

# Updating SMOKE to Create AERMOD-ready Inputs for Urban-scale Air Dispersion Modeling

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## ABSTRACT

The Environmental Protection Agency (EPA)'s Office of Air Quality Planning and Standards (OAQPS) is updating the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system to create model ready emission inputs for a local scale dispersion model: the AMS/EPA Regulatory Model (AERMOD). Currently SMOKE processes emissions for atmospheric grid models including CMAQ, CAM<sub>x</sub> and REMSAD. Modifying SMOKE for AERMOD will allow consistent emission modeling approaches for local and regional scale modeling, which will be a valuable step in building a multipollutant assessment capability at multiple geographic scales. The approach to enable SMOKE to produce AERMOD emission inputs will be accomplished using much of the existing SMOKE REPORT (SMKREPORT) features and the creation of a new AERMERGE module that will process several SMOKE input ancillary files and environment variables. The user will have the ability to process any emission source as an AERMOD point, area, or volume source. Local, state, and regional agency data can be incorporated into the inventories using new SMOKE ancillary files that will also enable source-specific AERMOD release parameters. SMOKE, coupled with an updated version of the MIMS Spatial Allocator will enable spatial allocation to fine resolution of any leftover county-level emissions not allocated to discrete locations. For optimization purposes, the user can also utilize the soon-to-be released Emissions Modeling Framework to subset the counties and pollutants of interest. The user will dictate the AERMOD domain and pollutants of interest and SMOKE will create one AERMOD-ready runstream file for each user-defined pollutant. This paper will discuss why and how SMOKE will be updated to process emissions for AERMOD, and provide an estimated schedule for testing and public release of the updated SMOKE-for-AERMOD system.

## INTRODUCTION

### Why AERMOD?

On November 9, 2005<sup>1</sup>, the EPA established the AMS/EPA Regulatory Model (AERMOD) to replace the Industrial Source Complex (ISC) model as the preferred air dispersion model in its "Guideline on Air Quality Models." (40 CFR 51, Appendix W). AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts and can include treatment of both surface and elevated sources and both simple and

complex terrain<sup>2</sup>. AERMOD is a state-of-the-science dispersion model that reflects advances in planetary boundary layer (PBL) meteorology and science. Similar to its ISC predecessor, AERMOD offers the advantage of its ability to compute the near field impacts of primary emitted pollutants. Dispersion models such as ISC or AERMOD are generally used to look at effects of emission sources on receptors that are generally less than 50 km from the source.

Up until the end of the last decade, Gaussian steady state dispersion models such as ISC were primarily used to assess the impact of an individual stack or an industrial source complex on one or more receptors of particular interest with respect to the source –for example, at the source fence line or at a population center with some proximity to the source. However, the advent of faster, more efficient computers, coupled with the desire to assess cumulative impacts of multiple sources in urban areas, have expanded the use of such dispersion models to quantify the near field impact of multiple sources over a larger area of receptors, such as an urban area of 100 by 100 kilometers. Because AERMOD does not account for chemical interactions or secondary formation, it can be used to estimate the relative contributions of particular sources to the receptor estimated ambient concentrations. AERMOD also allows for the estimation of the concentration impacts of potential control strategies on sources without the need to re-run the emission reductions through the model.

Initial multi-source urban area modeling applications with these dispersion models have focused on characterizing air toxics from the various types of emissions sources in the urban area<sup>3,4</sup>. In that individual urban areas could have hundreds or thousands of emission sources, EPA enhanced the hazardous air pollutant (HAP) emission processing tool, Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP) to prepare air toxics emission inventories for ISCST3 and described its use for an example application<sup>5</sup>. EMS-HAP was further modified for ISCST3<sup>6</sup> to allow the usage of readily available census tract-level emission surrogates; these tract-level surrogates were prepared for the Assessment System for Population Exposure Nationwide (ASPEN) model used in the national scale air toxics assessment<sup>7</sup>. With the exception of an improved deposition algorithm implemented in the revised version of AERMOD<sup>8</sup>, all of the emission inputs for ISCST3 could be used for AERMOD.

An AERMOD modeling application of primary particulate matter (PM) emissions was recently performed in support of the PM National Ambient Air Quality Standards (NAAQS) proposal<sup>9</sup>. The purpose was to quantify the spatial variation due to the local-scale primary PM<sub>2.5</sub> emissions, and to assess the relative contributions of various groups of emission source categories on the Federal Reference Monitor monitoring sites. In order to maintain consistency with the speciation and temporalization of PM<sub>2.5</sub> emissions used in larger-scale CMAQ modeling, while allowing for a finer scale resolution of the emissions, a combination of SMOKE (speciation and temporalization) and EMS-HAP (spatial allocation to census tract resolution) algorithms were used.

### WHY SMOKE?

Several enhancements have been made to SMOKE to support multipollutant assessments with grid models with the ambitious goal of making SMOKE<sup>10</sup> the “one-stop-shop” tool for many types of emissions modeling. The capability to process toxics emissions for use in grid models was developed in Version 2.1 of SMOKE. Although plans were made several years ago to extend SMOKE to dispersion models such as ISCST3 and AERMOD, shortage of resources and multiple competing needs have

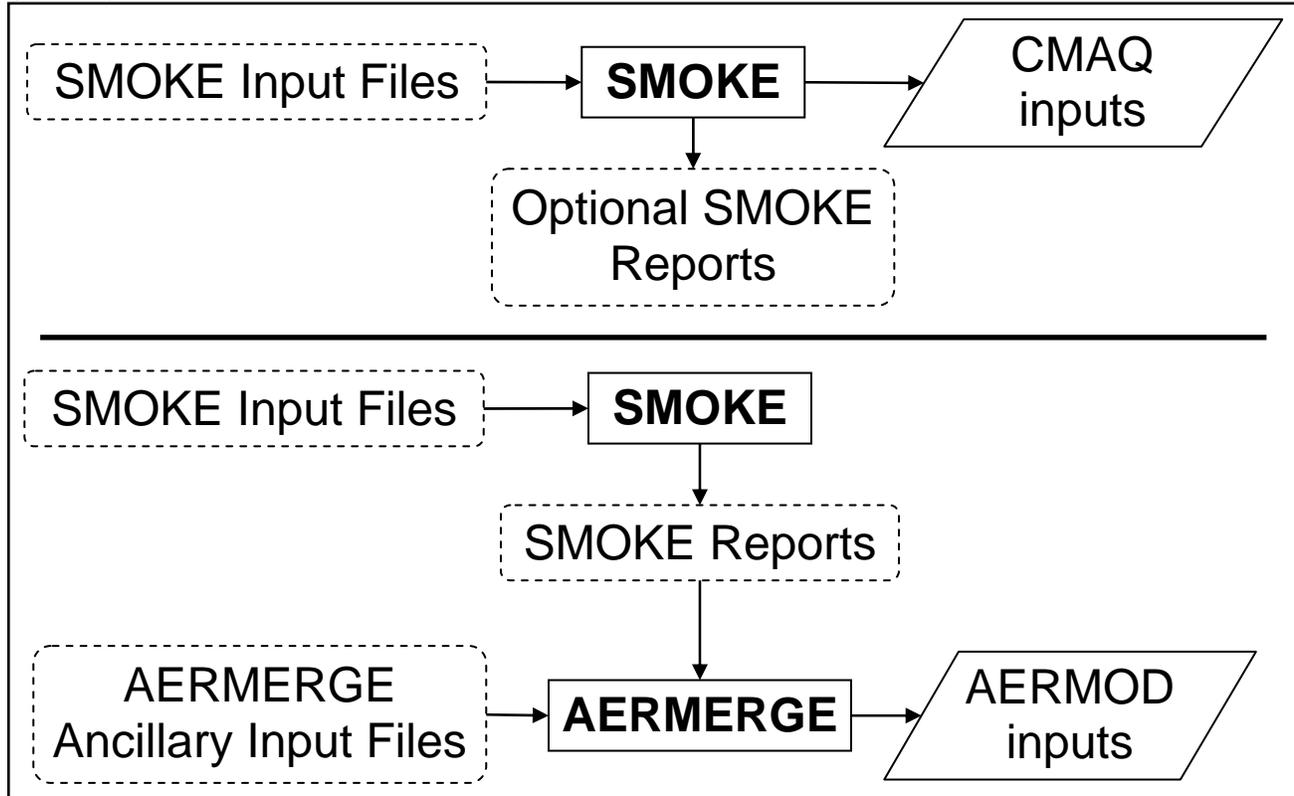
delayed the implementation. Furthermore EMS-HAP, which processes emissions for ISCST3 exists, which made it less pressing to implement the SMOKE updates previously.

With the development of the 2002 multipollutant emissions platform as the basis to build the capability and tools to implement multi-pollutant approaches to address air quality problems, a renewed effort to enhance SMOKE for AERMOD has been undertaken. The use of SMOKE will provide consistent methodology, and emissions processing data, and will result in a set of consistent emissions between grid and dispersion models. This will lead to a better understanding of the relationship between the regional and local air quality modeling results; this will also facilitate the continued development of the hybrid approach that produces sub-grid cell spatial variability by combining CMAQ and AERMOD modeling results.

Another reason to use SMOKE for creating AERMOD inputs is that SMOKE will also be a key tool in EPA's new Emission Modeling Framework, which will allow SMOKE-AERMOD users to take advantage of the EMF data versioning, data management, quality assurance (QA) protocols, and case management functions.

The focus on this paper is to provide an overview of the SMOKE and AERMOD modeling systems, the SMOKE modifications required to produce AERMOD-ready inputs, and an example of how SMOKE will produce these AERMOD input files. The top of Figure 1 illustrates the overall flow of SMOKE processing for grid models like CMAQ. The bottom of Figure 1 shows how SMOKE would be used as one of the inputs for processing emissions for AERMOD, and how a new AERMERGE module would be used to merge SMOKE reports and AERMOD-specific ancillary input files to create AERMOD-ready inputs.

**Figure 1.** Overall program flow for SMOKE: currently for CMAQ (top) and proposed for AERMOD (bottom)



## SMOKE AND AERMOD OVERVIEW

### SMOKE Overview

SMOKE allows emissions data processing methods to integrate high-performance-computing (HPC) sparse-matrix algorithms. Over the years, SMOKE has evolved into a truly multipollutant emissions processor that can support many air quality modeling needs such as: state and federal implementation plan development, regulatory efforts, and air quality forecasting. Most important, SMOKE continues to develop and improve as new emission processing needs continually arise in the air quality modeling community. Some of the more noteworthy attributes of SMOKE are:

- no limitation regarding the number or types of pollutants;
- any chemical mechanism can be applied to speciate pollutants into model species;
- supports different types of biogenics modeling;
- Includes a driver for MOBILE6 runs to generate onroad mobile criteria and toxics air pollutants and features to improve run time when using MOBILE6 for large domains and long time periods (can support annual, national runs using MOBILE6);
- can process up to 10 countries and several output grid projections with any number of grid cells;
- low disk space requirements and run-time memory allocation, eliminating any need to recompile the source code for different inventories, grids, or chemical mechanisms;

- integrated use of Continuous Emissions Monitoring (CEM) data, an hour-specific dataset of emissions from electric generating facilities. Also supports other day-specific and hour-specific point-source data;
- no third-party software is required to run SMOKE, although some input file preparation, such as gridded land use or spatial allocation surrogates, does require other software;
- flexible growth and control strategies possible;
- supports hour-specific point-source stack parameters (exit temperature, exit velocity, and exit flow rate);
- supports externally computed hourly plume rise (used for processing wildfires as point sources with a different plume rise algorithm than is available in SMOKE);
- supports emissions data input formats for several air quality models, including CMAQ, CAMx, and REMSAD;

## AERMOD Overview

The AERMOD model is especially designed to support EPA’s regulatory modeling programs on a local scale for any type of air pollutant. AERMOD is a Gaussian-based air dispersion model, based on the pre-existing ISC model that was developed with some primary goals being: user-friendliness, consistency in estimating ambient design concentrations, and open to modifications as the science dictates<sup>11</sup>.

The AERMOD system can account for multiple types of emission sources (e.g., stacks, area sources, and volume sources), user-defined source release parameters, receptor networks, the aerodynamic effects of building downwash, and non-uniform terrain features. AERMOD also allows defining source groups as specific as individual sources. AERMOD can produce several specialized types of estimated ambient concentrations, on many types of time scales, averaging techniques, and even restricted to occurrences of violations of user-defined threshold values over user-defined averaging periods and source groups.

AERMOD processes one pollutant for each model run. AERMERGE and its associated input files, discussed later, will be responsible for producing pollutant-specific AERMOD input files. The AERMOD model uses a runstream input file structure with a keyword/parameter approach to specify model run options and input data. A two-character ID placed at the beginning of each runstream record represents one of the five functional pathways. AERMOD is very strict about the order for each pathway, and even for each record, or “command” in the runstream file. These five pathways, in the order they appear in the runstream file, are:

- CO** - for specifying overall job **C**ontrol options,
- SO** - for specifying **S**ource (emissions-related) information,
- RE** - for specifying **R**eceptor information,
- ME** - for specifying **M**eteorology information,
- OU** - for specifying **O**utput options.

The AERMOD-related updates for SMOKE primarily focus on the **S**ource pathway section of the AERMOD runstream file. AERMERGE will essentially pass through the **C**ontrol, **R**eceptor, **M**eteorology, and **O**utput portions of the runstream via an AERMERGE input ancillary file that the

user must provide. AERMERGE will use dynamic internal macros to assign some parameter values based primarily on each user-dictated pollutant, and source categorization assignments. For the example input runstream in Figure 2, AERMERGE, for each pollutant, will assign the CONTROL the pathway keyword POLLUTID, and for gaseous pollutants, the HALFLIFE, GDSEASON, and GDLANUSE keywords (discussed later), as well as the entire SO pathway structure and the external INCLUDED file names, and unique OUTPUT file names. The AERMERGE runstream file structure and the specific role that SMOKE/AERMERGE will fulfill to create this will be discussed later.

Typical national or regional-scale emission inventories consist of point, non-point (denoted by some as “area” sources) and mobile sources. Point sources are generally emission sources with known geographic coordinates. Non-point and mobile sources are generally inventoried at some aggregate level, such as county, and are allocated to grid cells or census tracts by emissions processors. Mobile sources may also be provided at more detailed road link-based resolution for local studies. AERMOD handles three types of sources: POINT, VOLUME, and AREA, which are defined differently from the inventory sectors. A brief description of the three AERMOD sources is presented below.

- POINT: Refers to stacks and isolated vents; the following stack parameters must be provided (in metric units): emissions rate in g/s, stack height, stack temperature, stack velocity, and stack diameter. AERMOD requires stack temperature to be equal to or exceed the ambient temperature. AERMOD can also model a plume with a stack exit temperature that always exceeds the ambient temperature by a fixed amount.
- VOLUME: Used to model releases from various industrial sources such as building roof monitors, multiple vents, and conveyer belts. We have also used VOLUME sources to include point source inventory emissions that are defined as horizontal stacks or fugitives. VOLUME sources require the following release parameters: emissions in g/s, release height above the ground for the center of the volume, and the initial horizontal and vertical dimensions of the volume. Because AERMOD VOLUME sources do not use stack parameter information other than release height, without stack temperature information, VOLUME sources are assumed to have neutral buoyancy.
- AREA: Used to model low or ground-level releases with no plume rise, such as storage piles, slag dumps, and lagoons. We use AREA sources to define any source allocated from county-level emissions to the grid cells or tracts. AREA sources are also used to represent airport emissions, and we have also used AREA sources to model landfills. In addition, AERMOD does not model line sources and road links are typically modeled as AREA sources shaped as elongated rectangles. AREA sources require the following release parameters: emissions in g/s, release height above the ground, length of X side of the area (in the east-west direction if Angle is 0 degrees, length of Y side of the area (in the north-south direction if Angle is 0 degrees, orientation Angle for the rectangular area in degrees from North, and the initial vertical dimension of the area source plume. AERMOD has three options for modeling AREA sources; initially, SMOKE for AERMOD will only process the aforementioned rectangular area sources.

As just discussed, the input parameters associated with each source type are different. Regardless of the AERMOD source type, each source contains a record to identify the location and another to identify the source release parameters.

**Figure 2.** Example AERMOD input runstream file after the SMOKE/AERMERGE system

```

CO  STARTING
    TITLEONE   Draft Philadelphia 2002 sample emissions; Pollutant: BENZENE
    TITLETWO   tract surrogates dummy to 1km, and PHL airport
    MODELOPT   CONC TOXICS
    AVERTIME   1 3 24 MONTH ANNUAL
    URBANOPT   4500000 PHL 1
    POLLUTID  BENZ
    HALFLIFE   1209600
    GDSEASON  4 4 4 5 1 1 1 1 1 2 3 3
    GDLANUSE  36*1
    RUNORNOT   RUN
    ERRORFIL   BENZ_ERR.OUT
    SAVEFILE   PHL_test_dump.sav1 1 PHL_test_dump.sav2
**  INITFILE   restart_MMDDYY.sav
CO  FINISHED
**
SO  STARTING
    ELEVUNIT   METERS
    CONCUNIT   1.0E6 GRAMS/SEC MICROGRAMS/M**3
    DEPOUNIT   3.6E3 GRAMS/SEC GRAMS/M**2
**  general AERMOD release parameters for area, point, volume, link-based, and gridded sources
    INCLUDED   /AERMOD INCLUDE files directory/area.BENZ
    INCLUDED   /AERMOD INCLUDE files directory/pnt.BENZ
    INCLUDED   /AERMOD INCLUDE files directory/vol.BENZ
    INCLUDED   /AERMOD INCLUDE files directory/links.BENZ
    INCLUDED   /AERMOD INCLUDE files directory/grid.BENZ
**  file containing list of sources subject to urban dispersion
    INCLUDED   /AERMOD INCLUDE files directory/urb_src.BENZ
**  file containing building parameters for some AERMOD POINT sources
    INCLUDED   /AERMOD INCLUDE files directory/bldg.BENZ
**  file containing hourly emissions rates for all sources
    INCLUDED   /AERMOD INCLUDE files directory/hrlyemis.BENZ
**  file containing gas deposition parameters for all sources
    INCLUDED   /AERMOD INCLUDE files directory/gasdepo.BENZ
**  could also reference SRCGROUPs with an include file
SO  SRCGROUP  CAT00    00P00001-00P99999
**  In this example, there was another inventory sector "E" in source group "00"
SO  SRCGROUP  CAT00    00E00001-00E99999
SO  SRCGROUP  CAT02    02P00001-02P99999
SO  SRCGROUP  CAT03    03I00001-03I99999
SO  SRCGROUP  CAT04    04G00001-04G99999
SO  SRCGROUP  CAT05    05X00001-05X99999
SO  SRCGROUP  CAT22    22N00001-22N99999
SO  SRCGROUP  CAT77    77C00001-77C99999
SO  SRCGROUP  CAT77    77F00001-77F99999
SO  SRCGROUP  CATMY    MYA00001-MYA99999
SO  SRCGROUP  CATNJ    NJM00001-NJM99999
SO  SRCGROUP  ALL
SO  FINISHED
**
RE  STARTING
    ELEVUNIT   METERS
    INCLUDED   /receptor_file_directory/receptor file1.txt
    INCLUDED   /receptor_file_directory/receptor file2.txt
RE  FINISHED

```

**Figure 2 (cont).** Example AERMOD input runstream file after the SMOKE/AERMERGE system

```

ME  STARTING
    SURFDATA  13739 2002
    UAIRDATA  93734 2002
    SURFFILE  PHL04300-3.SFC
    PROFFILE  PHL04300-3.PFL
    PROFBASE  50 METERS
    STARTEND  02 01 01 02 12 31
ME  FINISHED
**
OU  STARTING
    POSTFILE  1      CATMY  PLOT  phl_BENZ_1_MY.PST
    POSTFILE  1      CATNJ  PLOT  phl_BENZ_1_NJ.PST
    POSTFILE  1      ALL    PLOT  phl_BENZ_1_ALL.PST
    POSTFILE  3      CATNJ  PLOT  phl_BENZ_3_NJ.PST
    POSTFILE  3      ALL    PLOT  phl_BENZ_3_ALL.PST
    POSTFILE  24     CAT77  PLOT  phl_BENZ_24_77.PST
    POSTFILE  24     CATNJ  PLOT  phl_BENZ_24_NJ.PST
    POSTFILE  24     ALL    PLOT  phl_BENZ_24_ALL.PST
    POSTFILE  MONTH  CATNJ  PLOT  phl_BENZ_MONTH_NJ.PST
    POSTFILE  ANNUAL CAT00  PLOT  phl_BENZ_ANNUAL_00.PST
    POSTFILE  ANNUAL CAT00  PLOT  phl_BENZ_ANNUAL_01.PST
    POSTFILE  ANNUAL CAT02  PLOT  phl_BENZ_ANNUAL_02.PST
    POSTFILE  ANNUAL CAT03  PLOT  phl_BENZ_ANNUAL_03.PST
    POSTFILE  ANNUAL CAT04  PLOT  phl_BENZ_ANNUAL_04.PST
    POSTFILE  ANNUAL CAT05  PLOT  phl_BENZ_ANNUAL_05.PST
    POSTFILE  ANNUAL CAT22  PLOT  phl_BENZ_ANNUAL_22.PST
    POSTFILE  ANNUAL CAT77  PLOT  phl_BENZ_ANNUAL_77.PST
    POSTFILE  ANNUAL CATMY  PLOT  phl_BENZ_ANNUAL_MY.PST
    POSTFILE  ANNUAL CATNJ  PLOT  phl_BENZ_ANNUAL_NJ.PST
    POSTFILE  ANNUAL ALL    PLOT  phl_BENZ_ANNUAL_ALL.PST
OU  FINISHED

```

## SMOKE UPDATES

Figure 1 presented a general flowchart of how emissions processing through SMOKE will be updated for the AERMOD system. In addition to the new AERMERGE module, some existing SMOKE programs will need to be modified in support of AERMOD processing.

### SMKINVEN modifications

The first SMOKE program to be modified, SMKINVEN, reads in and sorts the raw emissions data, and creates SMOKE inventory files that are required by most of the SMOKE programs. The most significant anticipated update to SMKINVEN will be to retain the location ID (LOCID) variable from the area-to-point (ARTOPNT) conversion/allocation file. Currently, the LOCID is primarily used as an airport identification code used to allocate particular fractions of the county-level area or mobile source emissions to discrete airport locations within the county. However, this ARTOPNT file is not restricted to airports; it could be used for local-scale modeling when the user has discrete location and allocation information about any SMOKE AREA or NONROAD county-level source category (SCC), such as landfills, ports, gasoline stations, and dry cleaners.

The LOCID variable will be stored in the PLANTID field after ARTOPNT assigns discrete location coordinates to the SMOKE AREA sources matched by the ARTOPNT ancillary file. When processing link-based (onroad mobile) emissions, SMKINVEN will also need to retain the LINKID and store it in the PLANTID field. An AERMERGE ancillary file containing AERMOD release parameters will link to the LOCID or LINKID, via the PLANTID field in the SMOKE report (SMOKE output/AERMERGE input).

### SMKREPORT modifications

SMKREPORT is used to create various emissions and activity data totals for quality assurance (QA). Like SMKINVEN, in a given run, SMKREPORT operates on one SMOKE source category (area, mobile, or point), speciation scenario, grid projection and resolution, and temporal resolution. SMKREPORT utilizes a report configuration (REPCONFIG) file to create SMOKE reports based on the instructions, or packets, it contains. While SMKREPORT is very flexible, when running for AERMOD, the REPCONFIG file must be designed to allow SMKREPORT to provide the necessary information to produce AERMERGE input files. Figure 3 shows an example REPCONFIG file that will create an AERMERGE input emissions file from a point source inventory. AERMERGE will allow source groups to be defined by source parameters not currently supported by SMKREPORT; these include, though are not limited to: MACT code and point source type (SRCTYPE), which is used to

**Figure 3.** Example REPCONFIG file used to create AERMERGE input emissions file

```
# This file is the report configuration file for running SMKREPORT
# for point sources to create AERMERGE input files.
```

```
SMK_SOURCE P
```

```
/DEFINE GROUP REGION/ SEATTLE
```

```
INCLUDE
```

```
053031
```

```
053033
```

```
053035
```

```
053041
```

```
053029
```

```
053045
```

```
053053
```

```
053061
```

```
053067
```

```
/END/
```

```
/NEWFILE/ REPORT1
```

```
/CREATE REPORT/
```

```
SELECT REGION SEATTLE
```

```
SELECT DATA POA PEC S-PMC PMFINE PNO3 PSO4 SULF
```

```
BY SOURCE NAME LATLON
```

```
BY HOUR
```

```
SPECIATION
```

```
NUMBER F14.5
```

```
UNITS ALL tons/hr
```

```
/END/
```

The sample REPCONFIG file in Figure 3 produces source-specific hourly emissions for speciation particulate matter emissions for counties in an urban domain. The LOCID information for ARTOPNT sources is retained in the PLANTID field via the BY SOURCE record. To save processing resources, SMKREPORT will probably be used to create day-specific files so that representative days can be used for those emissions sectors that have a couple of representative days each month. It is also probable that AERMOD will be run for episodic modeling for only part of the year, or for representative months.

When processing ORL-format point source emissions, SMKREPORT will be modified to pass through the ERPTYPE (emission release point type variable). The ERPTYPE variable will allow for easier AERMOD source release parameter assignments in the AERMERGE module.

## **AERMERGE MODULE**

When processing emissions for AERMOD, the AERMERGE module replaces the core SMOKE program SMKMERGE. AERMERGE is similar to SMKMERGE in the sense that both programs will combine all emissions and matrices into a format required for air quality modeling. AERMERGE differs from SMKMERGE in 2 main areas:

- 1) AERMERGE requires numerous AERMOD-specific input ancillary files, and,
- 2) AERMERGE outputs are ASCII and consist of one set of AERMOD input files for each pollutant, whereas SMKMERGE creates binary, typically hourly, gridded air quality input emissions containing all pollutants from all sectors.

As seen in Figure 1, AERMERGE will be created as an AERMOD-specific stand-alone module applied after SMKREPORT has been successfully run for all emission sectors. AERMERGE will utilize several new ancillary files that will be merged with the SMOKE reports to create the AERMOD runstream file and all emissions-related input files. Table 1 provides a list of the AERMERGE operations and, where appropriate, the AERMERGE ancillary input filename keywords (abbreviations). The following section details each of the AERMERGE operations listed in Table 1.

### **Detailed AERMOD Structure**

For the rest of this section, we break up the AERMERGE functions by the bullets above into Ancillary Input Files and Other/Environment Functions.

#### Ancillary Input Files

The following section describes the types of ancillary input files AERMERGE will use to create the AERMOD runstream and the external INCLUDED files. AERMERGE will utilize the SO INCLUDED structure to reference all external files used by AERMOD. This will keep the AERMOD runstream much simpler and amenable to quick quality assurance and modifications.

Figure 4 shows an example AERMERGE ancillary input file runstream template RUNSTRM1. This AERMERGE input file contains much of the overall AERMOD runstream structure. As discussed later, AERMERGE will use other ancillary input files and environment variables to create the AERMOD input runstream file (seen in Figure 2) from this RUNSTRM1 template file.

**Table 1.** AERMERGE operations, with ancillary filename abbreviations where appropriate

<b>AERMERGE Operation Description</b>	<b>Ancillary file keyword (if appropriate)</b>
read in the AERMOD runstream template containing COntrol, REceptor, and MEteorology pathways	RUNSTRM1
read in packet containing SMKREPORT outputs and sector definitions	DEFSECTS
read in packets that define the AERMOD source groups and OUtput pathway averaging options for the concentration estimates	SRC4OUT
read in pollutant-specific COntrol pathway options containing abbreviations for file naming, and gas deposition parameters for gaseous pollutants	COPTIONS
for particulate pollutants, read in particle deposition parameters applied by inventory sector and/or SCC	METHOD2
read in building dimensions for select AERMOD point sources, and create AERMOD input file containing acceptable sources and their corresponding building parameters	BLDGINFO
read in AERMOD source parameter definitions file used to assign default AERMOD source release parameters	SRCPARAM
read in a user-defined surrogate containing urban grid cell identification and create an AERMOD input file listing urban sources in these grid cells	
read in optional file that contains terrain heights from AERMAP and apply to emission sources based on lat/lon	
read in environment variables that will obtain grid domain, AERMOD model settings, and episode start and end dates which will also be used to parse the meteorology and emissions data into a format acceptable to AERMOD	
convert all emission source locations to relative UTM coordinates based on the AERMOD domain	

**Figure 4.** RUNSTRM1: Example AERMERGE ancillary input file AERMOD runstream template.

```

CO  STARTING
    TITLEONE   Draft Philadelphia 2002 sample emissions; Pollutant: <pollutant name via AERMERGE>
    TITLETWO   tract surrogates dummy to 1km, and PHL airport
    MODELOPT   CONC TOXICS
    AVERTIME   <dynamic from SETOUPATH packet>
    URBANOPT   4500000 PHL 1
    POLLUTID   <via AERMERGE>
    HALFLIFE   <via AERMERGE>
**   FLAGPOLE   0
    GDSEASON   <via AERMERGE: default is 4 4 4 5 1 1 1 1 2 3 3>
    GDLANUSE   <via AERMERGE: default is 36*1>
    RUNORNOT   RUN
    ERRORFIL   <via AERMERGE>
    SAVEFILE   PHL_test_dump.sav1 1 PHL_test_dump.sav2
**   INITFILE   restart_MMDDYY.sav
CO  FINISHED
**
RE  STARTING
    ELEVUNIT   METERS
    INCLUDED   /receptor_file_directory/receptor_file1.txt
    INCLUDED   /receptor_file_directory/receptor_file2.txt
RE  FINISHED
**
ME  STARTING
    SURFDATA   13739 2002
    UAIRDATA   93734 2002
    SURFFILE   PHL04300-3.SFC
    PROFFILE   PHL04300-3.PFL
    PROFBASE   50 METERS
    STARTEND   02 01 01 02 12 31
ME  FINISHED

```

Notice that AERMERGE will fill in the pollutant name, ID, and assign the parameters to the CO pathway keyword AVERTIME. The AVERTIME keyword tells AERMOD the averaging intervals that will be used for at least one of the source categories.

AERMOD users generally want the ability to determine specific emission source contributions to ambient model concentration estimates at nearby receptors. Unlike CMAQ, AERMOD concentration estimates are linear; therefore, model concentrations estimated at individual sources are possible as long as a unique AERMOD source group is defined. SMOKE reports will be used as AERMERGE inputs, and for each pollutant, AERMERGE will assign unique 8-character source identifiers to each source. This 8-character source ID will be composed of a 2-character source group (GrpID), a 1-character sector (i.e., nonroad mobile, onroad mobile) ID (RUN\_ID), and 5 characters (numbers only) for the emissions source ID. Every emissions source must be unique to be modeled correctly; therefore, the user is responsible for ensuring that source groups contain less than 100,000 sources.

For point source processing, SMKINVEN allows for a couple different modeling file formats. With the ORL (One Record per Line) format, the point source inventory contains a variable ERPTYPE that reflects the emissions release point type. Examples of ERPTYPE include “01” for fugitive releases, “02” for vertical stacks, and “03” for horizontal stacks. This information can be used by AERMERGE

to assign AERMOD source release parameters in a more efficient manner than at the inventory stack level. For example, in previous studies, we have assigned all point source fugitives and horizontal stacks as AERMOD VOLUME sources.

AERMERGE assigns source IDs by simply iterating all emissions in each defined source group for each SMKREPORT sector. Assigning unique RUN\_IDS based on the sector is therefore necessary to ensure each source is uniquely characterized. Figure 5 shows the ancillary file used to assign AERMOD RUN\_IDS to each SMOKE report based on the sector. The data in this file is an example based on sectors EPA has used in the 2001 modeling platform. The second field in Figure 5 contains the user-friendly name of the sector, and the third field contains the SMOKE report prefix for that sector. SMKREPORT will be producing one report for each day, or representative day. AERMERGE will use user-populated environment variables to complete the remainder of the input filenames. For the example in Figure 5, if the user wanted to process July 2001 emissions through AERMOD, AERMERGE would extract all SMOKE reports with a July date –in the example below if July 1st IPM sector emissions were named “rep\_aermod\_ipm\_01Jul2001.txt”, the user would ensure that specific AEMERGE environment variables were set up to extract this file.

**Figure 5.** DEFSECTS: Example AERMERGE ancillary input file containing cross-reference list of SMOKE reports, emissions sector names, and corresponding run identifiers (RUN\_IDS).

```

/SECTORS/
#DESC This AERMERGE ancillary input file assigns a 1-character RUN_ID to each SMOKE report
#DESC ...user must provide RUN_ID, sector name, and daily SMOKE report prefixes
I  ptipm      rep_aermod_ipm      ! "I" for the IPM sector emissions
P  nonipm     rep_aermod_nonipm   ! "P" for the nonIPM sector emissions
A  oarea      rep_aermod_oarea    ! "A" for the other-area sector emissions
G  ag         rep_aermod_ag       ! "G" for the aGriculture sector emissions
X  afdust     rep_aermod_afdust   ! "X" for area fugitive dust after transport fraction applied
Y  pfdust     rep_aermod_pfdust   ! "Y" for point fugitive dust after transport fraction applied
F  avefire    rep_aermod_avefire  ! "F" for fires sector
M  onroad     rep_aermod_onroad   ! "M" for onroad Mobile sector
N  nonroad    rep_aermod_nonroad  ! "N" for nonroad sector
C  airCraft   rep_aermod_aircraft ! "C" for airport-related sources extracted from the nonroad into-point (ARTOPNT) data
D  airCraft2  rep_aermod_aircraft2 ! "D" for airport-related sources extracted from the nonpoint into-point (ARTOPNT) data

```

The AERMERGE ancillary input file SRC4OUT, shown in Figure 6, contains the emissions source group definitions and AERMOD OUtput pathway options. This file is used to assign the 8-character AERMOD source ID and dictates the complete AERMOD output formats for every emissions source in all SMOKE reports (inventory sectors) that AERMERGE reads in.

The SRC4OUT file shown in Figure 6 consists of two packets. The first packet “SRCGROUP” assigns the AERMOD group ID (GrpID) as the first 2-characters for every emissions source. The AERMOD group ID can be assigned from the most general (entire state, or all states), to most specific of detail, which is individual stack or allocated area sources for point sources, or road link or grid cell/SCC for mobile and gridded area sources.

The second packet in the SRC4OUT file, “SETOUPATH”, allows the user to specify to temporal averaging that AERMOD estimated concentrations will be provided. This packet is entirely optional, and AERMERGE will by default, ensure that AERMOD creates annual average concentrations for each

source group (GrpID). AERMERGE will use all unique averaging periods in this packet to fill in the Control pathway keyword AVERTIME (see Figure 4).

The user will want specific control over how modeled concentration outputs are temporally averaged and output by AERMOD, and thus, the assignment of the AVERTIME variable is dynamically determined in the AERMERGE program by the array of averaging periods in the SETOUPATH packet. The OUtput pathway of the AERMOD runstream uses the AVERTIME parameters to dictate the specific types of AERMOD output files and is thus completely dependent on how the user wants to track particular emission sources or source categories. In the Figure 6 example, ANNUAL, monthly (MONTH), daily (24), 3-hour (3), and hourly (1) concentration estimates will be created for various AERMOD source groups; therefore, using this example, the CO AVERTIME record in Figure 4 would read “CO AVERTIME ANNUAL MONTH 24 3 1”.

Some of the Control pathway keywords seen in Figure 4 will be populated using the AERMERGE ancillary input file “COPTIONS”. Figure 7 provides an example for benzene and hexavalent chromium. For particulate pollutants, this ancillary file will simply cross-reference SMKREPORT pollutant identifiers (column A) to user-friendly pollutant names (column B) for AERMOD titles. For gaseous pollutants, this ancillary file will also provide the Control pathway keyword HALFLIFE, gas deposition parameters, monthly land use characteristics, and wind-based land use category. This last parameter is not anticipated to be very useful as most urban air quality studies are far too large in scale to uniformly dictate variable land use types in different directions for all sources; this option might be more useful on very small scale studies near disparate terrains such as shorelines. See the AERMOD addendum<sup>12</sup> for more details on all gas deposition parameters.

Particulate deposition parameters can be assigned to specific source types in AERMOD. As seen in Figure 8, AERMERGE will be built to allow SCC-specific particle deposition parameters. Under the METHOD\_2 particle deposition algorithm in AERMOD, the user must provide the fraction of the particulate mass that is fine-particle (under 2.5 micrograms) and the representative mass mean diameters. METHOD\_2 is the preferred particle deposition algorithm when less than 10% of the particulate emissions are suspected to be greater than 10 microns or when particle size distribution is not well known.

AERMOD includes algorithms to model the effects of aerodynamic downwash effects of nearby or adjacent buildings on AERMOD point sources not practicing good engineering practice (GEP). Stacks that are at least 65 meters in height are generally assumed to be practicing GEP and are thus assumed to not be subject to significant building downwash effects. There are five keywords used to specify building downwash information. BUILDHGT, BUILDWID, and BUILDLEN specify the building height, width, and length. AERMOD allows up to 36 direction specific building parameters; however, the initial version of AERMERGE will assume that all building parameters are the same for each of the 36 compass directions. The other two keywords, XBADJ and YBADJ refer to along and across-flow distances of the stack to the center of the upwind face of the projected building; we have never used these parameters, and will need to modify the initial version of AERMERGE if this becomes a need.

**Figure 6.** SRC4OUT: Example AERMERGE ancillary input file containing packets that define AERMOD source groups and OUtput pathway averaging options.

```

/SRCGROUP/
#DESC provide in most-specific format first for each sector
#DESC format is: GrpID, Inventory (RUN_ID), FIPS, SCC, SIC, MACT, plantid, pointid, stackid, segment
#DESC ...only the GrpID and RUN_ID (first 2 fields) are mandatory
#DESC In the first example below, source IDs will iterate from "01A00001" up to "01A99999" for emissions from the "A" (oarea) sector in
#DESC ...county="42101" (Philadelphia, PA), for SCC="30120202"
01  A  42101  30120202          ! FIPS assignment here was not needed (this is across sectors!!)
MY  M  34000      223          ! Subset of NJ onroad emissions, beginning with SCC=223*
NJ  I  34000          ! An example of making all New Jersey emissions into 1 source group
NJ  P  34000          ! An example of making all New Jersey emissions into 1 source group
NJ  A  34000          ! An example of making all New Jersey emissions into 1 source group
NJ  G  34000          ! An example of making all New Jersey emissions into 1 source group
01  G                      ! FIPS assignment here was not needed (this is across sectors!!)
02  N      -9  50300501
00  P  42101      -9  9  9  4210101416  001  1  1  ! Make AERMOD track this single stack
05  P  42000          ! Put all remaining PA ptnonIPM emissions in source group=05
03  I                      ! "I" for IPM sector emissions not otherwise assigned a GrpID via more specific crit.
04  A                      ! "A" for oarea not otherwise assigned a source group via more specific criteria
05  G                      ! "G" for aGriculture not otherwise assigned a source group via more specific criteria
22  N                      ! "N" for nonroad sector, could have also used SCC assignments
77  C                      ! "C" was the RUN_ID chosen for aircraft extracted from the nonroad into-point data
/END/
#
/SETOUPATH/
#DESC OUtput pathway averaging options
#DESC format is SRCGROUP, array of averaging periods
#DESC If NO averaging period defined, AERMERGE will create ANNUAL by default for each source category+ALL
#DESC AERMERGE will fill in the CO pathway variable AVERTIME from a list of all unique averging intervals provided in this packet
00  ANNUAL
01  ANNUAL
02  ANNUAL
03  ANNUAL
04  ANNUAL
05  ANNUAL
22  ANNUAL
77  ANNUAL 24
MY  ANNUAL 1
NJ  ANNUAL MONTH 24 3 1
ALL ANNUAL 24 3 1
/END/

```

**Figure 7. COPTIONS:** Example AERMERGE ancillary input file containing pollutant-specific Control pathway options and gas deposition parameters for gaseous pollutants.

```
#DESC File contains pollutant name in SMOKE report (field A), pollutant name for AERMOD titles (field B)...
#DESC ...& gas deposition parameters for gaseous pollutants only: CO pathway keyword HALFLIFE (field C)
#DESC ... then 4 gas deposition parameters (GASDEPOS), then monthly land use categories (GDSEASON)
#DESC ...and wind-specific land use categories (GDLANUSE)
BENZ Benzene      12096000    8.96E-02    1.04E-05    2.51E+04    5.75E+02  4 4 4 5 1 1 1 1 1 2 3 3    36*1
CR6   Chromium-6
```

**Figure 8. METHOD2:** Example AERMERGE ancillary input file containing particle deposition parameters applied by inventory sector and/or SCC

```
/METHOD_2/
#DESC see AERMOD addendum p5-6 for Source pathway METHOD_2 discussion
#DESC format is: pollutant, RUN_ID (sector abbrev), SCC...
#DESC ...(-9 means all SCCs in the sector/SMOKE report),
#DESC ...fraction of fine particulate under 2.5 micrograms, representative mean mass diameter in microns
CR6 P 30901006 0.88 1.55
CR6 P 0.71 1.922
CR6 A 0.71 1.922
CR6 M 0.86 1.44
CR6 N 0.8 1.66
LEAD P 0.74 1.875
LEAD M 0.76 1.85
LEAD N 0.88 1.77
/END METHOD_2/
```

**Figure 9. BLDGINFO:** Example AERMERGE ancillary input file containing building dimensions for select AERMOD point sources.

```
#DESC This BLDCALCS record indicates that for stack heights between 3.05 and 65 meters,...
#DESC ...building height/width/length are stkheight*0.625/1.25/1.875, respectively
BLDCALCS 3.05 65 0.625 1.25 1.875
#DESC: format is: FIPS, plantid, pointid, stackid, segment, SCC, compass direction (36 is default),...
#DESC ... BUILDHGT, BUILDWID, BUILDLEN, XBADJ, YBADJ
#DESC Compass direction will almost always be 36 (all directions); XBADJ&YBADJ will likely be blank (zero).
42101 4210101416 001 1 1 -9 36 12 20 40
#DESC Below is a case where XBADJ and YBADJ are assigned for all directions
42101 4210101416 001 1 2 -9 36 4 6 7 5 5
#DESC ALL stacks in the county/SCCs below get these building parameters
42101 21040000 36 10 25 40
42101 21040005 36 5 8 16
/END BUILDPARAMS/
```

As mentioned in the AERMOD Overview section, AERMOD can process three types of sources: POINT, VOLUME, and AREA. Each AERMOD source type requires specific source release parameters and the AERMERGE ancillary input file “SRCPARAM” is used to help facilitate this process. The SRCPARAM file is entirely optional as AERMERGE will assign every source default AERMOD source release parameters if necessary. If the SRCPARAM file is not populated, all point source emissions are modeled as AERMOD point sources with stack parameters retained from the inventory; all other sources would be modeled as AERMOD area sources with environment variables

determining the source release parameters. None of the inventory emissions would be modeled as AERMOD VOLUME sources under this default scenario.

One important use of the SRCPARAM ancillary input file is to assign some point source emissions as AERMOD VOLUME sources with all the requisite release parameters. As discussed under the SMOKE UPDATES section, the ORL-formatted point source inventory contains an emissions release point type (ERPTYPE) variable that distinguishes stack types such as fugitives (01), vertical stacks (02), and horizontal stacks (03).

There are four packets in the SRCPARAM file:

- 1) SPPTVOL: Assigns point inventory emissions as AERMOD VOLUME sources with release parameters for release height, and initial lateral (Syinit) and vertical (Szinit). The user can assign release parameters to an emissions release point type (ERPTYPE) such as fugitives (01), vertical stacks (02), and horizontal stacks (03). As seen in the example in Figure 10, release parameters can also be assigned by source category (SCC), or any level of detail, from the entire sector or state-county FIPS, to individual stack. The inventory stack height will be used as the release height if not provided.
- 2) SPPTAREA: Assigns point inventory emissions as AERMOD AREA sources with release parameters for release height (stack height if not provided), X and Y length of the area, orientation angle of rotation in degrees from north, and initial vertical dimension (Szinit). The user can apply these AERMOD release parameters to the same level of detail as SPPTVOL entries.
- 3) SPGDVOL: Assigns gridded inventory (generally nonroad mobile or area inventories) emissions as AERMOD VOLUME sources with release parameters for release height, and initial lateral (Syinit) and vertical (Szinit). The user can assign release parameters for the entire sector or by state-county FIPS and/or SCC.
- 4) SPGDAREA: Assigns gridded inventory (generally nonroad mobile or area inventories) emissions as AERMOD AREA sources with release parameters for release height, X and Y length of the area, orientation angle of rotation in degrees from north, and initial vertical dimension (Szinit). The user can apply these AERMOD release parameters to the same level of detail as SPGDVOL entries.

As seen in the example in Figure 10, area and nonroad mobile sources allocated by SMKINVEN to discrete locations via the ARTOPNT SMOKE routine, such as airports, can be assigned AERMOD release parameters through this ancillary file. In this example, AERMERGE will use the plantid field to link the airport location ID (LOCID) to the dimensions of the airport, and model the source as an AERMOD AREA source via the SPPTAREA packet.

### Other/Environment Functions

AERMERGE requires explicit user instructions to create AERMOD-ready runstream files and the corresponding Source pathway INCLUDED files. The ancillary input files, combined with AERMERGE environment variables enable this. Table 2 lists some of the AERMERGE environment variables, their purpose/description and some sample values.

**Figure 10. SRCPARAM:** Example AERMERGE ancillary input file containing AERMOD source parameter definitions file used to assign default AERMOD source release parameters.

#DESC CSV-format, fills the AERMOD SO SRCPARAM card w/ valid VOLUME or AREA source release parameters													
#DESC AERMOD User's Guide Section 3.3.2.2: VOLUME format: Relght (m), Syinit (m), Szinit (m)													
#DESC AERMOD User's Guide Section 3.3.2.3: AREA format: Relght (m), Xinit (m), <Yinit> (m), <Angle>, <Szinit> (m)													
#DESC By default, if processing point source emissions, AERMOD release height=stack height													
#DESC Capable of handling 4 packets:													
#DESC 1) SPPTVOL: Assigns point inv. sources as AERMOD VOLUME by FIPS/plantid/pointid/stackid/segment/erptype													
#DESC 2) SPPTAREA: Assigns point inv. As AERMOD AREA sources by FIPS/plantid/pointid/stackid/segment/erptype													
#DESC 3) SPGDVOL: Assigns area & mobile inventory sources as AERMOD VOLUME sources by FIPS and SCC													
#DESC 4) SPGDAREA: Assigns area & mobile inventory sources as AERMOD AREA sources by FIPS and SCC													
#DESC For each packet type, put most-specific entries first, and more general defaults last													
/SPPTVOL/													
#DESC SPPTVOL Format: sectorabbrev/FIPS/plantid/pointid/stackid/segment/SCC/erptype, VOLUME params: Relght (m), Syinit (m), Szinit (m)													
P	42101	4210101416	001	1	1				1	5	! Release-point specific assignment: will use default "number" for VOLUME source release height		
P	42101	4210101416	001	1	2			10	1	5	! Release-point specific assignment: will use 10m for VOLUME source release height		
P							01			2	! Fugitives assigned default release height and syinit, and assigned szinit of 2m		
P							03		2	2	! Horizontal stacks assigned default release height, while syinit and szinit set to 2m		
/END/													
/SPPTAREA/													
#DESC SPPTAREA Format: sectorabbrev/FIPS/plantid/pointid/stackid/segment/SCC/erptype, AREA parameters: Relght (m), Xinit (m), <Yinit> (m), <Angle>, <Szinit> (m)													
C	42101	PHL				2275		2	1655	4000	75	2	! All aircraft emissions at Philadelphia International airport
C	42101	PHL						2	100	100	0	1	! All other emissions (probably ground support or aviation refueling) at PHL
P						30400105		3	5	5	0	2	! Assigns all this SCC as AERMOD AREA source with release parameters provided
P						40399999		2	6				! Will default y-init to 6 (same as x-init), and assign defaults for angle szinit
P						39999999							! SMOKE needs to assign default x&y dimensions if not provided and print a WARNING
/END/													
/SPGDVOL/													
#DESC SPGDVOL Format: sectorabbrev/FIPS/SCC, VOLUME parameters: Relght (m), Syinit (m), Szinit (m)													
G	42000	2805030000	1	20	3								! Assign Poultry operations in Pennsylvania as rather large AERMOD volume sources
/END/													
/SPGDAREA/													
#DESC SPGDAREA Format: sectorabbrev/FIPS/SCC, AREA parameters: Relght (m), Xinit (m), <Yinit> (m), <Angle>, <Szinit> (m)													
G			1	2	2	0	1						! Assigns all remaining Agriculture emissions as AREA sources with given parameter values
A			1	2	2	0	2						! Default AERMOD release parameters for this sector
X			1	2	2	0	2						! Default AERMOD release parameters for this sector
Y			1	2	2	0	2						! Default AERMOD release parameters for this sector
F			1	2	2	0	2						! Default AERMOD release parameters for this sector
M			1	2	2	0	2						! Default AERMOD release parameters for this sector
N			1	2	2	0	2						! Default AERMOD release parameters for this sector
C			3	100	100	0	5						! If allocated ARTOPNT sources not already assigned AERMOD release parameters
/END/													

**Table 2.** Potential AERMERGE environment variables and sample values

Variable name	Value (Example)	Purpose/Description
GRID_NAME	PHL106x92km	Use SMOKE ancillary input file GRIDDESC to get size of grid, X of SW corner, Y or SW corner, UTM zone; consistent w/ surrogates used in SMOKE
EPI_SDATE	2002001	episode start date (Julian), 01JAN2002 here
EPI_STIME	000000	episode start time (HHMMSS), midnight here
EPI_RUNLEN	87600000	episode run length (HHHHMMSS), all 365 days here
AERMOD_SPECIES	BENZ, CR6, LEAD	comma separated list of species names to extract from Smkreport files and use for AERMOD processing
AREADEFLT	2	user-defined AERMOD release height for AREA sources (meters)
TERRHGTS	phl_terrain.txt	optional file containing terrain heights from AERMAP
USRCSURR	123	urban source surrogate (number) used to define AERMOD sources subject to the increased surface heating from an urban area on pollutant dispersion under stable atmospheric conditions.

AERMERGE will perform many functions not explicitly user-defined by environment variables and ancillary input files. AERMERGE will create domain-specific relative Universal Transverse Mercator (UTM) coordinates for every emissions source. For point and volume sources, AERMERGE will simply use the existing source coordinates and the GRIDDESC file for this, but for AERMOD area sources, AERMERGE will calculate the southwest corner for each source based on its dimensions and angle of rotation.

When necessary, AERMERGE will also default any emissions source parameter necessary to produce valid AERMOD input files. For example, for AERMOD POINT sources, AERMERGE will use environment variables to assign default building dimensions for stacks within a defined range of stack heights, and unless the user specifies otherwise, will assign AREA and VOLUME release heights equal to the stack height for point sources.

### Limitations for Initial Version

SMOKE for AERMOD, specifically, AERMERGE, will create an AERMOD-ready runstream files and their corresponding AERMOD Source pathway INCLUDED files. The user will need to be intimately familiar with AERMOD modeling requirements to ensure that the AERMOD system will produce ambient concentration estimates in the expected and necessary formats. The initial version of AERMERGE will essentially simply “pass-through” much of the AERMOD runstream file; it will be up to the user to ensure that the most of the CONTROL, and all of the METEOROLOGY and RECEPTOR pathways satisfy the AERMOD structure, and more importantly, are set up to create specific, desired outputs ambient concentration values. An example of a common problem is that AERMOD requires that each record in the input runstream not exceed 132 characters, something to remember because INCLUDED file references must include directory paths to the files; with the pathway and keyword taking up the first 11 characters, the user must ensure that all INCLUDED file paths and filenames not exceed 120 characters.

Future AERMERGE modifications will likely include quality assurance routines that will ensure AERMOD runstream formats are satisfied for all pathways –not just the Source Pathway, which is the primary focus of the SMOKE updates and initial version of AERMERGE. At the same time, another possible future feature anticipated in AERMERGE is an output report detailing the AERMOD inputs and expected outputs in a more readable text, or metadata format; this would also be expected to integrate with the Emissions Modeling Framework.

### Specific Limitations

- Deposition Algorithm: For gaseous pollutants, land use category descriptions (Control pathway keyword GDLANUSE –see Figure 7) will not be definable by wind direction. Particle deposition is limited to the METHOD\_2 algorithm; see the Addendum to AERMOD User’s Guide for the AERMOD deposition options.
- Spatial Resolution: The initial version of AERMERGE will not create non-rectangular shaped area source emissions from county-level based surrogates. Census tract surrogates can be fitted to whatever square grid; however, census tract polygon emissions, or AERMOD AREAPOLY source types, will not be possible in the initial version of AERMERGE. As is the case with all detailed local-scale modeling, it is recommended that all large county-level emissions inventory data be allocated to (or replaced with) discrete coordinates and therefore modeled through AERMOD as distinctly located point, area, or volume sources.
- Temporal Resolution: Initially, SMOKE and AERMERGE system will produce only hourly emissions for AERMOD processing for a continuous time period, ranging from a single day, an episode, up to an entire year. If an entire year is required, the AERMOD input files will be extremely large. In the future, SMOKE and AERMERGE will allow for varying levels of temporal resolution and will allow for discontinuous AERMOD modeling such as January, April, July, and October.
- Link-Based Mobile Emissions Processing: It is not clear how the SMOKE/AERMERGE system will create link-based emissions for AERMOD processing. One possible option is that link-based emissions processing will bypass SMOKE and AERMERGE will process link-based emissions derived outside of SMOKE.
- Building parameters will not be definable by wind direction.

User’s familiar with AERMOD input requirements can overcome many of these limitations by modifying the AERMERGE output files. For example, the user can redefine gas or particle deposition parameters or more specific building parameters by modifying the appropriate AERMOD INCLUDED files.

## **SCHEDULE**

Updated SMOKE code (SMKINVEN and SMKREPORT) for AERMOD	late 2006
Release beta version of AERMERGE for EPA testing	mid 2007
Public release of updated SMOKE and AERMERGE module	late 2007

## REFERENCES

- 
- <sup>1</sup> U.S. Environmental Protection Agency, 2005: Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions, Federal Register, Vol. 70, No. 216, p 68218, November 9, 2005.
- <sup>2</sup> U.S. Environmental Protection Agency, 2004: User's Guide for the AMS/EPA Regulatory Model – AERMOD. EPA-454/B-03-001. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711 Available at: [http://www.epa.gov/scram001/dispersion\\_prefrec.htm](http://www.epa.gov/scram001/dispersion_prefrec.htm)
- <sup>3</sup> U.S. Environmental Protection Agency, 1999: Air Dispersion Modeling Of Toxic Pollutants in Urban Areas, Guidance, Methodology And Example Applications, **Error! Main Document Only.**EPA-454/R-99-021 U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711
- <sup>4</sup> U.S. Environmental Protection Agency, 2002: [Example Application of Modeling Toxic Air Pollutants in Urban Areas](#), EPA-452/R-02-003 U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711
- <sup>5</sup> U.S. Environmental Protection Agency. User's Guide for the Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP, Version 2.0), Office of Air Quality Planning and Standards, Research Triangle Park, NC, 2002, Report No. EPA-454/B-02-001.  
[http://www.epa.gov/scram001/dispersion\\_related.htm#ems-hap](http://www.epa.gov/scram001/dispersion_related.htm#ems-hap).
- <sup>6</sup> U.S. Environmental Protection Agency. User's Guide for the Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP, Version 3.0), Office of Air Quality Planning and Standards, Research Triangle Park, NC, 2004b, Report No. EPA-454/B-03-006.  
[http://www.epa.gov/scram001/dispersion\\_related.htm#ems-hap](http://www.epa.gov/scram001/dispersion_related.htm#ems-hap).
- <sup>7</sup> 1999 National-Scale Air Toxics Assessment website. <http://www.epa.gov/ttn/atw/nata1999/>
- <sup>8</sup> Wesely, M.L, P.V. Doskey, and J.D. Shannon, 2002: Deposition Parameterizations for the Industrial Source Complex (ISC3) Model. Draft ANL report ANL/ER/TR-01/003, DOE/xx-nnnn, Argonne National Laboratory, Argonne, Illinois 60439.
- <sup>9</sup> U.S. Environmental Protection Agency (EPA). January 2006. Interim Regulatory Impact Analysis (RIA) for the Proposed National Ambient Air Quality Standards for Particulate Matter.
- <sup>10</sup> Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system. Available at: <http://cf.unc.edu/cep/empd/products/smoke/version2.3/html/>
- <sup>11</sup> AERMOD-latest features, 2003: [http://www.epa.gov/scram001/7thconf/aermod/aermod\\_mep.pdf](http://www.epa.gov/scram001/7thconf/aermod/aermod_mep.pdf)
- <sup>12</sup> Addendum to the User's Guide for the AMS/EPA Regulatory Model –AERMOD.  
<http://www.epa.gov/scram001/7thconf/aermod/aermodug-addm-04300.pdf>

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## KEYWORDS

SMOKE, AERMOD, emissions processing