVEs
155	Conflicting Decay Keyword. Inputs Ignored for	Keyword
156	Option ignored - not valid with SCIM. Option =	DEPOS
157	Wet SCIM Not Supported - Wet SCIM Inputs Ignored	Keyword
158	EMISUNIT Keyword Used With More Than 1 Output Type	
159	EMISUNIT Keyword Used With the Following Keyword:	Keyword
160	Duplicate ORIG Secondary Keyword for GRIDPOLR:	NETID
170	Invalid Secondary Keyword for Receptor Grid:	NETID
175	Missing Secondary Keyword END for Receptor Grid:	NETID
180	Conflicting Secondary Keyword for Receptor Grid:	NETID
185	Missing Receptor Keywords. No Receptors Specified.	
189	No Keywords for OU Path and No PERIOD/ANNUAL Aves.	
190	Incompatible Option Used With SAVEFILE or INITFILE	Keyword
191	PM-2.5 without MAXIFILE is incompatible with	EVENTFIL
192	FASTALL option also implies use of FASTAREA option	

Message Number	Error/Warning Message	Hint
195	Incompatible Keyword used with GASDEPVD option	Keyword
196	Gas deposition algorithms are non-DFAULT options	Keyword
197	METHOD_2 for particulates is a non-DFAULT option	
198	TOXICS Option obsolete; see Users Guide Addendum	
199	Non-DFAULT BETA Option Required for	Option
200	Missing Parameter(s). No Options Specified For	Keyword
201	Not Enough Parameters Specified For the Keyword of	Keyword
202	Too Many Parameters Specified For the Keyword of	Keyword
203	Invalid Parameter Specified. Troubled Parameter:	Parameter
204	Regulatory DFAULT Conflicts with Non-DFAULT Option	Option
205	No Option Parameter Setting. Forced by Default to	
206	Regulatory DFAULT Overrides Non-DFAULT Option For	Option
207	No Parameters Specified. Default Values Will Used.	Keyword
208	Illegal Numerical Field Encountered in	
209	Negative Value Appears For Non-negative Variable.	Variable
210	Number of Short Term Averages Exceeds Max: NAVE =	
211	Duplicate Averaging Period Specified for Keyword	Keyword
212	END Encountered Without (X,Y) Points Properly Set	NETID
213	ELEV Input Inconsistent With Option: Input Ignored	NETID
214	ELEV Input Inconsistent With Option: Defaults Used	NETID
215	FLAG Input Inconsistent With Option: Input Ignored	NETID
216	FLAG Input Inconsistent With Option: Defaults Used	NETID
217	More Than One Delimiter In A Field for Keyword	Keyword
218	Number of (X,Y) Points Not Match With Number Of	
219	Number Of Receptors Specified Exceeds Max: NREC =	
220	Missing Origin (Use Default = 0,0) In GRIDPOLR	NETID
221	Missing Distance Setting In Polar Network	NETID
222	Missing Degree Or Dist Setting In Polar Network	NETID
223	Missing Distance or Degree Field in	
224	Number of Receptor Networks Exceeds Max: NNET =	
225	Number of X-Coords Specified Exceeds Max: IXM =	
226	Number of Y-Coords Specified Exceeds Max: IYM =	
227	No Receptors Were Defined on the RE Pathway.	
228	Default(s) Used for Missing Parameters on Keyword	Keyword

Message Number	Error/Warning Message	Hint
229	Too Many Parameters - Inputs Ignored on Keyword	Keyword
230	Source ID field is too long (>8); first 8 chars:	SRCID(1:8)
231	Too Many Numerical Values Specified for	EMISFACT
232	Number Of Specified Sources Exceeds Maximum: NSRC=	
233	Building Dimensions Specified for Non-POINT Source	SRCID
234	Too Many Sectors Input for	Keyword
235	Number of Source Groups Exceeds Maximum: NGRP =	
236	Not Enough BUILDHGTs Specified for SourceID	SRCID
237	Not Enough BUILDWIDs Specified for SourceID	SRCID
239	Not Enough QFACTs Specified for SourceID	SRCID
240	Inconsistent Number of Particle Categories for	SRCID
241	Not Enough BUILDLENs Specified for SourceID	SRCID
242	No Particle Cat. or Gas Depos. Specified for SRCID	SRCID
243	Wet depos (DEPOS, WDEP, WETDPLT) incompatible with	GASDEPVD
244	Source parameters are missing or incomplete for	DRYDEP or WETDEP
245	No. of Particle Categories Exceeds Max: NPDMAX =	
246	Not Enough XBADJs Specified for SourceID	SRCID
247	Not Enough YBADJs Specified for SourceID	SRCID
248	No Sources Were Defined on the SO Pathway.	
249	Source elevation is missing (-9999.0); SRCID =	SRCID
250	Duplicate XPNT/DIST or YPNT/DIR Specified for GRID	NETID
252	Duplicate Receptor Network ID Specified. NETID =	NETID
254	Number of Receptor ARCs Exceeds Max: NARC =	
256	EVALFILE Option Used Without EVALCART Receptors	NUMARC=0
259	Receptor elevation is missing (-9999.0); IREC =	Rec Number
260	Number of Emission Factors Exceeds Max: NQF =	
262	First Vertex Does Not Match LOCATION for AREAPOLY	SRCID
264	Too Many Vertices Specified for AREAPOLY Source	SRCID
265	Not Enough Vertices Specified for AREAPOLY Source	SRCID
266	Invalid shape defined (area=0) for AREAPOLY source	SRCID
270	Number of High Values Specified Exceeds Max: NVAL=	
275	Number of Max Values Specified Exceeds Max: NMAX=	
280	Number of Output Types Specified Exceeds Max:NTYP=	

Message Number	Error/Warning Message	Hint
281	Number of OLMGROUPs Specified Exceeds Max: NOLM =	
282	Following SRCID Included in Multiple OLMGROUPs:	SRCID
283	Either OZONEVAL or OZONEFIL Card Needed for Option	OLM or PVMRM
284	Invalid POLLUTID Specified for PVMRM/OLM; Must Use	NO2
285	Number of Urban Areas Exceeds Maximum. NURB =	
286	Following SRCID Included in Multiple PSDGROUPs:	SRCID
287	PSDGROUP ID Must be INCRCONS, RETRBASE or NONRBASE	
288	Use of "*" for repeated values not meaningful for	Keyword
289	Source defined as both particulate and gaseous	SRCID
290	Number of Events Specified Exceeds Max: NEVE =	
291	Filename specified is too long. Maximum length =	ILEN_FLD
292	Format specified is too long. Maximum length =	ILEN_FLD
293	User-specified met data format not used; use FREE	Format
294	PERIOD and ANNUAL averages are both selected for	Keyword
295	Invalid Averaging Period Specified for SCREEN Mode	1hr Only
296	Averaging Period .NE. 1-Hr for TOXXFILE Option	
297	Aver. Period must be .LE. 24 for EVENT Processing	EVNAME
298	Error Allocating Storage for Setup Arrays!	Error Code
299	Error Allocating Storage for Result Arrays!	Error Code
300	Specified SRCID Has Not Been Defined Yet: KEYWORD=	Keyword
301	Urban Area ID Has Not Been Defined. URBID =	Urban ID
302	Following SRCID Included in Multiple Urban Areas:	SRCID
303	Urban ID has already been defined. URBID =	Urban ID
310	Attempt to Define Duplicate LOCATION Card for SRC:	SRCID
313	Attempt to Define Duplicate EVENTPER card for	EVNAME
315	Attempt to Define Duplicate SRCPARAM Card for SRC:	SRCID
317	Specified SRCID not included in any PSD/SRCGROUP:	SRCID
318	No Sources Defined for Urban Area. URBID =	Urban ID
319	No Sources Included in Specified Source Group:	GRPID
320	Input Parameter May Be Out-of-Range for Parameter	Parameter
322	Release Height Exceeds Effective Depth for OPENPIT	SRCID
324	Release Height Exceeds 3000 Meters for SRCID:	SRCID
325	Negative Exit Velocity (Set=1.0E-5) for SRCID:	SRCID
330	Mass Fraction Parameters Do Not Sum to 1. for Src	SRCID

Message Number	Error/Warning Message	Hint
332	Mass Fraction Parameter Out-of-Range for Source	SRCID
334	Particle Density Out-of-Range for Source	SRCID
335	Particle Diameter Out-of-Range for Source	SRCID
336	NO2RATIO Invalid or Not Specified for PVMRM Source	SRCID
338	Neg Emis Rate Cannot be Used with OLM/PVMRM. Src:	SRCID
340	Possible Error in PROFBASE Input: Value is < 0	Keyword
342	Src ID Mismatch in Hourly Emissions File for ID =	SRCID
344	Missing HOUREMIS fields; EmisRate set = 0. KURDAT=	YYMMDDHH
345	Problem processing the HOUREMIS file. KURDAT =	YYMMDDHH
346	Too many fields for HOUREMIS file. KURDAT =	YYMMDDHH
350	Julian Day Out Of Range at	JDAY
352	Missing Field on MULTYEAR Keyword for	H6H
353	Urban Roughness Length (m) May Be Out-of-Range:	URBZ0
354	High-8th-High Only Required for PM-2.5 24-hr Ave	RECTABLE
360	2-Digit Year Specified: Valid for Range 1950-2049	Keyword
363	24HR and ANNUAL Averages Only for PM-2.5 NAAQS	AVERTIME
365	Year Input is Greater Than 2147	Keyword or YR =
370	Invalid Date: 2/29 In a Non-leap Year.	YR =
380	This Input Variable is Out-of-Range:	
381	Latitude in Surface File Is Not Valid:	Lat
382	Error Decoding Latitude:	Lat
384	Not enough fields specified for HOUREMIS; KURDAT =	YYMMDDHH
386	PARTDIAM and METHOD_2 specified for same SRCID:	SRCID
387	METHOD_2 option already specified for this SRCID:	SRCID
391	Aspect ratio (L/W) of area source greater than 100	SRCID
392	Aspect ratio (L/W) of open pit is greater than 10	SRCID
395	Met. Data Error; Incompatible Version of AERMET:	Version Date
397	SCREEN option used without use of SCREEN Met Data	Version Date
398	SCREEN met used without specifying SCREEN option	
399	EXP format specified with no applicable file types	FILEFORM
400	Output values exceed format limit; use OU FILEFORM	= EXP
405	Value of PHEE Exceeds 1.0 on KURDAT =	YYMMDDHH
406	Numer of Vertices Exceeds Maximum (NVMAX) for Src:	SRCID
410	Wind Direction Out-of-Range. KURDAT =	YYMMDDHH

Message Number	Error/Warning Message	Hint
413	Number of Threshold Events > 9999 for Ave Period	
420	Wind Speed Out-of-Range. KURDAT =	YYMMDDHH
430	Ambient Temperature Data Out-of-Range. KURDAT =	YYMMDDHH
432	Friction Velocity Out-of-Range. KURDAT =	YYMMDDHH
435	Surface Roughness Length Out-of-Range. KURDAT =	YYMMDDHH
438	Convective Velocity Data Out-of-Range. KURDAT =	YYMMDDHH
439	Monin-Obukhov Length Out-of-Range. KURDAT =	YYMMDDHH
440	Calm Hour Identified in Meteorology Data File at	YYMMDDHH
441	Vert Pot Temp Grad abv ZI set to min .005, KURDAT=	YYMMDDHH
442	Vert Pot Temp Grad abv ZI exceeds 0.1 K/m, KURDAT=	YYMMDDHH
450	Record Out of Sequence in Meteorological File at:	YYMMDDHH
455	Date/time Mismatch: Hourly Emission File. KURDAT =	YYMMDDHH
456	Date/time Mismatch on Surface & Profile. KURDAT =	YYMMDDHH
457	Date/time Mismatch on OZONEFIL Data. KURDAT =	YYMMDDHH
458	Substitution made for missing ozone data. KURDAT =	YYMMDDHH
459	Missing ozone data; Full conversion used. KURDAT =	YYMMDDHH
460	Missing Hour Identified in Meteor. Data File at	YYMMDDHH
465	Number of Profile Levels Exceeds Max: MXPLVL =	
470	Mixing Height Value is < or = 0.0. KURDAT =	YYMMDDHH
474	WS RefHt invalid (<0.001); Not msg or clm: KURDAT=	YYMMDDHH
475	WS reference height is higher than 100m. KURDAT =	YYMMDDHH
480	Less than 1 year for MULTYEAR or ANNUAL Averages	
481	Data Remaining After End of Year. Number of Hours=	
483	User Start Date is Earlier Than Start of Met File	YYMMDDHH
484	Restart Date < STARTEND date or start of met file	STARTEND or YYMMDDHH
485	MULTYR DataGap; Restart Date < STARTEND or MetFile	STARTEND or YYMMDDHH
486	MULTYR Date Overlap; STARTEND Date < Restart Date	YYMMDDHH
487	MULTYR Date Overlap; Met File Start < Restart Date	YYMMDDHH
488	First met HR.ne.1; ST results may not be valid for	First Day
489	First met HR.ne.1; EV results may not be valid for	MnDyHr
490	Problem reading SURFFILE date for EVENTS; MNDYHR =	MnDyHr
495	Surface met file does not include enough variables	with-DEP or Non-DEP

Message Number	Error/Warning Message	Hint
496	Total precipitation in SURFFILE is zero (0.0) with	WetDepos
499	PRIME plume rise error; check stack parameters for	SRCID
500	Fatal Error Occurs Opening the Data File of	FileName or FileType
510	Fatal Error Occurs During Reading of the File of	FileType
520	Fatal Error Occurs During Writing to the File of	FileType and Unit
530	CAUTION! Met Station ID Mismatch with SURFFILE for	Keyword
540	No RECTABLE/MAXTABLE/DAYTABLE for Average Period	nnn-HR
550	File Unit/Name Conflict for the Output Option:	Keyword
555	File Unit/Name conflict across options: GRP# AVE	GrpNum and AvePer
560	User Specified File Unit .LT. 30 for OU Keyword:	Keyword
565	Possible Conflict With Dynamically Allocated FUNIT	Keyword
570	Problem Reading Temporary Event File for Event:	EVNAME
580	End of File Reached Trying to Read the File of	Keyword
585	Output data file for INITFILE option was not found	File Type
590	The INITFILE filename matches a SAVEFILE filename	
592	MAXIFILE includes data past start of MULTYEAR run	YYMMDDHH
593	POSTFILE includes data past start of MULTYEAR run	YYMMDDHH

APPENDIX D

EPA MODEL CLEARINGHOUSE MEMORANDUM DATED JULY 9, 1993

July 9, 1993

MEMORANDUM

SUBJECT: Proposal for Calculating Plume Rise for Stacks with Horizontal Releases or Rain Caps for Cookson Pigment, Newark, New Jersey

FROM: Joseph A. Tikvart, Chief
Source Receptor Analysis Branch, TSD (MD-14)

TO: Ken Eng, Chief
Air Compliance Branch, Region II

In response to your request, the Model Clearinghouse has reviewed your proposal for treating horizontal and capped stacks at Cookson Pigment so that the model (SCREEN or ISC2) will properly treat plume rise from the Cookson Pigment stacks. We concur in principle with the approach, with some relatively minor changes.

First, the analysis provided by New Jersey Department of Environmental Protection is technically correct. We suggest, however, that the exit velocity for horizontal and capped stacks be set to a lower figure than 0.1 m/s. A 0.1 m/s exit velocity may still result in significant momentum plume rise being calculated, even though these kinds of sources should have zero momentum rise. We therefore suggest setting the stack exit velocity to a lower value, such as .001.

For horizontal stacks that are not capped, we suggest turning stack tip downwash off, whether there are buildings or not. Stack tip downwash calculations are inappropriate for horizontal stacks.

For vertical stacks that are capped, turn stack tip downwash off and reduce the stack height by three times the actual stack diameter. The cap will probably force stack tip downwash most of the time. The maximum amount of the stack tip downwash (as calculated in ISC2) is three times the stack diameter. Reducing the stack height by this amount, while turning off the stack tip downwash option, causes the maximum stack tip downwash effect. The resulting concentrations may err slightly on the high side. For stacks with small diameters, such as those at Cookson Pigment, the error should be quite small. Note, however, that this approach may not be valid for large diameter stacks (say, several meters).

cc: A. Colecchia
D. Wilson

APPENDIX E. EVALUATION OF MODIFIED URBAN OPTION

The urban option in 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 associated with the urban nighttime heat island effect was ignored once the boundary layer turned convective. This could result in an unrealistic drop in the mixed layer height during early morning hours for urban applications, which could contribute to unrealistically high concentrations for low-level plumes. This effect was observed in the application of AERMOD for the Risk and Exposure Assessment (REA) in support of the NO_2 NAAQS review in association with mobile source emissions (EPA, 2008). Beginning with version 11059 the urban option in AERMOD continues application of the urban boundary layer approach for urban sources until the daytime convective mixing height exceeds the urban nighttime mixing height, based on the user-specified population (Cimorelli, *et al.*, 2004). This revision to AERMOD will generally reduce concentrations during the early morning transition to convective conditions for low-level urban sources, but may increase daytime concentrations for elevated urban sources.

The modified implementation of the urban option was evaluated using data from the 1985 Indianapolis SF_6 urban field study (Perry, et al, 2005), and model-to-monitor comparisons at four ambient monitors for 2002 from the Atlanta NO_2 REA (EPA, 2008). The Indianapolis study involved an elevated buoyant release and the Atlanta REA study involved mostly low-level mobile source emissions. Results from the Indianapolis study are presented in the form of Q-Q plots of ranked 1-hour modeled vs. observed concentrations, unpaired in time and space. Figure E-1 shows model performance for all stabilities and Figure E-2 shows model performance for convective conditions only. The revised urban option does not affect results under stable conditions. Results from the Atlanta NO_2 REA are also presented in the form of Q-Q plots of 1-hour ranked modeled vs. observed concentrations, unpaired in time, for each of the four ambient NO_2 monitors, shown in Figures E-3 through E-6. Both of these evaluations show improved model performance with the modified urban option in AERMOD.

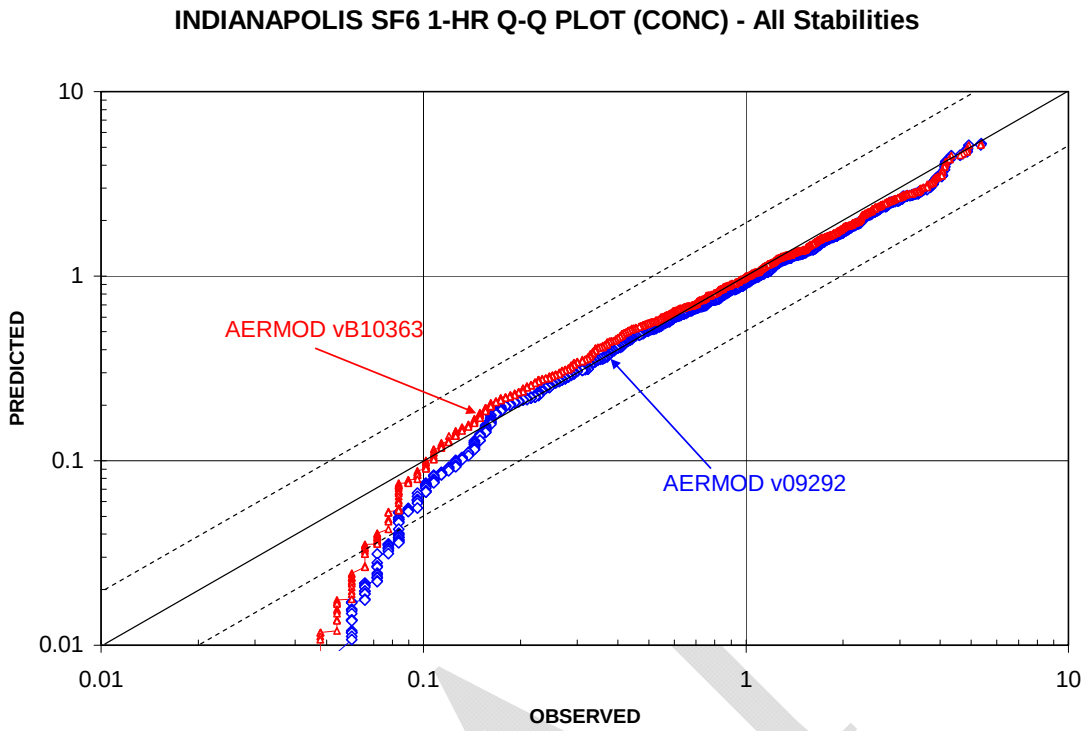

Figure E-1. 1-hour Q-Q Plot for Indianapolis SF_6 Study for All Stabilities

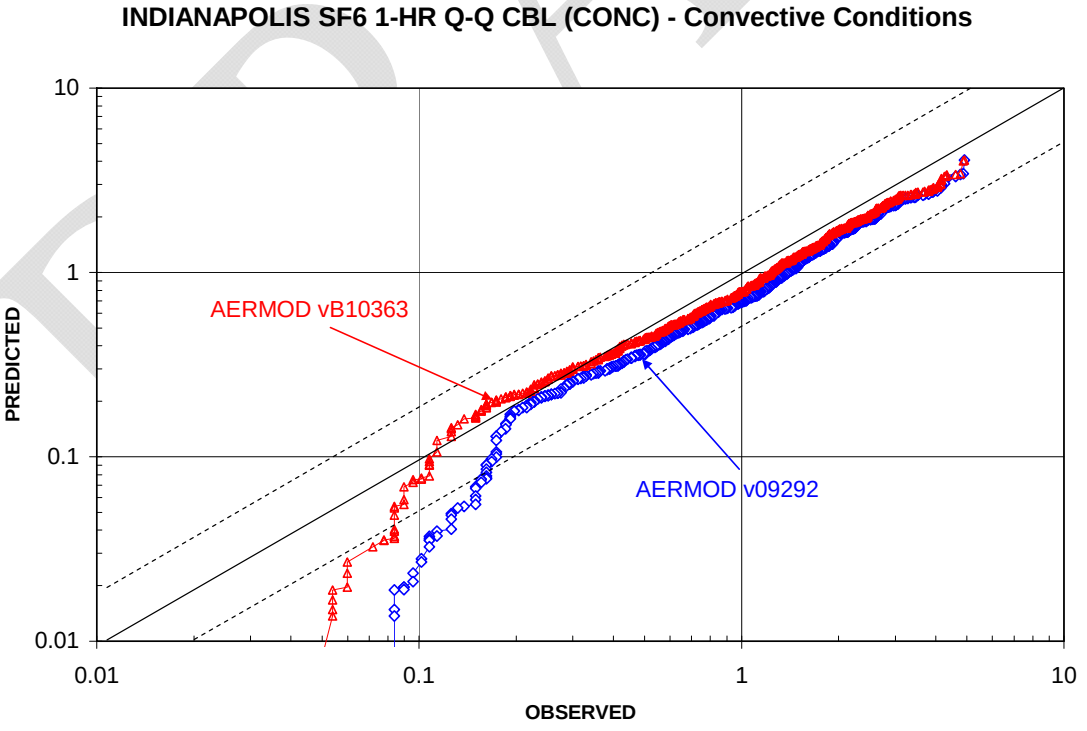

Figure E-2. 1-hour Q-Q Plot for Indianapolis SF_6 Study for Convective Conditions

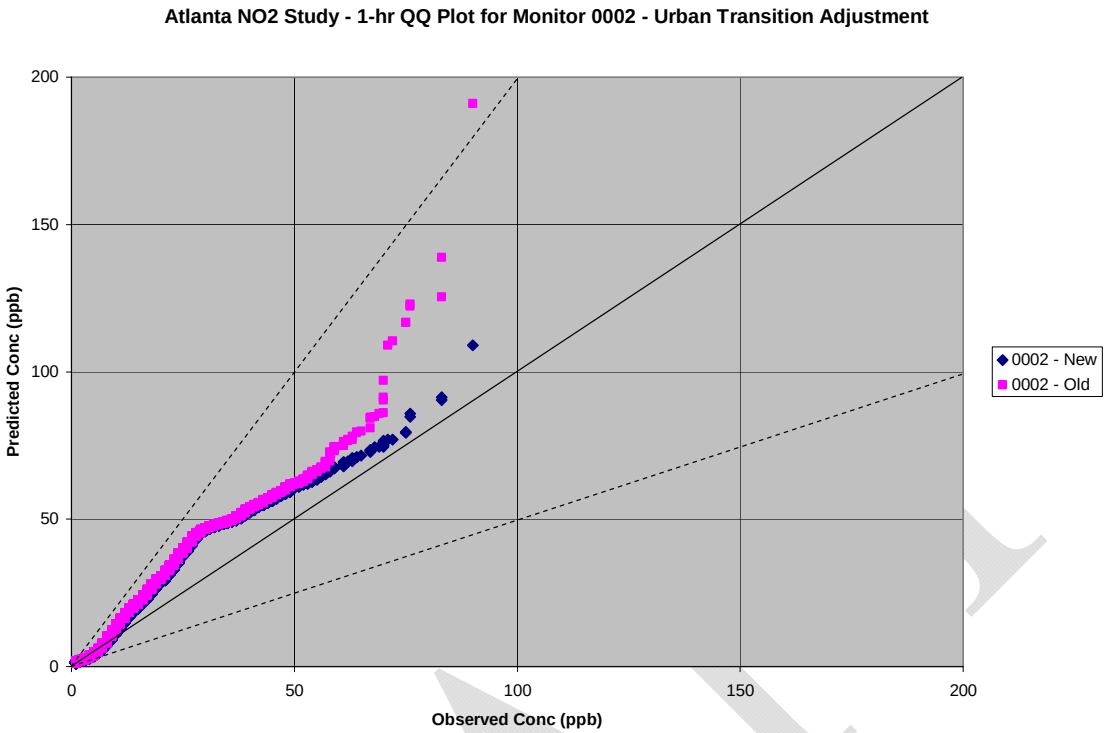

Figure E-3. 1-hour Q-Q Plot for Atlanta NO_2 Study for Monitor 0002

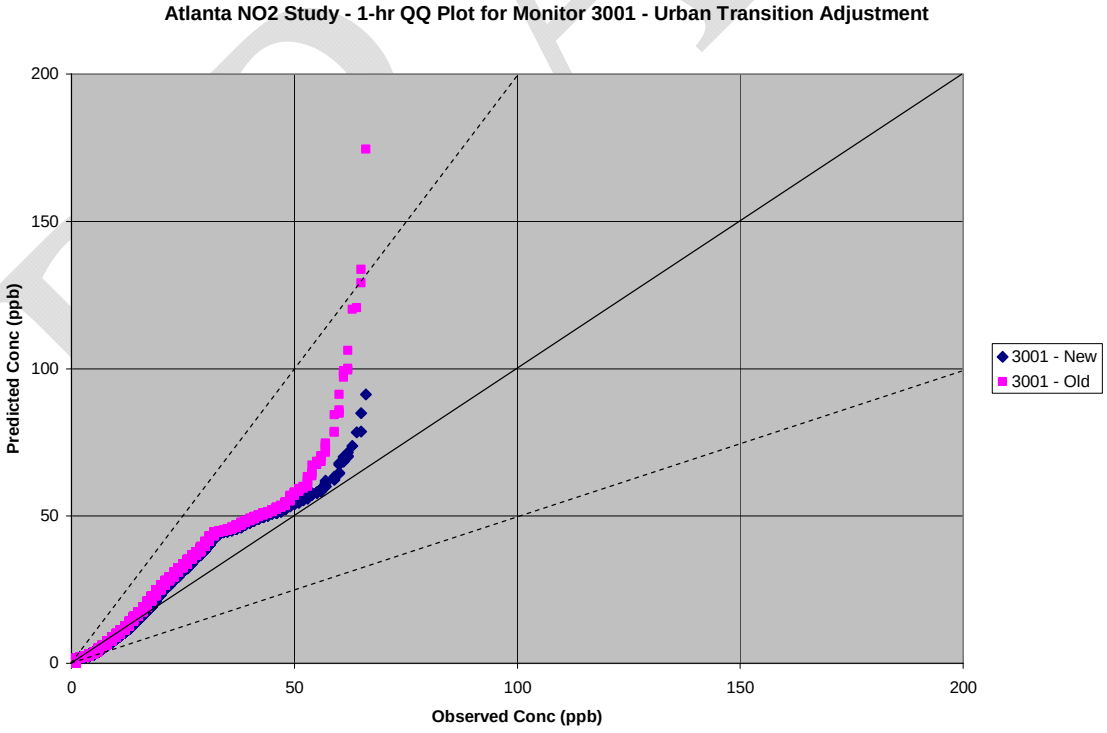

Figure E-4. 1-hour Q-Q Plot for Atlanta NO_2 Study for Monitor 3001

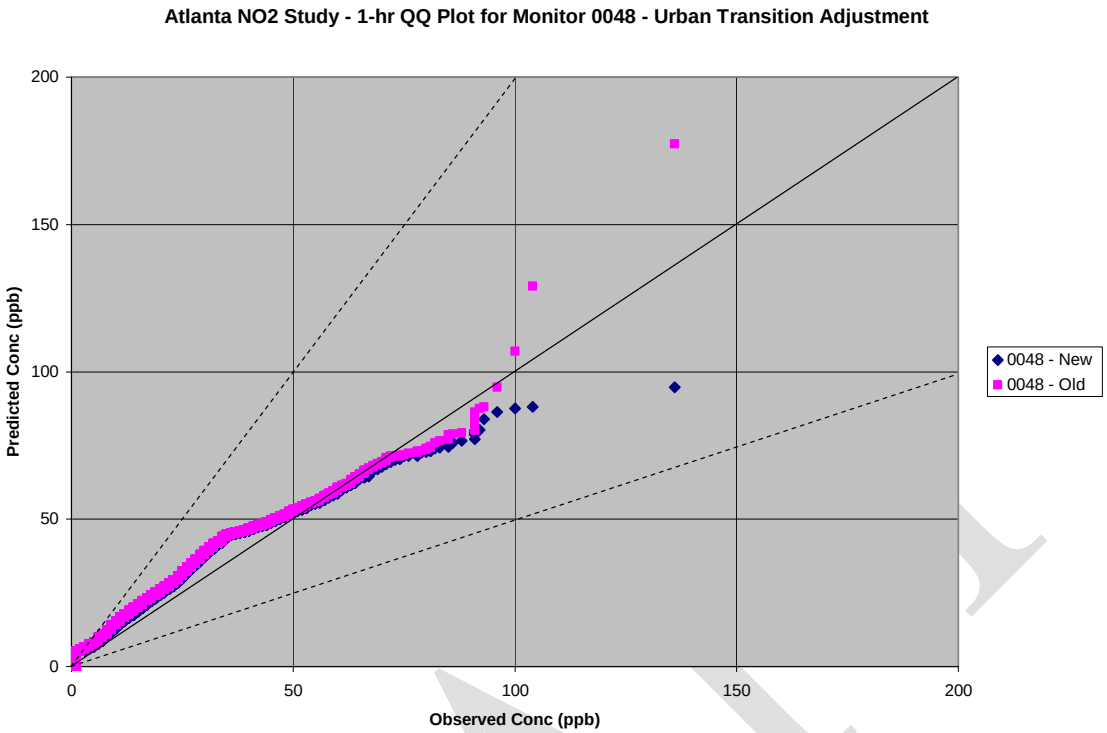

Figure E-5. 1-hour Q-Q Plot for Atlanta NO_2 Study for Monitor 0048

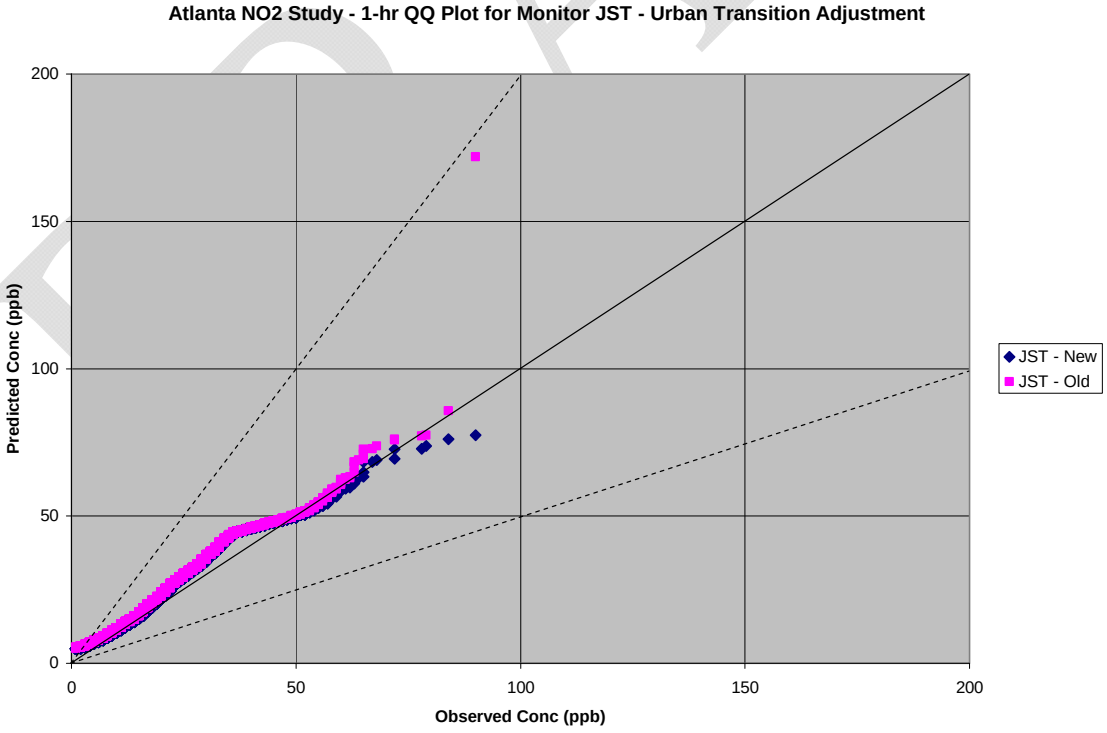

Figure E-6. 1-hour Q-Q Plot for Atlanta NO_2 Study for Monitor JST