

Volume I - User's Guide

The Air Quality Integrated Management System (AIMS)

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PREFACE

This user's guide provides documentation and instructions for the Air Quality Integrated Modeling System (AIMS). Volume I includes detailed instructions on the use of each component of AIMS. Volume II provides more details on the technical basis of AIMS. As a set, these two volumes were designed to provide training and to serve as a reference for the application of AIMS in Baltimore, Maryland. These documents also could guide the application of this prototype system in other metropolitan areas.

AIMS was developed to support the EPA urban air toxics initiative. Specifically, this software helps meet the need mandated by the Clean Air Act to identify specific pollutants and source categories that most heavily contribute to urban air toxics risks. AIMS was developed and initially installed in Baltimore, which is one of the three urban centers under review to support the preparation of EPA's national urban air toxics strategy.

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1.0 INTRODUCTION

1.1 Overview

As the U.S. looks to increase the efficiency of environmental management, there are increasing reasons to seek innovative solutions to complex environmental problems. The incentive to enhance the cost-effectiveness of air quality management is no exception. The Air Quality Integrated Management System (AIMS) prototype software developed for EPA represents the state-of-the-art in metropolitan scale air quality systems management, and by adaptation, more systematic future management of major industrial-scale operations. Integrated environmental management is a familiar concept, extending back to a decade of testing and evaluation by EPA through the Integrated Environmental Management Project (IEMP), and other related studies. The automation of much of this methodology through AIMS, however, represents a substantial development in promoting systems management of air quality for more general use.

Two major strategies exist to manage air quality: (1) through technology-based emission control standards, or (2) through tracking air quality compared with acceptable ambient air quality standards, and applying sufficient controls to attain air quality goals. Air quality management in the U.S. is a combination of these two basic approaches. Emission restrictions serve as the points of control, while ambient air quality measurements provide the basis to evaluate the adequacy of the control measures. While both components are used, they are often carried out separately. A weak connection can exist between expected air quality benefits and those benefits that are ultimately achieved. Too often, emission control programs and the review of attainment status based on measured air quality are independent activities. This disconnect has likely contributed to the limited success and/or inefficiencies in achieving projected air quality benefits. A more holistic approach that manages emissions, dispersion modeling, and ambient monitoring as a **system** would be preferable to the current methods. AIMS meets this need at the urban-scale and could be adapted for industrial-scale analysis.

1.2 AIMS as a Systems Approach to Urban Air Quality Management

Dispersion Modeling as a Coupling Function Between Emissions and Measured Air Quality

Data - Dispersion modeling can serve as an important "bridge" between emissions and measured air quality. Emissions are the points of control and the measured air quality is the basis for evaluating attainment of air quality goals. Detailed review of measured air quality vis-a-vis comparable model-predicted concentrations can give analysts the opportunity to evaluate how realistically, and under what conditions, model-predicted concentrations adequately represent baseline air quality. In other words, if predicted and observed concentrations do not reasonably agree for the selected base year, how can there be confidence that projected air quality benefits of enhanced controls will be achieved? Demonstrating adequate performance of air quality modeling using the base year inventory, on the other hand, opens many opportunities to improve the efficiency and effectiveness of air quality management.

Advantages of Enhanced Air Quality Management - There are many advantages to managing air quality at the metropolitan scale as a tested and integrated system, rather than separately managing component parts:

- Develop more effective SIP strategies. Improve confidence in "what if" analyses of control options through demonstrated model performance for the base year using actual emissions data.
- Track predicted versus observed trends associated with 15 percent plans for VOCs and NO_x, with year-by-year meteorological influences specifically considered for transport and dispersion. Specific tracers can be used to track modeled versus measured trends for selected source categories.
- Strengthen analyses for redesignation of attainment status.

- Promote metropolitan-scale air toxics exposure assessment based on comprehensive consideration of point and area sources.
- Promote evaluation of co-control benefits of alternative emission control strategies to reduce emissions of ozone precursors and reduced risks from exposures to air toxics.
- Provide a framework to promote more efficient National Ambient Air Quality Standards (NAAQS) review in Prevention of Significant Deterioration (PSD) modeling analyses for new major sources to be constructed or modified in a metropolitan area.
- Provide a more objective basis to enhance site selection and data interpretation for air quality monitoring networks.
- Provide a framework to simplify review of localized attainment of NAAQS, based on allowable and actual emissions data, as Title V comes online.
- Consider the relative importance of background (imports) to a metropolitan area relative to controllable emissions within the modeling domain.

1.3 Background on AIMS Development

AIMS was designed to achieve the preceding objectives through automation of the EPA Integrated Environmental Management Project (IEMP) air quality management methodology. This methodology was developed through 10 years of metropolitan-scale analyses conducted through the EPA IEMP and related studies. The air quality component of the IEMP was designed to consider emissions, modeling, and measured air quality data as an integrated system. Including related metropolitan-scale studies, this approach has been applied and tested in differing

degrees of detail in the following metropolitan areas: ³⁻⁸

- Philadelphia
- Kanawha Valley (WV)
- Silicon Valley (CA)
- Atlanta
- Ostrava (Czech Rep.)
- Baltimore
- Denver
- Houston
- St. Louis
- Katowice (Poland)

The initial installation of the AIMS prototype software in Baltimore is part of the Baltimore Air Toxics Study (BATS).¹⁻²

1.4 Major Components of AIMS

AIMS contains three major features: (1) the emissions component, (2) modeling component, and (3) model performance testing (Ambient Module).

Emissions Component - The emissions component was designed to compile point and area source emissions data suitably resolved to support metropolitan-scale modeling analysis. Available point source and county total emissions data for VOCs and PM₁₀ data are entered to this module. Emissions data for other pollutants, such as NO_x or SO₂, could be entered for point sources and county totals, analogous to the procedures described for VOCs or PM₁₀, which have been used to support the evaluation of air toxics. Gridded area source emissions are calculated based on spatially apportioning county emission totals as a function of land use, population, and gridded vehicle miles traveled data. Point sources that are specifically covered in the inventory are subtracted from the area source totals before spatial apportionment, with the subtraction computed as a function of source category. Refer to Volume II for additional information on the methods used to fill the emissions database for the Baltimore application.

Past metropolitan-scale studies have shown the importance of considering the variability

of emissions from point and area sources as a function of time. Emissions can vary as a function of season, hour of the day, day of week, and ambient temperature. The emissions preprocessor contains scalars that vary emissions as a function of time for point and area sources. Point source variability is based on hours of operation data, while variability for areas sources is based on default source category-specific emissions scalars, which can be overridden with metropolitan-specific data. PM_{10} and VOC data for area sources are then speciated into specific pollutants¹⁰⁻¹¹ as a function of source category, again with the option to enter data more specific to the metropolitan area, as available. Volume II provides further details on the specific temporal allocation factors used in the initial Baltimore application.

Ambient Module - Dispersion modeling results are only truly useful if they realistically represent observed air quality, considering contributions from background, point, and area sources within the modeling domain. Before using the full features of the AIMS to evaluate the benefits of alternative control scenarios or to interpret trends, the Ambient Module is available to test alternative model formulations. Alternative model formulations can be based on different options of the same dispersion model. These may include different dispersion models, different emission treatments (such as different speciation, spatial allocation, or temporal allocation factors), treatments with and without background concentrations, and so forth.

The ambient model allows testing operational model performance for up to four different model formulations per run. The goal of this module is to pair concurrent modeled and measured concentrations and compute statistical tests automatically. Results of these statistical test are displayed as a function of different groupings of the data, called data partitions. The term partition refers to grouping paired measured and modeled concentrations as a function of common conditions. Examples include grouping the paired data by season, daytime and nighttime periods, or for specific ranges in meteorological conditions. Partitioning allows the strengths and weaknesses of alternative model formulations to be isolated more effectively, which provides a systematic basis to improve the physical model treatments and model input data. The objective is to have analysts spend more time **interpreting** alternative modeling approaches and less time

setting up complex modeling analyses and post-processing the results. The present version of AIMS uses the AREA-ST⁹ version of ISCST as the core dispersion model.¹ AREA-ST allows for alternative treatments using the features of this model. Future versions could include the option of testing different core dispersion models.

The results are displayed for the full data set as a function of several variables. These variables are season, time of day (as feasible based on the resolution of measured data), stability, wind flow quadrant, mixing height, temperature, and weekday / weekend periods. This feature would be even more useful for criteria pollutants, such as PM₁₀, SO₂, or NO_x where hourly resolved measured air quality data are available. For the BATS study, 12-hour time-integrated air toxics samples were collected to support future evaluation of model performance as a function of daytime and nighttime periods. Since the data from partitions are summarized on a seasonal and annual basis, the limitations associated with displaying model performance as a function of specific time and space are minimized.

The output displays from the Ambient Module automatically present bias, correlation, noise, and other standard statistics tests for each data partition. Through sorting or partitioning the paired modeled and measured data into subgroups, more useful insights can be found. For example, seasonal bias can be displayed and potential causes evaluated. Bias as a function of flow past specific source regions can be used to target industrial and urban area sources for follow-up review of emissions data. For example, bias may be shown to be a more significant problem with flow from highly industrialized regions or from the central business district. Similarly, by displaying weaknesses in the alternative modeling approaches as a function of meteorological conditions (e.g., stability, mixing height, and temperature), the outputs from the Ambient Module may reveal underlying causes for poor performance during specific conditions. The partitioned displays can help guide refinements to inputs (e.g., point or area source emissions data) or physical model treatments, which would not necessarily be evident if results were displayed only

¹

Could be upgraded to ISCST3 in the future, which for the current use, will not significantly affect the modeled results.

for the full data set.

Output Module - This component was designed specifically for the BATS study, but has features that are generally useful. The Output Module tabulates concentrations and risks as a function of 178 source categories, separately showing the contribution from major and minor sources within each category. This output is needed to support the EPA urban air quality initiative. These displays are available for nearly 200 individual pollutants, and with risks grouped across all pollutants emitted by each source category. Contour mapping capabilities are provided, which can be overlaid onto base maps of the study area.

1.5 System Requirements

AIMS is designed to run on a personal computer in a Windows 95[®] environment. The following are recommended minimum hardware and software to run AIMS:

- Pentium Processor
- 32 MB RAM
- 1 GB available hard drive storage
- FoxPro 2.6 for Windows
- SURFER for Windows

2.0 INTRODUCTION TO AIMS OPTIONS

There are four menu options of AIMS: (1) Database Manager, (2) Air Quality Factors, (3) Air Quality Model, and (4) Ambient Module (testing model performance). Together, these components provide an integrated system for urban-scale air quality management. Access to these components is provided through the following menu bar:

Database Manager Air Quality Factors Air Quality Model Ambient Module Utilities Help Quit

A description of the capabilities under each menu bar option follows.

3.0 DATABASE MANAGER

The Database Manger subsystem in AIMS provides access to nine related tables to maintain the information used in AIMS. They are related to each other by certain key codes, such as the premise or CAS numbers. A change made in any given database is associated with the data in other tables through these codes. More detailed explanation of these tables will follow and the following list provides the names of the FoxPro files with a brief description of each.

- DSCOMPAN.DBF - general facility information
- DSEMSITK.DBF - source / stack data used for ISC input files
- DSTAPEM.DBF - emissions rates data
- DSEMISCH.DBF - operation schedule for a source / stack
- MEASDTA.DBF - measured data from monitoring sites
- MONITLOC.DBF - location of each monitoring site
- SRCCAT.DBF - 4-digit source category number and description
- RECEPLOC.DBF - receptor location data
- VAPOR.DBF - chemical properties of pollutants

These nine databases support most of the analyses done by AIMS in both the Output and Ambient Modules. **Any mishandling of this information may have serious effects to the results of the analyses.** Therefore, as a safeguard, a password option was created so that only select users can use this information. Before calling any database by using a screen, the user must type in the correct password. The steps use to change the password is given in Appendix A.

The Database Manager screens allow users to access single records stored in each table, where a record is a line of information in a table. Objects on these screens display individual fields in a record. Not every object on each screen can be edited. Write-protected parameters are shown in blue and are protected for two reasons. First, the data may be a key code that relates different tables to another, or second, the write-protected data is information pulled out from a table other than the primary one associated with the screen. For example, a facility name in the Source Data screen cannot be changed. Changes to facility names need to be made in the Facility Data screen.

Each screen also is accompanied by a control panel that provides options to scroll through the database, search for specific information, or quit the screen. There are two other search screens. One allows users to search for a premise number given the facility name. This screen is included with the Source, Emissions and Operation Schedule Data screens. The second search screen allows users to search for a pollutant number given the pollutant name. This is used with the Chemical and Measured Data screens in the Database Manager, but it also can be accessed with the Speciation Data screen in the Emission Rates submenu.

The following steps show how to search for Bethlehem Steel in the Emissions Data screen in order to view the emission rates at Bethlehem Steel.

1. Click on the Premise Number Identifier screen.
2. Type in the Facility Name in the first object and press return.
3. The Premise Number should appear in the next object. If it does not, check the spelling of the facility name. If it still does not appear, the facility does not exist in

the facility database.

4. Click on the Control Panel screen.
5. Click on the search button.
6. Scroll down the "in-field" menu to the "PREMIS" field
7. Type in the premise number and click "OK"

Immediately, Bethlehem Steel's screen will be displayed where the TAP design capacity, projected operation and allowable annual emission rates are available for review or modification.

Searching and editing in these screens are very easy but also dangerous if AIMS is used by multiple persons. Changes are automatically saved whenever users move from one object to another on the screen. Therefore, it is extremely important that users be careful even when scrolling through the database. As a safeguard, the nine data tables should be backed up periodically and saved in the c:\aims\archive directory. When doing so, the .DBF and associated .CDX files need to be saved.

3.1 Facility Data

The database associated with this screen is DSCOMPAN.DBF. It contains basic information on each facility in the point source emissions inventory, including premise number, coordinate location, and SIC code. There are currently 765 facilities in the Baltimore application. These facilities were covered through an inventory of toxic air pollutants conducted by the Maryland Department of the Environment. The primary key in this database is the six-digit premise number, which is the combination of state and facility codes. The first two digits are the state code, and the last four represent the facility code.

3.2 Source Data

The source database builds on the facility-wide data provided in the facility database. This

screen shows release specifications needed for dispersion modeling, such as stack height, exit velocity, and UTM coordinates for industrial / commercial sources that will be specifically modeled in AIMS. The five character source codes for each release point also are listed here. The first space is occupied by a letter that shows whether the source is a volume, area, or point source (V, A, or S, respectively). The final four digits are the source category. Any changes to be made to release specifications or the 4-digit source code must be made here.

Since changes in release specifications will modify the normalized concentrations used for modeling, there are warning screens to alert the user. The normalized concentrations are the basis for all concentrations and exposures output from the system. It is anticipated that changes in release specification will be rare, so the need to rerun model files also will be infrequent. Changes in emission rates are likely to occur much more frequently, but these changes are automatically updated when producing all system output, without any further actions required by users of the system. To ensure those changes in release specifications are properly updated in AIMS, users need to:

- Rerun the ISC model. This is necessary to update the normalized concentrations. Since a password will be required to modify any records in the database files, only one or several individuals should maintain responsibility for keeping the model files current.
- Run the normalized model files and area source processing programs. Refer to Section 5.3 for step-by-step instructions to rerun the model files after changes to release specifications.
- For the model performance testing procedures of the Ambient Module, it is recommended that at the start of each session the ISC model files be run to ensure the integrity of the current files. These modeled runs will be completed much faster than from the Output Module. Approximately five to ten minutes are

required on a Pentium 120 processor. On this basis, any changes to the release specification will flow to the subsequent model files. Then, testing of model performance for various pollutants could be based on the same normalized concentrations.

3.3 Emissions Data

The emissions database file, DSTAPEM.DBF, contains the point source emissions inventory compiled by MDE. This is the master file for allowable and projected annual average and maximum emission rates. All changes to point source emission rates need to be made here. In practical terms, only a fraction of the available fields is filled for the Baltimore application. Frequently, the allowable and projected emission rates are the same. As these data are refined, the quality of the AIMS outputs will improve. Once emission rates are changed in this master file, then the output features automatically link these emission rates with the normalized modeling and produce exposures, concentrations, and risks based on the updated emissions data.

The screen shows the emission rates associated with each pollutant (identified by a p-number) in a given facility. The Toxic Air Pollutant (TAP) emissions are listed for design capacity, projected operation, and allowable annual emissions in lb/hr for short-term maximum concentrations and tons/yr for annual average concentrations. When running the ISC model, the emission rates used from this table is the TAP projected operation in tons/year.

3.4 Operation Schedule

This screen is used to set up the scalar treatments in the ISCST model input files. When emission rates follow a diurnal or seasonal pattern, there is a strong potential for bias. This screen allows a user to describe seasonal and diurnal characteristics of sources in a facility. If changes are made here, however, it would be necessary to recreate the model input file and to rerun the model before creating further output. Just as in the Source Data screen, a warning was added to

this option to alerting users of this requirement. Running the model typically takes a several hours. Therefore, it is recommended that the execution take place overnight. The need to rerun the model should be infrequent (such as once or twice per year)

The objects on the screen display the times a stack is in operation. The displays are shown in minutes per hour, hours per day, days per week, and weeks per year. Users also can indicate whether the stack operates continuously or intermittently, and enter the seasonal percentage of operation. The maximum sum of the seasonal percentages is 100. Therefore, if each season is at 25 percent, the stack is operating continuously. Other important objects on this screen are the UTM coordinates for the sources.

3.5 Measured Data

This screen displays the measured air quality data that will be used in AIMS to support model performance evaluation features in the Ambient Module component of the system. The objects on the screen describe the receptor at which the data was recorded, the averaging period, date of sample, the starting hour of sampling period, and the concentration of the different pollutants.

For users of AIMS outside Baltimore, the measured data file should be set up in an ASCII table with columns in the following order: receptor name, date of sample, starting hour of sampling period, the averaging period, and the pollutants listed horizontally.

Generally, these data would not be modified once entered into AIMS. While this screen is not used to input a full measured air quality data set (refer to the above for that), providing corrections is useful, as needed, to the data set. The prototype is set up using pollutant numbers, or p-numbers. The Pollutant Identifier screen can be used as follows to make the connection between pollutant name and pollutant number:

1. Click on the Pollutant Identifier Screen.
2. Type in the Pollutant name where indicated and hit return.
3. The Pollutant number will appear in the next object of the screen.

The dates, start time, and sample duration, are used to match model input files for the Ambient Module. The Monitor Data screen described next contains the location coordinates also needed to create the matched modeled/measured data set.

3.6 Monitor Data

This screen simply displays the UTM coordinates for each monitor. Errors in coordinates can be corrected here. With the on/off times available from the "measured data" data base, these screens allow AIMS to set up matched modeled and measured data files.

3.7 Source Category

While AIMS models major point sources as discrete locations, the need to group common facilities (including area sources) to display exposures and risks is important. This allows culpability to be displayed more clearly. AIMS uses four-digit source category codes to group facilities, including common tagging for point and urban area sources. The first two digits refer to the major category, while the last two provide a finer resolution. For example, source category 0105 refers to combustion sources (01) and stationary internal combustion engines (05). These source categories are write protected to reduce the possibility of inadvertently changing a code number. While there generally is not a need to modify the source category numbers or descriptions, there can be a need to add new categories. Currently, the only way to add new records is to append them while in the database itself. The following steps describe how to do this:

1. Exit out of the AIMS system.

2. In the Command Window, type `SELECT 0`
3. Next, type `USE SRCCAT.DBF`
4. Type `APPEND`.
5. Type in the information prompted when the append window comes up for the `SRCCAT.DBF` database.
6. After typing in all the new records, move the mouse over the upper left hand corner of the `APPEND` screen and click on the Microsoft FoxPro icon. Scroll down to `CLOSE` and click closed
7. In the Command Window, type `DO aqmsmde` to start AIMS again.

Future versions of AIMS could have an option to add records while still in the system.

3.8 Grid Data

The database `RECEPLOC.DBF` contains information on grid cells. The only field likely to change is the population data. When the population data need to be updated, users can simply insert the information into the appropriate object. Refer to Volume II for a description of the procedure followed to fill these fields for the initial Baltimore application.

The importance of this screen is in identifying the boundaries of grids within different counties. Each grid cell is numbered from one to 100, and the southwest corner of the grid's coordinates are shown in UTM coordinates. The length of each grid is displayed along with the county in which this grid is located and the population residing within the grid. This information is used when processing the area source emissions and to support exposure assessment analyses.

3.9 Chemical Data

This screen contains all of the chemical-specific data used in AIMS, including physical characteristics and health effects data. Each chemical has a p-number, the chemical referencing code in AIMS. The information provided for the chemical are vapor pressure, molecular weight,

chronic cancer potency, relative reactivity (used for co-control analyses to show the benefits of air toxics control strategies to reduce ozone precursors), residence time, chronic and acute RfCs (reference concentration), dry deposition, washout ratio (available input to wet deposition analyses) and background concentration.

4.0 EMISSION RATES

Since AIMS is currently a prototype system, it is important to recognize that many required information to populate these databases require substantial processing outside AIMS, such as the urban area sources. When AIMS is taken to full development, each of these inputs could be prepared via AIMS input screens and processing programs. For the initial Baltimore application, however, the urban area source components were computed by linked spreadsheets, including the data required by AIMS to show the percent allocation of VOCs and PM₁₀ for each grid and the identification of growth factors for each source category. The screens that display these databases are shown under the Emission Rates menu bar.

Currently, users can adapt the current spreadsheets, as described in Volume II, or can use alternative procedures to meet the input requirements of AIMS when applying AIMS to other metropolitan areas, or to different years of coverage in Baltimore. The initial installation in Baltimore is set to 1990 as the base year.

AIMS can serve as a repository for point and area source data. In the initial Baltimore demonstration, the air toxics data are contained in AIMS as a stand-alone database. In future applications, when larger state wide emissions systems are used as the primary emissions repository, a utility could be written to connect the analytical features of AIMS to a different master emissions inventory. For this user's guide, it is assumed that AIMS is installed as a stand-alone system, where air toxic emissions data for the Baltimore metropolitan area are maintained directly in AIMS.

The Emission Rates component of AIMS contains five subsystems that are available to maintain the emissions data used in the system: Area Source Scalars, VOC County Totals, PM₁₀ county Totals, Speciation Factors, and Grid Cell Spatial Allocation Factors. A description of each follows.

4.1 Area Source Scalars

This screen allows for the recreation of the urban area source emission scalars for six different categories. For each area source group listed, users can readily modify the assumptions initially made as defaults when the system was installed for the initial Baltimore application. For example, the defaults used for industrial / commercial operations on a 5-day schedule assumed the plants operated from 9 a.m. to 5 p.m. For swimming pools, the percentage of outdoor pools were assumed to be 80 percent, operating from 9 a.m. to 9 p.m. Simple changes can be made, and then the normalized modeling results would need to be updated and processed to fully incorporate these changes into the system. The first two categories, Home Heating Sources and Mobile Sources, have unique features, which are described below.

Home Heating Sources are complex because different fuel apportionment and emission rates apply to each county. Although it is possible to change these scalars, the complexity of this component prevented it from being fully accessible to the user via the input screens in AIMS. Therefore, when users select this option, a window will appear stating that this option is not available at this time.

Mobile Sources, the second option, allows users to modify the mobile source scalars, such as for an updated base year or for applications in another metropolitan area. MOBILE5 or future emissions models could be used to compute emission scalars relative to typical ambient temperatures and vehicle speeds. Refer to Volume II for further details on how this information was set up for the initial Baltimore application. Users should be careful that a suitable fleet mix and options are selected that represent the base year, since growth scalars are used to show

relative differences in emissions from each area source category (including mobile sources) as a function of the number of years after the base year. The base year emission scalars and growth factors need to be compatible.

Pressing the remaining four options will produce small windows that prompt users for information needed for the specific area scalar. For example, for industrial and commercial source scalars operating on a five-day schedule, users will be prompted for the beginning and ending hours of the facilities. Default values of 9 and 17 hours are displayed, but users can edit these values by simply typing in the desired value and pressing return.

After making any adjustments, users will be asked whether the scalar file will be prepared then. If users choose to continue to create the new scalars, the Windows[®] environment of AIMS will be temporarily disabled. The scalars are automatically created by running a FORTRAN program in the MS-DOS mode. After completion of the run, the user must click the MS-DOS window closed to return to AIMS.

4.2 VOC County Totals

This screen simply lists county total VOC emission for each area source category (four-digit codes). If updated data or more metropolitan-specific area source emissions data become available, these values can be easily updated. No further processing is required to fully incorporate these values into the system. For applications where bottom-up emission inventories are available, the use of such data would be preferred. Our recommendation would be to set the total VOC emissions for each county to match the source category total compiled based on metropolitan-specific data. Then, the speciation menu can be used to incorporate metropolitan-specific speciation data to correspond to these county totals. In this sense, the use of county-wide VOCs and national speciation factors can be considered as defaults. For example, if more specific data could be compiled on industrial solvent use in a metropolitan area, such data could be readily incorporated into the county totals and speciation database for this source category (refer to

speciation described later in this section).

4.3 PM₁₀ County Totals

These entries are comparable to the VOC data described above. Again, if more site-specific data are available, they should be incorporated into the database as listed above.

4.4 Speciation Factors

These screens give users the flexibility to modify the default speciation data used to allocate VOCs and PM₁₀ into component species as a function of source category (4-digit codes). The percents of each individual species are listed. Each pollutant will have either a "V" or "P" designation internally in AIMS. Therefore, the percentage values will apply either to VOCs or PM₁₀, but not both.

Users need a means of relating pollutant numbers to pollutant names. As a guide, the Pollutant Identifier window on the right side of the desktop screen contains a feature that allows users to enter a pollutant name and then display the pollutant number.

4.5 Grid Cell Spatial Allocation Factors

This screen displays 38 categories of emission factors that are inputs to AIMS on how to apportion county emission rates into individual grid cells. These factors are based on land use, population, and vehicle miles traveled. The initial information displayed on this screen are yearly growth factors for the various categories listed.

5.0 AIR QUALITY MODELING

The previous two menu bar selections dealt primarily with data management. By selecting

this option, AIMS enters the dispersion modeling component of the system. Users can choose to merge tables, create the ISC input file, run the file, view the output, calculate speciation factors, recalculate the actual factors, or go into the Output Module. Calculating speciation factors applies scalars for industrial / commercial and home heating sources according to the fuel type per county. Recalculating the actual factors sets the normalized concentrations back to their original values, and this option is available in case users want to reapply scalars differently.

Merging tables will create the main data file by extracting data from the existing databases. The files used are facility, source, operation schedule, emissions, and chemical tables. BALTEM.TXT is created which is used later to create the normalized ISC input file.

5.1 How to Create a New ISCST Input File

The ISCST input file is created two different ways, depending on whether users want to run the model in the Output or Ambient Modules. The procedure, however, is similar for both. Therefore, only the procedure for the Output Module will be addressed here. Creation of the ISCST input file begins by choosing the Air Quality Model menu bar option and clicking on Create ISC Input File.

At the top of the first screen are lines for two titles for the input file. Title one is a mandatory input, whereas title two is not. Initially, the default box is checked which disables the following options: gradual dispersion, no stack-tip downwash, no buoyancy-induced dispersion, bypass calms processing routine, and use emission data processing routines. Clicking on the default box allows users to choose these options as a part of the ISC run. Other options initially set are the averaging period, pollutant name, terrain heights, elevation units, and whether or not to run. The averaging period is set for one hour periods, but it can be changed to six hours. However, this is not recommended because the scalars used throughout AIMS are based on hourly data. There are six pop-up options for pollutant: Other, SO₂, NO_x, CO, PM₁₀, or TSP. "Other" is the default option and should be used to create the normalized concentrations. Terrain

height can be flat or elevated, the elevation units can be in feet or meters, and the run option is set to RUN. If users want to check if the input file was created properly, click the RUN option off. Running the ISC model that way will test the input file for completeness.

After clicking the finished button on this first screen, a second screen that will prompt users to identify the meteorological data to be associated with the ISC input file. The meteorological data files available in the current directory will be displayed so users can choose the appropriate file. Users can input the anemometer height information, and edit the upper air and surface station information. Currently, the station numbers displayed are defaulted for those related to Baltimore. This information needs to match what is contained in the meteorological file or running the ISC file will create errors. The other objects in this screen show the processing days and give users the option to rotate the wind direction any amount of degrees. Finally, clicking on the FINISHED button will write the information users have entered to a temporary file for processing.

AIMS does not create the final ISC input file until right before it is needed to run. Therefore, the user does not have the option of viewing the final input file until after the ISC model has been run. To understand more of the options that go into the input file, refer to the ISC User's Guide.

5.2 How to Run ISCST

Just as in creating the ISCST input file, there are two ways users can run the ISCST model, in the Output or Ambient Modules. Running the model in the Output Module will update the normalized concentration file.

Running ISC to update the normalized concentration file requires about 372M bytes of memory, so it should be done very sparingly. The ISC run will create a large file, AREACONC.BIN, which is kept only temporarily to process hourly normalized concentrations

and scalars. After processing this information, AIMS deletes AREACONC.BIN and saves only the pertinent data needed to recalculate the normalized concentrations. Running the ISC model is simple. Under the Air Quality Model menu bar, select the Run ISC option. It will create the necessary ISC input file, run ISC, and process the output for the normalized concentration file.

Whenever AIMS runs the ISCST model, it does so in the MS-DOS mode. An MS-DOS window will come up as AIMS executes the model. When it is finished, users must close the MS-DOS window to return to AIMS. The system will then continue processing from where it left off. Running the ISCST model can take anywhere from several minutes in the Ambient Module to several hours in the Output Module. Therefore, users should plan accordingly, even to the extent that the ISCST runs are done for the Output Module overnight or over a weekend.

5.3 How to Recalculate Concentrations

The Output Module provides users options to test out different scenarios and try future projections that may change the emission rates. Since the data used in the Output Module may be from an old ISC run, the concentrations in the current table may have been corrupted from previous usage. Therefore, AIMS has the option to recalculate the concentrations from the original ISC output files and reset the emissions data. To do so, under the Air Quality Model menu bar, simply select the Recalculate Actual option. This option should be executed before entering the Output Module as a safety measure to use the correct data when doing what-if and future projection analyses.

5.4 How to Do "What If" Analyses

To conduct a "What If" analysis, users must be in the Output Module. The Output Module is under the Air Quality Model menu bar and selecting it from the menu will create a new menu bar with the following options:

What-if Analyses Future Projections Generate Displays Create Report

Selecting "What-If Analyses" will bring up several windows simultaneously. One window will show source group numbers with applicable scalars. Another window provides users with options to apply or clear scalars, reinitialize the database, or exit the screens. Two additional windows are available to help users identify names for the various source group numbers.

In the scalars window, the values for the scalars are all initially 9999.000. Users can simply enter the scalars window and change any of the numbers to the desired value. After making the changes, in the second window, click the Apply Scalars option. Doing so will apply the new scalars to the applicable concentrations. AIMS applies this value by simply multiplying it to the source's normalized concentration. Therefore, to model a twenty percent reduction to a source group, 0.80 should be entered into the scalar column. To view the results, users will need to go to the Create Report menu bar option and select a report from those available. If scalars are applied for all sources in a source group and also for a site specific facility, the facility-specific data has priority.

5.5 How to Do Projections of Air Quality for Years Past the Baseline Year (*which is 1990*)

Future projection of air quality is done by selecting Future Projections from the Output Module. The screen that appears with this option allows users to select the number of years to be projected from the base year, or 1990. AIMS calculates the future projections by multiplying the VOC or PM₁₀ growth factors times the existing concentration values for the number of years projected. The results of applying growth factors can be seen by creating a report from the Create Report option.

5.6 How to Generate Displays

Selecting Generate Displays from the Output Module allows users to either Plot Data or

create one of seven reports. With the Plot Data option, users can create up to six different plot files, as shown on the upper right-hand corner of the screen. Simply enter the name of the file to create in the box that describes the file desired. The options are for concentration, exposure, or cancer plot for the second-highest 1-hour or annual average data. On the left side of the screen, choose from nine different options to designate the type of sources to include in the plots. The main divisions are for industrial or urban sources by source category. For source category, users can choose to include all sources or select one by entering the source category number in the appropriate box. Besides the source category, users can also choose the pollutant(s) to process. Clicking on the Create Plot will create the files indicated.

To create the actual plot, users must run SURFER² by clicking this option on the menu bar. While in SURFER, select GRID from the menu bar and click on DATA. Choose the appropriate .DAT or .TXT file to process from those available. When AIMS creates plot files, it stores them in the directory appropriate for its category. The three directories are CONC for concentration plots, CANCER for cancer plots, and EXPOSURE for exposure plots. In the following screen that comes up with the selected file, click OK. After SURFER processes the file and creates a .GRD file, users can view the results by choosing MAP and then CONTOUR from the menu bar. For more details on running SURFER, refer to the SURFER User's Guide.

Seven standard reports are available through the Output Module. They are:

- Cancer Case by Source Category
- Cancer Risk by Grid and Source Category
- Cancer Risk by Pollutant Contribution
- Hazard Index by Grid Cell
- Hazard Index by Pollutant
- Exposure by Grid Cell

²

The SURFER software needs to be in the c:\windows\winsurf directory in order for AIMS to execute it.

- Reactivity by Source Category

When users click on the report desired, AIMS will guide users to a screen where they can choose Annual or Second Highest 1-Hour averages. Users can also preview before printing. With some reports, users also have the option of choosing the pollutant(s) for the report.

6.0 AMBIENT MODULE (MODEL PERFORMANCE TESTING)

This final part of the AIMS system allows users to test different model performance up to four different model formulations per run. The options under this menu bar are first, to conduct a Model Performance Test and second, to view results. The Performance Test will run three programs that will match measured and modeled data, assign partition numbers to each measured block, and conduct statistical analyses. Before running this series of programs, however, AIMS will guide users through a series of screens to create ISC input files and enter in emission rate scalars for emission reductions. AIMS can either use the latest ISC run output or rerun the model (preferred approach) with the options users provide. Running the ISC model in the Ambient Module does not take as much time or memory as running it in the Output Module, so it can be easily run to evaluate different model formulations.

Two of the three screens that appear by running the Ambient Module are the same as those when creating the ISCST input file of the Output Module. The third screen, however, gives users the option of entering in emission rate scalars to model emissions reductions for a specific year. Initially, the yearly values are all set to 9999 by source group. To change the values to reflect the expected reductions, simply click on the year and source group desired and make the change. Note that even if the change is only for one year of the five, users must change the 9999 to zeros for the remaining years. Otherwise, the presence of the 9999 will cause AIMS to ignore the reductions in the other years.

After running the performance test, users may view the results. The reports available

show the summary sheet, the summary statistics, and the diagnostic results. In addition to these results, users also may attain a graphical display of the modeled vs. measured values used in the statistical analysis. This is created in the Trends Analysis part of the Ambient Module.

The Trends Analysis runs the `_GENGRAPH` function of FoxPro 2.6. The first screen to appear will allow users to type in the model formulation number, number of receptors, and the averaging period of interest. The averaging periods can be for annual, seasonal, or for each measured averaging period. Clicking on Continue will start the graphing process.

First, users must select the type of graph desired from the screen. Selecting the line graph produces the best results for this analysis. The next screen shows the axis and the legend. Simply continue to the next screen. Enter a title for the graph, and click Next to display the graph.

When the graph appears, values in the x-axis of the graph should be adjusted so that it will be easier to read. The following steps will change the format:

1. When the graph is displayed, click on Zoom.
2. On the graph that is shown next, double click the mouse and reformat the graph display.
3. To reformat the x-axis, double click on the x-axis and a Format Axis window will pop up.
4. On the Number page of this window, click Date as the category.
5. Next, in the Alignment page, click the text that prints the value sideways.
6. Click OK, and the x-axis should then be formatted to read the dates more easily.
7. To return to AIMS, refer to the window behind the graph. Click on File and select Exit and Return to FoxPro. Close the window that has the graph, and users will return to the initial screen that displayed the graph on the AIMS system. From here, users can print or save the graph, or click OK, which will take users back to the Trends Analysis Graphing Utility window.

7.0 UTILITIES

Under this menu bar, there are five options, but only two are available at this time. The

two current options are to run SURFER and execute the Filer program in FoxPro. SURFER will run the graphing software of the same name, and Filer will bring up a simple file manager available through FoxPro. The other utilities could be added in the future.

REFERENCES

1. Sullivan, David A., Dennis J. Hlinka, and Thomas G. Grosch, "Strategic Planning and Coordination Efforts for the EPA Baltimore Air Toxics Study," Annual Meeting of the Air & Waste Management Association, June 1995.
2. Sullivan Environmental, "Baltimore Air Toxics Study Project Report," Prepared for the U.S. Environmental Protection Agency, Region III, Contract # 68-D30035, March 1995.
3. Sullivan, David A., Thomas G. Grosch, and Dennis J. Hlinka, "Atlanta Ozone Precursor Study: Dispersion Modeling of NO_x and NMOC," presented at the Annual Meeting of the Air & Waste Management Association, Kansas City, Missouri, June 1992.
4. Sullivan, David A., Dennis J. Hlinka, and Thomas G. Grosch, "Monitoring Network Strategies to Address the Potential 15-Minute to 1-Hour SO₂ Ambient Air Quality Standard," presented at the Annual Meeting of the Air & Waste Management Association, Kansas City, Missouri, June 1992.
5. Sullivan, David A., Dennis J. Hlinka, and Thomas G. Grosch, "Monitoring Network Strategies to Address the Potential 15-Minute to 1-Hour SO₂ Ambient Air Quality Standard," presented at the Annual Meeting of the Air & Waste Management Association, Kansas City, Missouri, June 1992.
6. Sullivan, David A. and Alan Jones, "Results of the U.S. Environmental Protection Agency's Air Toxics Analysis in Philadelphia." Air Pollution control Association Annual Meeting, Detroit, Michigan, June 19, 1985.
7. Sullivan, David A., "An Evaluation of the Effectiveness of Dispersion Modeling to Estimate Human Exposure: A Case Study Based on the Baltimore Total Exposure Assessment Methodology (TEAM) Study," presented at the 1989 EPA/ Air & Waste Management Association International Symposium on Total Exposure Assessment Methodology, Las Vegas, Nevada, November 29, 1989.
8. Sullivan, David A., "Lessons Learned From the U.S. Environmental Protection Agency's Kanawha Valley Studies of Toxic Air Pollutants," presented at the Annual Meeting of the Air & Waste Management Association, Pittsburgh, Pennsylvania, June 1990.
9. USEPA, "User's Guide for the Industrial Source Complex (ISC2) Dispersion Models - Volume I - User Instructions," U.S. Environmental Protection Agency, EPA-450/4/92-008a, Office of Air Quality Planning and Standards, Research Triangle Park, NC, March, 1992.
10. USEPA, "Air Emissions Species Manual: Volume 1 - Volatile Organic Compound Species Profiles," PB88-225792, Office of Air Quality Planning and Standards, Research Triangle

Park, NC, April 1988.

11. USEPA, "Air Emissions Species Manual: Volume 2 - Particulate Matter Species Profiles," PB88-225800, Office of Air Quality Planning and Standards, Research Triangle Park, NC, April 1988.

APPENDIX A

CHANGING THE PASSWORD

The following steps assume that AIMS is not running and that the user is in FoxPro. The steps to changing the password is as follows:

1. In the Command Window of FoxPro, type SET DEFAULT TO c:\aims.
2. Type MODI PROJ AQMSMDE.
3. Scroll down the project window until Password Screen Set appears. Double-click on it.
4. In the window that pops up, click on Edit. The password screen should come up.
5. From the menu bar, select SCREEN.
6. Select OPEN ALL SNIPPETS, or do ctrl-S.
7. Escape from the windows that pop up until you are at the PASSWORD - SETUP window.
8. Type in the password desired to replace the password currently in the quotation marks for m.codeword.
9. Hit ctrl-F4 twice and when asked to save, click on YES.
10. Once back into the FoxPro desk top, in the AQMSMDE project window, click on BUILD.
11. Rebuild project to install the new password.
12. In the Command Window, type DO AQMSMDE to start AIMS.

Technical Report Abstract

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REPORT ABSTRACT

This report describes the Air Quality Integrated Management System software developed in conjunction with the Baltimore Air Toxics Study. The system addresses the need for a holistic approach to manage emissions, conduct dispersion modeling, and monitor the ambient air quality. The report itself details how to use the many features of the software, such as managing the database, running the ISC model, conducting what-if and future projection analyses, and performing model testing compared with measured data.

KEY WORDS / DESCRIPTORS

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1.0 BACKGROUND

Title III of the Clean Air Act of 1990 (Section 112(k)) requires that EPA develop a national strategy to control emissions of toxic air pollutants from stationary area sources. By definition, stationary sources emit less than 10 tons / year of individual hazardous air pollutants (HAPs), and less than 25 tons / year of cumulative HAPs. The goal of this strategy is to complement the management of major sources through controlling groups of stationary industrial sources that collectively could pose high risks for cancer and other human health effects, including both chronic and acute exposures.

Congress has directed the national strategy to manage 90 percent of the toxic air pollutants emitted from stationary area sources. It also has set the goal of developing regulations aimed at reducing the incremental incidence of cancer from stationary area sources by 75 percent.

EPA needs to identify 30 pollutants that pose the most significant risks by stationary area sources, and identify the most significant sources that emit these pollutants to meet the requirements of the Clean Air Act. This effort needs to consider the range of pollutants broadly (e.g., across the 189 hazardous air pollutants), and consider impacts across a wide range of source categories, including the 166 source categories established by EPA through Title III.

Congress specified in Section 112(k) of the Clean Air Act that EPA study area sources to help formulate the policy for regulating stationary area source emissions of toxic air pollutants. The focus of this study was set on stationary area sources. The goal is to support the decision by EPA further to regulate stationary area sources that are minor under Title III. Beyond considering exposures to directly emitted air toxics, EPA also needs to consider the connection between urban area sources and: (1) ozone precursors, and (2) transformation issues. Following these studies, Congress has directed that ambient monitoring and emissions modeling be done to demonstrate that the goals and objectives of the national strategy for stationary area sources are being met.

EPA has selected three metropolitan areas to be studied to support the development of the national strategy: Baltimore, Chicago, and Houston. EPA's goal is to use the results of these three independent studies, which should broadly rank stationary area source categories for exposures and

risks, to help define the most significant 30 pollutants and identify stationary area source categories that potentially may need further regulation.

The Baltimore Study is particularly significant because EPA has focused its ambient air quality monitoring resources in Baltimore to support the national strategy. This provided special opportunities for Baltimore to support the development of the national strategy, and to evaluate objectively the achievement of the goals of the formulated plan in the future. In summary, the availability of enhanced measured air quality data in Baltimore provided opportunities:

1. To test dispersion modeling versus measured air quality through the available three-year VOC data set at three sites in Baltimore. In addition, the EPA Office of Research and Development (ORD) augmented monitoring at the Essex site. The augmented monitoring at the Essex site broadened pollutant coverage to include formaldehyde, pesticides, metals, and products of incomplete combustion.
2. To further strengthen the confidence in the air toxics dispersion modeling assessment. This could occur by confirming the source apportionment of concentrations based on receptor modeling at the Essex site, the EPA supplemental data set. This component was not addressed at this time.
3. To serve as an example to show trends based on joint review of the long-term measured data planned by ORD with dispersion modeling. This could help confirm the goal set by Congress to evaluate the effectiveness of the national strategy for stationary area sources.

2.0 INTRODUCTION

The goal of this study was to support the national strategy for area sources, and the State of Maryland's two supplementary objectives of: (1) using measured data to confirm model-based findings, and (2) to develop an integrated approach that can jointly track air toxics and ozone precursors. This introduction is presented in two subsections: 2.1 (Study Design), and 2.2 (Examples of Initial Results for Baltimore).

2.1 Study Design

The general project design is presented in Figure 2-1. The first steps in this project included the necessary data gathering, review, and processing. Five basic data categories were considered: population data, gridded mobile source vehicle miles traveled (VMT) data, USGS land use data, five years of meteorological data, and pollutant characteristics data. To manage all this data, a core data base management system was developed that handles all the data to be compiled and used to create dispersion model input files and store model concentrations. This system also is used for model performance testing.

This system, called the Air Quality Integrated Management System (AIMS), is central to the data analysis of the Baltimore Air Toxics Study (BATS) study, and is described in this section to provide an introduction to this study.

AIMS is a software that supports data tables to integrate all metropolitan-scale information on emissions, dispersion modeling, meteorological data, and measured air quality. The objective of the system is to promote more effective air quality management at the metropolitan scale. AIMS does this through confirming compatibility between modeling the available emissions data (point of control) and the available measured air quality data (proof of attainment with ambient standards or health thresholds). The system automates the procedure of isolating model performance compared with measured air quality by showing performance as a function of a wide range of meteorological conditions, time of day and season, and as a function of flow past specific source regions.

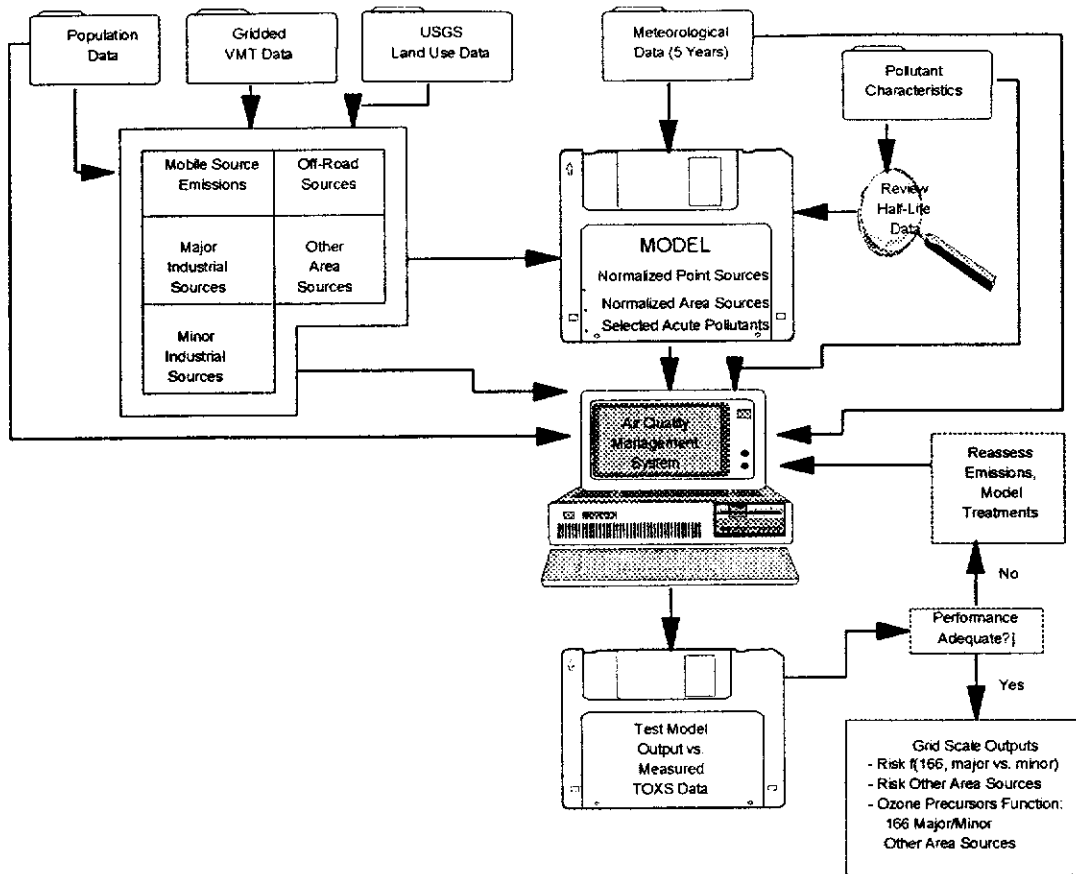


Figure 2-1 Basic Flow of Modeling Procedure

In addition, after reasonable model performance is shown, AIMS can display the benefits of alternative control strategies by showing exposures and risks for each alternative and the reductions of ozone precursors for that control strategy. By starting with a modeling system that has been optimized and confirmed through measured data, the selected air quality management strategy should achieve the projected air quality benefits. An ideal metropolitan-scale air quality management system would have the following characteristics:

1. **Automate emissions data base management** for point and area sources, including the automatic download to create dispersion model input files.
2. **Account for the variability of emissions** as a function of time of day, season, weekday versus weekend, and ambient temperature.
3. **Include consideration of background air quality.**

4. Be able to **display trends in air quality** by contrasting model predicted concentrations with measured (observed) concentrations. This would provide a means to rapidly identify the need for mid-course corrections to control strategies. Users also could create a variety of graphical displays and spreadsheets of measured and modeled concentrations. Through comparing concurrent tested model results with observed trends, meteorological influences on trends can be reduced.
5. **Automate the pairing of measured and modeled concentrations to test model performance.** Provide an automated procedure to pair modeled concentrations with measured concentrations for each receptor and modeling formulation modeled.
6. **Display the strengths and weaknesses of model performance** as a function of meteorological conditions and temporal factors. This information could then be displayed along with interpretation of the measured and modeled data for each receptor and each model formulation modeled.
7. An array of **statistical results to assist the user in determining the best model formulation** for the current modeling scenario. These statistical calculations would include those recommended by EPA / AMS committee (Fox, 1981).
8. Contain features aimed at supporting the **interpretation of the measured and modeled data to isolate questionable emissions data.** This information can be used to highlight model bias relative to measured data as a function of season and flow past each source region around each monitor.
9. **Promote the use of metropolitan-specific data to apportion classes of pollutants,** such as VOCs and PM₁₀ into specific constituents.
10. **Automate the evaluation of "what-if" scenarios** through showing risk benefits and the ozone precursor reductions benefits for each control scenario.
 - Main module of AIMS allows for display of benefits of alternative control scenarios in terms of risk reduction and reduction in ozone precursors.
 - Shows results as function of major and minor sources and as a function of 4-digit source category.
 - Considers cancer and non-cancer effects (chronic and acute).
11. Use **GIS-based displays to facilitate the presentation of output data** from the system.

AIMS was developed to provide each of these features to promote the effectiveness of managing metropolitan-scale air quality.

The remaining sections of this report are organized as follows:

- Section 3.0 - Recommended technical approach that discusses general as well as specific emissions data input requirements.
- Section 4.0 - Supplemental input data files needed for proper utilization of AIMS.
- Section 5.0 - A discussion of dispersion modeling within AIMS.
- Section 6.0 - A discussion of the currently available measured air quality data.
- Section 7.0 - Features of AIMS.
- Section 8.0 - Receptor modeling component.
- Section 9.0 - Summary / conclusions / recommendations.

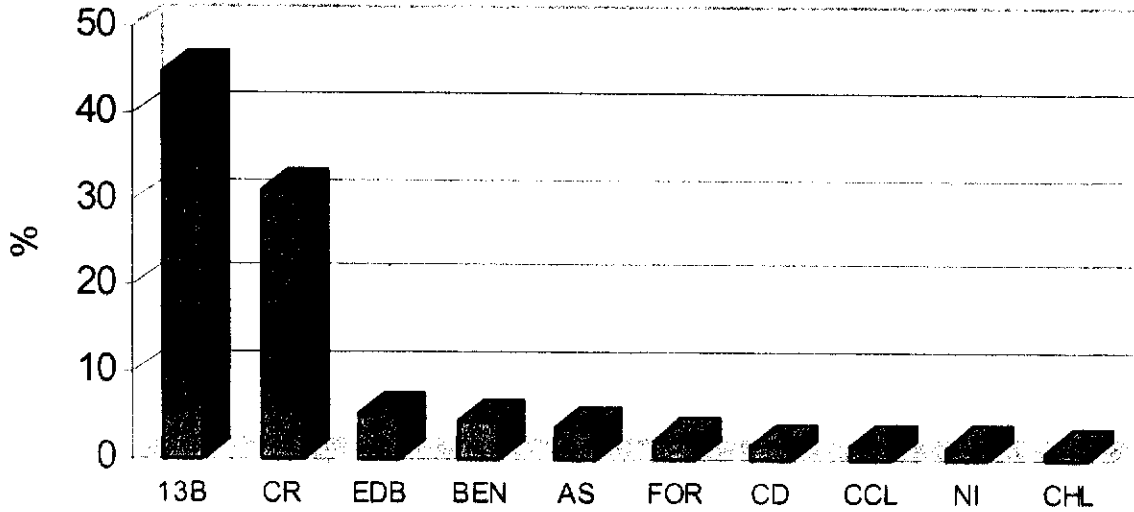
2.2 Example Results From Initial BATS Demonstration of AIMS

Tentative results are available for the Baltimore metropolitan area, pending further confirmation by the Maryland Department of the Environment (MDE). These results are presented in this section in order to provide examples of the benefits of the AIMS system. The remainder of this report then provides the technical background on the system. Volume 1 is the user's guide for AIMS.

Specific examples of initial Baltimore results (as of August 20, 1996) are as follows:

- Figure 2-2 presents pollutant rankings for cancer and contributions to the hazard index (non-cancer effects). *1,3 butadiene and chromium are shown as the dominant contributors for cancer. Two important points need to be considered when interpreting these results. First, based on comparison with measured data (considering metropolitan-specific measured data and measured data from the UATMP study), it appears that populated weighted modeled 1,3 butadiene exposures are high by a factor of four. This bias appears to be due to the high reactivity of the pollutant with photochemically produced pollutants, such as ozone, which is most evident for monitoring sites removed from the central business district. On this basis, 1,3 butadiene cancer risks may not be as dominant as suggested by Figure 2-2. Second, the chromium risks are expected to be highly overstated because all chromium was treated as hexavalent for screening purposes. If distributed between the hexavalent and trivalent states as a function of source category, it would be expected that the chromium ranking would drop substantially. For the noncancer hazard ranking, on the other hand, acrolein is shown to be the dominant pollutant. Ethylene dibromide, hydrochloric acid, and manganese also are shown to be relatively high contributors to the hazard quotient.*

Top Pollutants for Cancer Ranking



Top Pollutants Contributing to Hazard Index

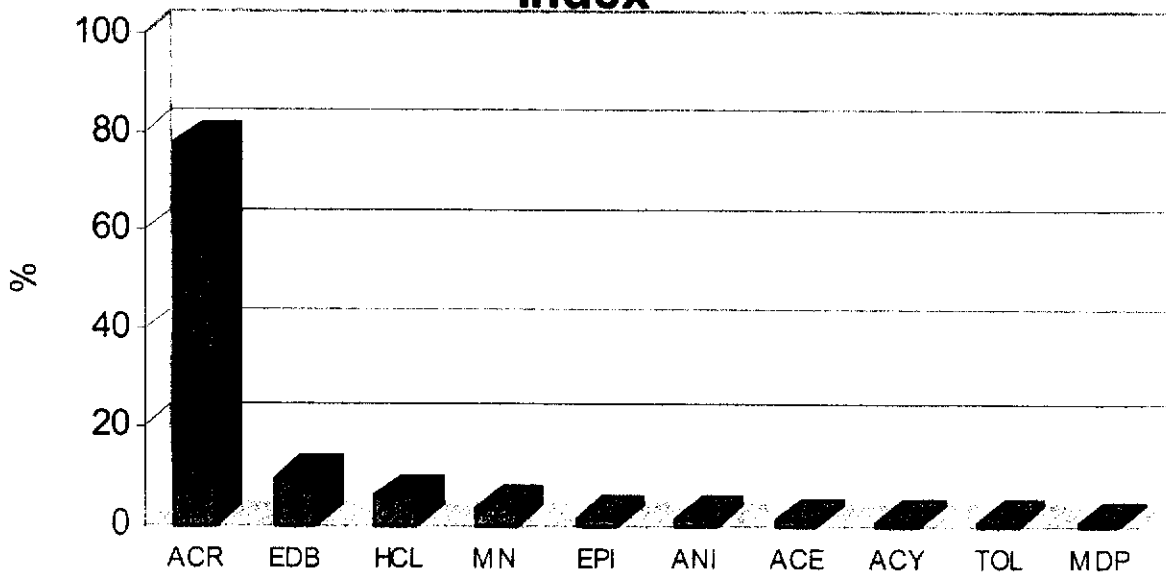


Figure 2-2 Pollutants Contributing to Cancer and Hazard Index

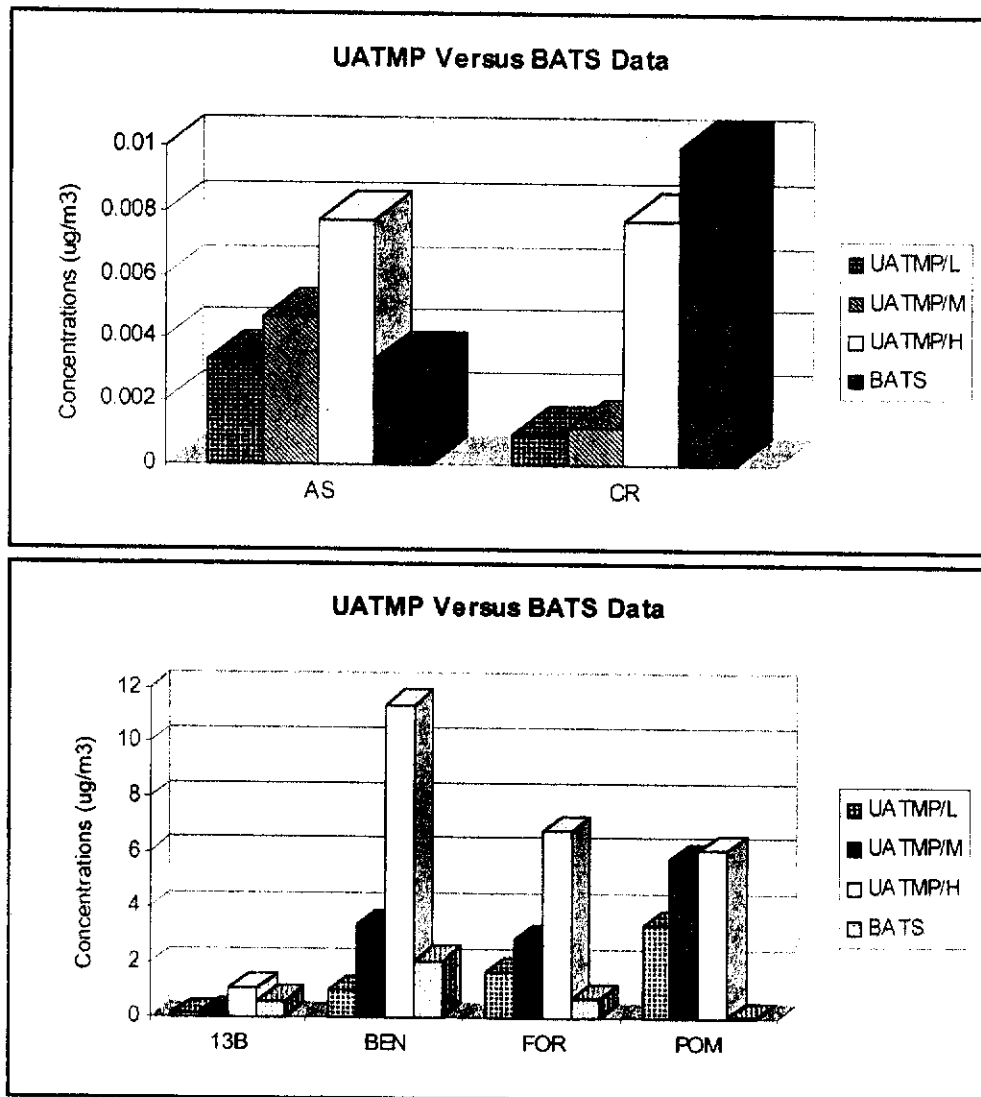


Figure 2-3 UATMP vs BATS Data

- Figure 2-3 compares population-weighted average modeled BATS concentrations with measured concentrations from the 30 city UATMP study (EPA, 1994). Pollutants with available measured data and relatively high cancer risks were selected. *Some interesting observations can be noted. Chromium (total) concentrations are shown to be high compared with the total chromium concentrations measured in the UATMP study. Although the limitation of using total chromium as a surrogate for trivalent chromium remains an important limitation, it is possible that chromium risks in Baltimore may be high compared with other cities because of the specific industrial base in this metropolitan area. Figure 2-3 also bears out some anticipated findings: (1) modeled 1,3 butadiene exposures are high by a factor of approximately*

four, apparently due to the high reactivity of this pollutant with ozone and/or other photochemically produced pollutants¹; (2) modeled formaldehyde may be relatively low by a factor of approximately two to three because only direct emissions were modeled; and (3) BATS representations of POMS as 16-PAH shows concentrations to be only a small fraction of measured POMS concentrations, which results in relatively low modeled risks from POMS as defined for this study.

% of Hazard Quotient

(UATMP:Measured, BATS:Modeled)

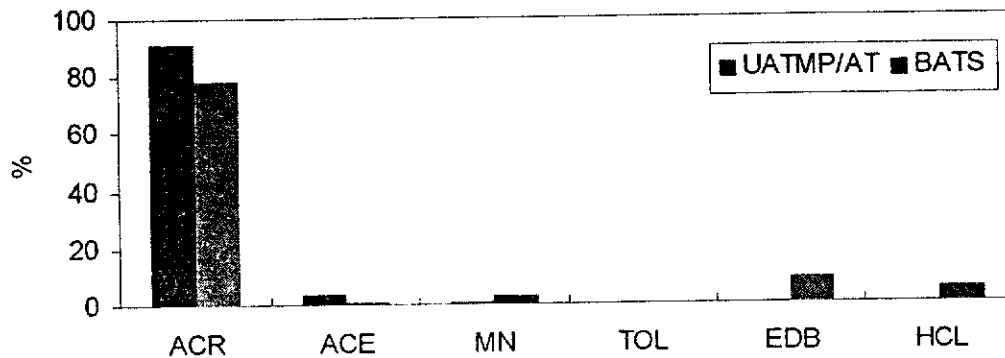


Figure 2-4 Percent of Hazard Quotient

- Similar comparisons of BATS modeled data with the UATMP 30-city measured data set revealed consistent contributions to the hazard quotient. Refer to Figure 2-4. *In both studies, acrolein is shown to be the dominant contributor to the index, based on the current EPA RfC for acrolein. If this is the case, review of mitigation options to reduce acrolein exposures would appear warranted. BATS and UATMP also listed acetone, manganese, toluene, and ethyl benzene as contributors to the hazard*

¹ This assumes that the measured air quality data are not significantly biased. It also should be noted that initial testing based on special model runs for 1,3 butadiene with a half-life of 2.8 hours included did not account for the large differences between measured and modeled concentrations for this pollutant.

quotient. The most significant difference between the two studies is the high modeled contributions (5-10 percent) of ethylene dibromide and hydrochloric acid, which were not measured in the UATMP study.

Culpability

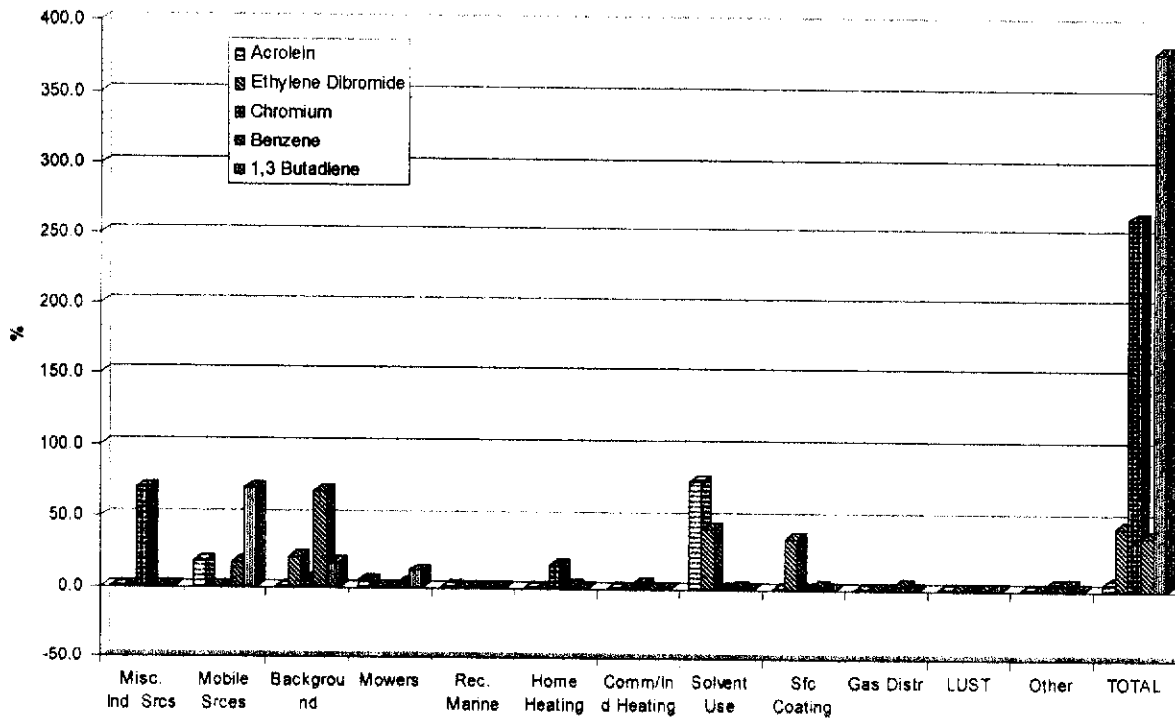


Figure 2-5 Estimates of Source Culpability

- Figure 2-5 presents modeled estimates of source culpability for selected pollutants that have high modeled risks. As anticipated, mobile sources are substantial contributors to cancer risks, especially for 1,3 butadiene. Lawn mower emissions also are shown to be high contributors to 1,3 butadiene, and to a lesser extent for benzene. Background is shown to be an important contributor to exposures in the AIMS output. Limitations in the availability of representative background data, however, may have produced some model artifacts, e.g., possibly for benzene. Nevertheless, background (imports) are anticipated to be an important contributor to exposures and risks. Future air toxics monitoring in Baltimore, and other metropolitan areas, would be well served by including better representation of background concentrations for air toxics (and likely other pollutants). Chromium

culpability was different from the other pollutants reviewed because industrial point sources were shown to be the dominant modeled contributors to population-weighted average exposures. In spite of the valent state issue, these results suggest that chromium may have some important maximum exposed individual (MEI) exposures, which could be assessed in the future if the valent states are assigned by source category. Solvent use is shown to be the dominant contributor to the hazard quotient, since acrolein was shown to account for nearly 80 percent of the index. Solvent use also is shown to be an important contributor to ethylene dibromide impacts.

Perchloroethylene

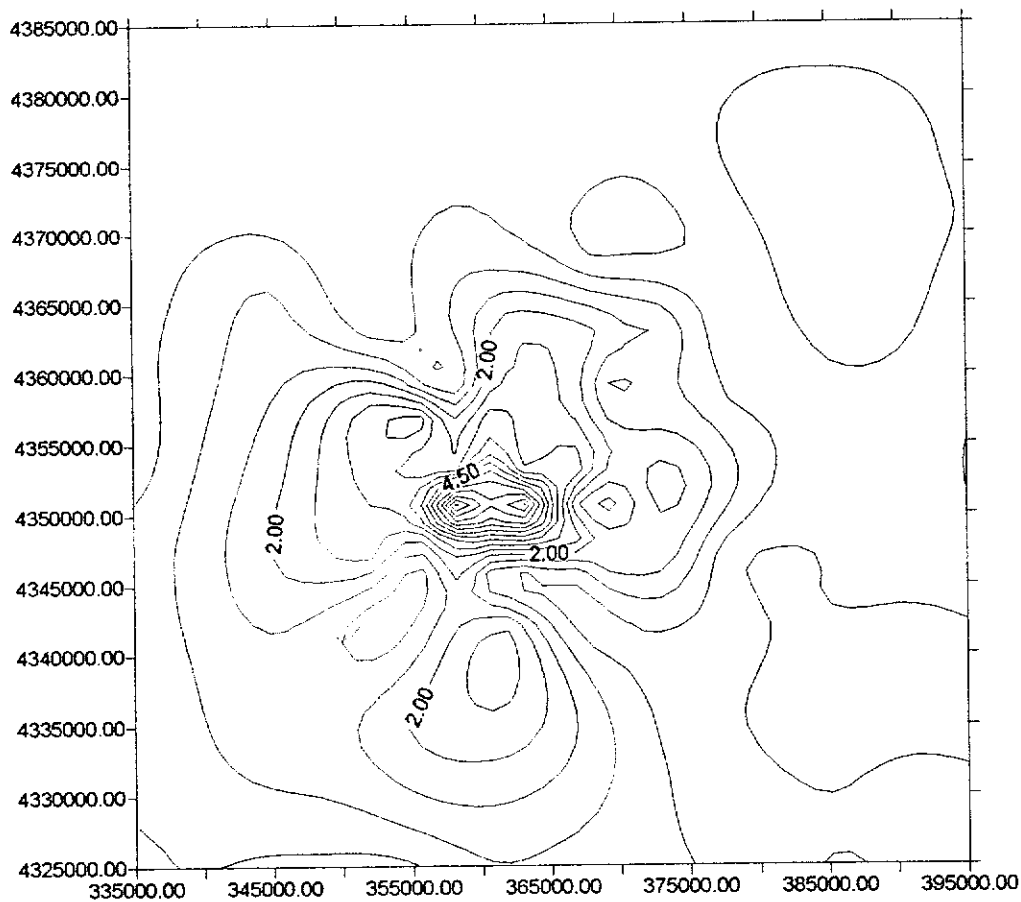


Figure 2-6 Contour plot of Perchloroethylene ($\mu\text{g}/\text{m}^3$) Annual Concentration

POMS (16-PAH)

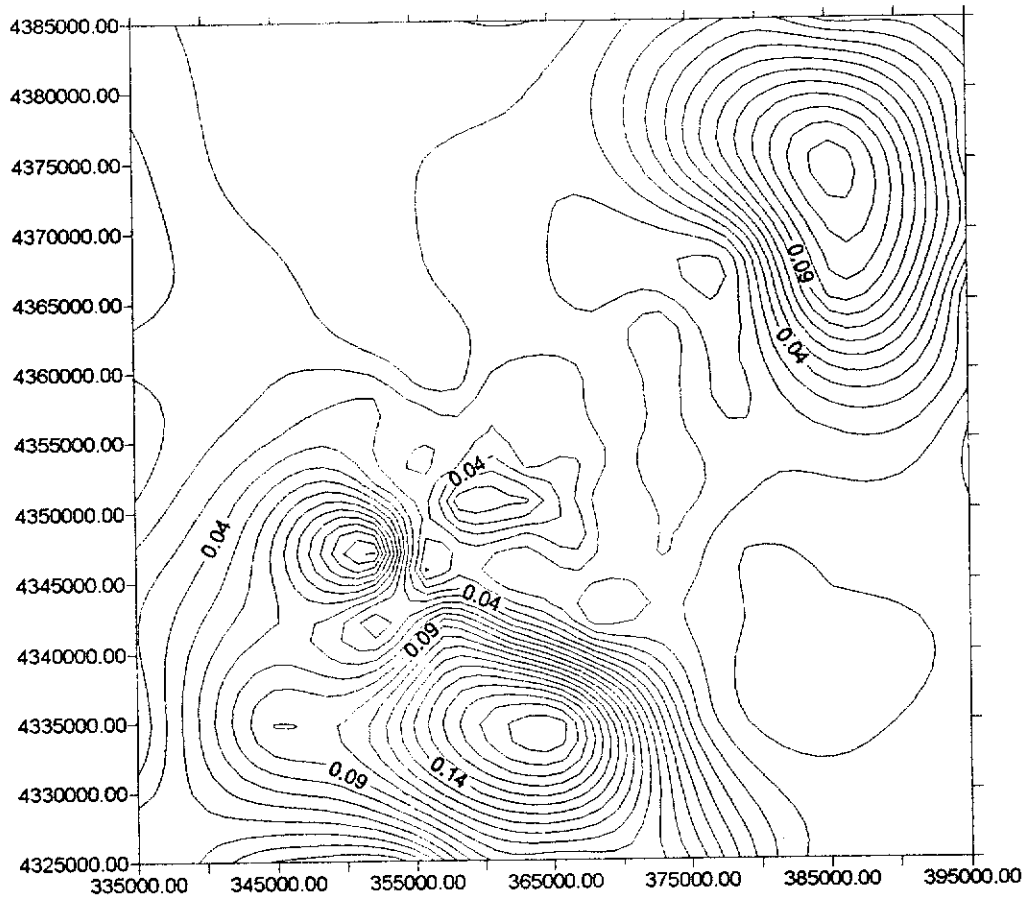
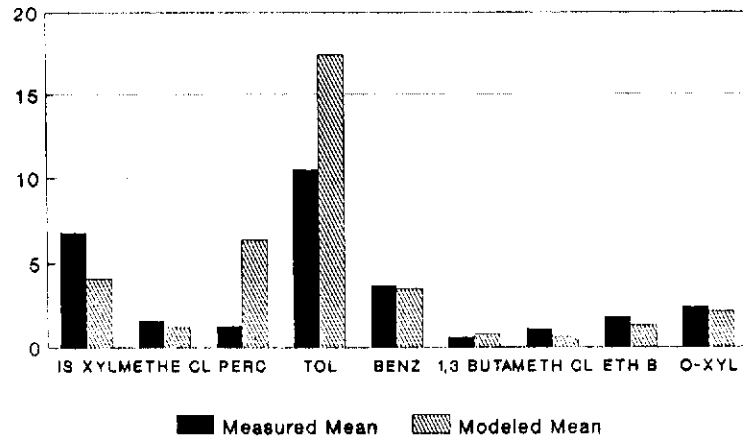


Figure 2-7 Contour plot of POMS (16-PAH) ($\mu\text{g}/\text{m}^3$)

- Contour mapping of metropolitan-wide concentrations, exposures, and risks can be done for more than 100 pollutants in the AIMS data base. Figures 2-6 and 2-7 present perchloroethylene and POMS (actually 16-PAH), respectively, as examples.
- An important feature of AIMS is the reality check provided by the comparison of modeled concentrations with measured values. Figure 2-8 presents an overview of measured and modeled concentrations for selected pollutants with available measured concentrations. This figure is based on the central business district site, Old Town. *As shown, usually the modeled concentrations are within a factor of two of observed values. The most notable exception is perchloroethylene, which was modeled to be nearly four times higher than observed concentrations. It appears that EPA per capita usage factors for dry-cleaning may be overstated, at least for the Baltimore metropolitan area. Noting that average model estimates of 1,3 butadiene for monitoring sites beyond the central business district were shown to be overstated by*

a factor of four to five also is important though low bias (such as 50 percent) is shown for this central business district site.

Summary Statistics (ug/m³)



(ug/m³)

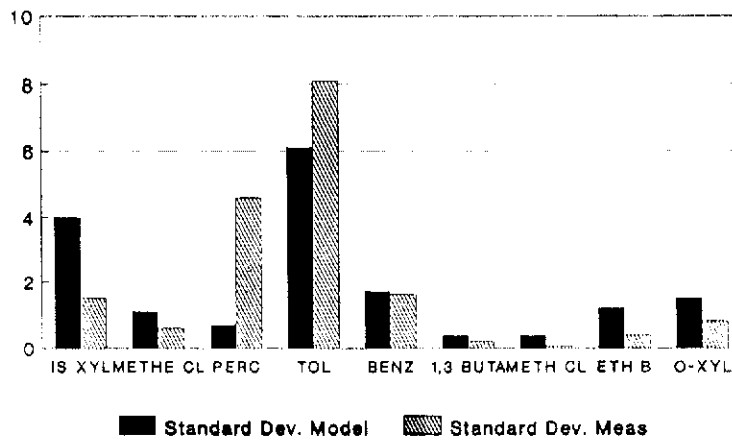


Figure 2-8 Summary Statistics

3.0 EMISSIONS ASSESSMENT

The emissions assessment approach used for this study emphasizes the use of facility-specific and Baltimore-specific nonindustrial emissions data (as available). Although automated national data bases can be used to produce default data, no effective substitute for facility-specific emissions data exists. The national strategy for area sources and local regulatory strategies can be best served based on using specific emissions data whenever possible. The approach for each major category is based on this philosophy, including: major industrial sources (section 3.1), minor industrial sources (section 3.2), other area sources (section 3.3), and mobile sources (section 3.4).

3.1 Major Industrial Sources

Major industrial sources will be tightly regulated for hazardous air pollutants (HAPs) based on the Clean Air Act Amendments of 1990, and are beyond the scope of the area source study mandated by Congress. This category was carried for completeness in the Baltimore Air Toxics Study because the reality check of the modeling analysis needed to consider all source categories to make full use of the high availability of measured air toxics in the Baltimore metropolitan area.

The Maryland Toxic Air Pollutant (TAP) program requires detailed reporting of emissions data, release specifications, and hours of operation data to support the evaluation of toxic air pollutants. Approximately 1,100 facilities are presently covered in this inventory, with approximately two-thirds of these facilities located within the counties that comprise the modeling domain, (i.e., Baltimore City, Baltimore County, Anne Arundel County, and Howard County). Approximately 100-200 of the sources in the modeling domain are major sources of HAPs as defined by the 10 / 25 tons per year cutoff, and would fall in this category.

MDE has coded the air toxics emissions inventory into a computerized data base. The following fields are of greatest interest to this study:

- Emission rates (direct model input, and used to identify sources that belong in major or minor source categories).
- Type of source (stack, volume, or area sources).

- Release specifications, e.g., release height, exit velocity, inner stack diameter, and exit velocity (direct model input).
- Federal UTM coordinates (direct model input).
- SIC codes to help confirm specific source categories (4-digit codes).
- Hours of operation data, including seasonal variability data, which are used in AIMS to generate scalars to vary emission rates as a function of hour and season.
- Building dimension data.
- Four-digit source categories.

MDE staff ranked the toxic sources in the modeling domain, and selected the top twelve sources for detailed assessment. For these sources, site layout maps were used to establish sets of modeling units, to more accurately account for emissions from the most significant sources. The remaining inventoried sources also were coded, but the detail was substantially reduced. For example, most small sources were modeled as one modeling unit, often a default volume source suitable for the source category. Staff of Sullivan Environmental supplemented the MDE review of source specifications by inspecting, from the fence line, approximately twenty additional facilities identified as priority sources based on risk screening.

Note that if one inventory will be used by MDE in the future to meet the needs of air toxics and photochemical modeling initiatives, all data need to represent a base year, e.g., 1990, 1994, etc.). The industrial source inventory represents the current data on file, not a specific period "frozen" in time, such as 1990. This would require a two-step process for the selected major industrial sources and the area sources included in this level of review. Historical files would need to be reviewed to account for plant closings, major changes in production, and major changes in control or operating characteristics that substantially alter emissions.

3.2 Minor Industrial Sources

Since area sources are the focus of this study, small industrial sources represent the highest priority source category for potential regulatory development based on the national strategy for air toxics. This category was the most difficult to characterize in the emissions assessment, considering

the sheer number of individual sources. The MDE air toxics inventory contains approximately 700 minor industrial sources.

Three important factors are important to consider when addressing these sources:

1. Grouping By Source Category - Most sources (major and minor) were coded by MDE staff into approximately 200 source categories to facilitate EPA review for future regulatory development. The grouping was based on SIC code, and review of description information about each source. The linkage of the SIC codes to these sources was found in the Crosswalk (XATEF) (EPA, 1992) emission factor software and manual. This information was provided to MDE staff to help them in assigning four-digit source categories for each inventoried source.

Not all of the HAP sources could be matched to the 4-digit source categories. Some judgment was required to place each source into the proper category. Those sources without an assigned code could not be modeled in this study. In addition, some sources have been incorrectly coded and will need further MDE review.

2. Selecting a cost-effective level of resolution for coding and modeling analysis - An appropriate compromise needed to be set between the benefit of increasing resolution in terms of coding individual sources, and the cost benefit (coding, modeling, and data management) of grouping sources by grid. The following cutoff was used to select between individual versus grid treatment, i.e., treat individually all sources that emit more than one ton / year of any individual HAP, or more than five tons per year of all HAPs combined.
3. Confirmation of speciation data - MDE has approximately twenty regulatory initiatives currently underway that may result in more specific speciation factors for urban area source categories. The results of these data gathering activities were not completed in time to support this study. In the future, however, improving the default speciation data used for the current analysis may be possible based on inputting Baltimore-specific data into the speciation database.

3.3 Other Area Sources

This category is a "catch-all" for sources that do not fit into any of the other four categories. Source categories include residential / commercial / institutional heating, degreasing, dry cleaning, and so forth. Often, the VOC emission estimates for these categories were computed by MDE staff as part of the ozone State Implementation Plan, many of which are based on per capita emission rates. In other cases, project staff computed emissions based on available data, as indicated below. Section

3.3.1 describes how emission rates were estimated. Section 3.3.2 presents the spatial allocation factors used to apportion county-wide emissions into modeling grids. Refer to Appendix A for additional information concerning spatial allocation procedures. Section 3.3.3 shows the temporal allocation factors used to account for the variability of these emission rates as a function of time.

3.3.1 Emission Estimates

The VOC emissions for most of the area sources in this report were taken directly from MDE's VOC report (MDE, 1993). Adjustments to the VOC emissions were done for those sources having new emissions factors based on AP-42 documentation (USEPA, 1993c; USEPA, 1992c; USEPA, 1991; USEPA, 1990; USEPA, 1988; USEPA, 1986; and USEPA, 1985).

Sources containing methane in their emissions were checked against original emissions factors to determine whether the non-methane emissions factors were applied. A listing of sources having methane in their emissions and the percentage of methane are provided below:

Area Source	Percent of Methane
Municipal Landfill	98.7
POTWs	69.7
Structure Fires	9.8
Commercial / Industrial Heating	56 (nat. gas)
Lawn Mowing	10
Forest Fires	9.8
Recreational Marine	10
Petroleum Vessels	8.8 (dist. oil)
Home Heating	100 (nat. gas)
Open Burning	38.3

If the original emissions factors were for non-methane emissions and the sources were found to emit methane (based on speciation data), the emission factors were adjusted accordingly to avoid bias in VOC speciation.

PM₁₀ emissions were derived by factoring VOC emissions. This was achieved by multiplying by the ratio of PM₁₀ emissions factors over the VOC emissions factors, as appropriate.

3.3.1.1 Residential Fuel Use

Fuel use needed clarification to speciate the VOC emissions associated with fuel use and to estimate PM₁₀ emission rates by applying AP-42 emissions factors (EPA, 1985; EPA, 1986; and EPA, 1988) and PM₁₀ total particulate ratios (Maryland DOE, 1986). Residential fuel use was evaluated based on the Maryland Fuels Use & Emission Report (Maryland DOE, 1986), which had county-level data for wood combustion, heating oil, natural gas, coal, and LPG. This information allowed for estimates of VOCs and PM₁₀ emissions from this source category. Tables 3-1 and 3-2 tabulate the heating emissions data as a function of fuel type and county for both VOCs and PM₁₀ respectively.

3.3.1.2. Traffic Markings

The Maryland Volume 6 Appendix D: "Area Source Supporting Documentation" (Maryland, DOE, 1993) reports 66,170 gallons of marking paint to be used per year, with 6.41 grams/second (0.61 tons/day) of emissions in the six-county Baltimore metropolitan area. This category was tracked based on source code 1710. Speciation of these emissions was done based on the EPA SPECIATE computer program (EPA, 1993b). These emissions were allocated proportional to VMTs per grid by county percentage.

Table 3-1

Tabulation of VOC Emissions (g/s) for
Residential Heating for Each County and Fuel Type

County	Coal	Dist. Fuel Oil	Natural Gas	LPG Fuel	Wood Burning	Total
Anne Arundel	0.13	0.20	0.28	0.02	2.40	3.03
Baltimore	0.14	0.33	0.95	0.02	0.76	2.19
Baltimore City	0.22	0.35	1.26	0.04	0.68	2.56
Carroll	0.19	0.06	0.03	0.01	2.01	2.30
Harford	0.16	0.09	0.11	0.01	1.29	1.65
Howard	0.02	0.09	0.11	0.01	0.35	0.57
Kent	0.04	0.01	0.00	0.01	0.10	0.16
Prince Georges	0.10	0.35	0.77	0.02	1.81	3.06

Note that the VOC emissions from wood burning were set at the previous factor of 26 pounds per ton, rather than the new EPA factor of 229 pounds per ton. Initial model testing showed substantial bias with the revised emission factor.

Table 3-2

Tabulation of PM₁₀ Emissions (g/s) for
Residential Heating for Each County and Fuel Type

County	Coal	Dist. Fuel Oil	Natural Gas	LPG Fuel	Wood Burning	Total
Anne Arundel	0.33	0.99	0.30	0.01	1.59	3.23
Baltimore	0.48	1.38	0.97	0.01	0.51	3.34
Baltimore City	0.99	1.69	1.22	0.01	0.45	4.37
Carroll	0.43	0.47	0.02	0.00	1.34	2.27
Harford	0.07	0.45	0.10	0.01	0.86	1.49
Howard	0.14	0.46	0.13	0.00	0.23	0.97
Kent	0.04	0.10	0.00	0.00	0.07	0.21
Prince Georges	0.25	0.82	1.27	0.00	1.21	3.55

3.3.1.3. Dry Cleaners

Dry cleaners were subdivided into two categories (transfer and dry-to-dry). MDE staff provided estimates of the percent transfer and dry-to-dry throughput in each county. This information was used to subdivide further the dry cleaning emissions. The XATEF emissions data base (EPA, 1992) identifies specific emission rates for transfer (82.4 lbs/ton clothes cleaned) and dry-to-dry (41.2 lbs/ton clothes cleaned), which supported the apportionment of emissions between the two categories. The four-digit source codes established for this project contain separate codes for each type of dry cleaning process, i.e., transfer machines (1703) and dry-to-dry machines (1704). This approach will better support the subsequent evaluation of controls by MDE staff.

3.3.1.4. Commercial Sterilization Facilities

This category was approached based on the assumption that the most important sources are hospitals and food processing (primarily for McCormick spice company). For each hospital in the study domain, MDE staff provided the following information: federal UTM coordinates, building dimensions, type of chemical sterilizer (e.g., ethylene oxide), and any release specifications available concerning the venting of these emissions. These sources will be modeled as stack or volume sources in the same manner as other industrial / commercial sources. The category was tracked through source code 1705. At this time, however, no sources were identified by MDE staff as source category 1705. MDE staff would need to reevaluate this source category in the future to incorporate this source category into the analysis.

3.3.1.5. Waste Holding Ponds

Emissions from holding ponds are a function of the area and depth of the ponds, and constituent concentrations, ambient temperature, and wind speed. EPA emissions model CHEMDAT7 (EPA, 1989) could be used to estimate annual average emission rates for three generic sets of ponds (small, medium, and large). For each pond that MDE staff could provide the constituent characteristics, area, depth, and UTM coordinates, one of the three sets of generic emission factors could be assigned.

All species identified by MDE and contained in the CHEMDAT7 pollutant data base could be modeled in the future if suitable input data are available. Further review showed that MDE does not have specific data readily available to isolate these emissions, although some facilities may have included these emissions in their fugitive emissions that have been inventoried. It was not possible, however, to separate out these emissions at this time. A four-digit source category (0807) was established to track these emissions in the event that they can be quantified in the future.

3.3.1.6. Pesticide Application

State and county-level statistics on pesticide usage by farm operators, certified private applicators of restricted use pesticides, commercially licensed businesses, and public agencies were researched (Maryland DOA, 1988; Maryland DOA, 1993). A representative compilation of the amount and types of pesticides used in 1988 for Baltimore City and 1991 for surrounding counties is shown in Table 3-3.

Table 3-3

Estimates of 1988 and 1991 Pesticide Usage (Tons/Year)* in the Baltimore Metropolitan Area and Surrounding Counties

Pesticide Common Name	Counties								Total
	Baltimore City - 1988	Baltimore	Anne Arundel	Carroll	Harford	Howard	Kent	Prince Georges	
chromated copper arsenate			363.37						363.37
metolachlor				53.79			101.49		155.28
atrazine				44.76			69.16		113.92
simazine				11.60			54.01		65.61
24D		10.18		7.40	6.41	8.47	6.44	4.90	43.80
chloropyrifos			15.32		14.96			13.07	43.35
benefin		1.00						29.34	30.34
MCPP		12.83	2.36		1.99	2.22		2.81	22.21
paraquat				5.71		4.33	10.19		20.23
glyphosate	1.20			5.07		7.92	5.98		20.17

Pesticide Common Name	Counties								Total
	Baltimore City - 1988	Baltimore	Anne Arundel	Carroll	Harford	Howard	Kent	Prince Georges	
alachlor				8.92			10.90		19.82
cyanazine				3.47		8.11	7.23		18.81
dicamba				17.57					17.57
oils(hort,surf)		12.49			4.09				16.58
bacillus thuringiensis		2.61	3.22	2.95			4.01	3.06	15.85
isofenfos		2.24	5.90					6.52	14.66
pendimethalin		8.55						4.90	13.45
linuron							11.06		11.06
trifluralin								10.74	10.74
butylate							10.18		10.18
methyl bromide		8.72						1.21	9.93
carbaryl		1.91	4.18					2.50	8.59
phasmet		0.31		7.50				0.08	7.89
tributyltin		7.66							7.66
permethrin	3.15						3.10	1.24	7.49
malathion			6.35						6.35
chlorothalonil		4.20	1.40						5.60
2,4-DP dichloroprop		0.87	1.10			0.90		1.64	4.51
metam- sodium			1.31					2.70	4.01
clomazone							3.89		3.89
diazonon	1.25	0.85			0.98			0.51	3.59
EPTC				1.94	0.66			0.34	2.94
siduron			2.68					0.24	2.92
acephate		2.83							2.83
diuron		2.14							2.14
carbofuran		0.62				0.66	0.61		1.89
hydramethylnon							1.85		1.85
nicosulfuron				1.56					1.56
mancozeb		1.18	0.37						1.55
dimethoate				0.62			0.92		1.54
methomyl			1.41						1.41
bendiocarb		0.32						0.88	1.20
terbufos							1.15		1.15

Pesticide Common Name	Counties								Total
	Baltimore City - 1988	Baltimore	Anne Arundel	Carroll	Harford	Howard	Kent	Prince Georges	
boric acid			0.91					0.18	1.09
captan		1.02							1.02
all others		8.21	3.22	1.87	1.47	0.31	4.55	2.18	21.81
Total	5.60	90.72	413.07	174.74	30.57	32.91	306.72	89.05	1143.38
1990 g/sec	0.46	7.46	33.99	14.38	2.52	2.71	25.24	7.33	94.09

* Pesticide use by farm operators, certified private applicators of restricted use pesticides, commercially licensed businesses, and public agencies. Does not account for homeowners and other non-licensed, non-farm segments of the population. (Maryland Dept. of Agric., 1993)

The three most widely used pesticides are chromated copper arsenate (preservative), metolachlor (herbicide), and atrazine (herbicide). Anne Arundel, Kent, and Carroll counties appear to apply the greatest amount of pesticides, since they have more agricultural activities. About 5.6 tons of pesticides (active ingredients) were reported to be used in Baltimore City during 1988, under the names of glyphosate, permethrin, and diazonon (Maryland DOA, 1988).

The VOC portion of these pesticides that evaporates, emissions of semi-volatile emissions, and the emission rates (VOC and PM₁₀) for various pesticides and formulations by user categories (consumer, agricultural, commercial, and general) were not specifically available. However, MDE used a factor of 2.45 times the amount of pesticide applied (includes active ingredients and solvent) in each county to derive VOC emissions (MDE, 1993). The EPA SPECIATE program (EPA, 1993b) was used as a default. Sullivan Environmental staff contacted a distributor of agricultural pesticides to request the materials safety data sheet on the three most commonly used pesticides in this category. Our purpose was to obtain approximate ranges (in percent) of each hazardous constituent. Based on review of the Material Safety Data Sheets, we found that only chlorobenzene matched the pollutants listed as the 189 HAPS.

If data on the percent of agricultural, commercial, and residential usage becomes available, it may be possible to enhance this treatment in the future.

3.3.1.7. Wood Smoke

Residential wood smoke was addressed based on the data supplied by MDE on residential fuel consumption (Maryland DOE, 1986). Using MDE supplied wood consumption rates by county (Maryland DOE, 1986), Sullivan Environmental estimated county total VOCs and PM₁₀. It was based on EPA emission factors spatially allocated by population, and applied constituent speciation factors for fireplace consumption only (wood stove speciation data was not available). Refer to the residential fuels section for more information. Tables 3-1 and 3-2 present VOC and PM₁₀ emission rates by county.

3.3.1.8. Colonial Pipeline

The Colonial Pipeline is an interstate pipeline that passes through the study area, and is a potential source of volatile organics. Emissions from pipelines can occur from breakout stations, distribution terminals, above ground storage tanks, and loss of product from loss of integrity of the pipeline (catastrophic or minor leaks). It was assumed that the breakout stations, distribution terminals, and product storage emissions are adequately covered through the air toxics inventory of stationary sources. Follow-up activities were, therefore, limited to emissions associated with loss of integrity of the underground pipeline.

Sullivan Environmental has contacted the Office of Pipeline Safety (OPS) in Washington to request information on barrels of petroleum products reported as lost within the Baltimore metropolitan area. Based on barrels lost by product category we would be able to speciate and quantify the pollutants lost in the study area. SPECIATE (EPA, 1993b) could have been used as the basis to assign percentages to each constituent as a function of the product. The average emission rates, however, were determined to be insignificant based on review of available data. Sullivan Environmental contacted many EPA offices to learn if EPA tracked environmental impacts (to surface water, ground water, and air quality) of losses of material through the interstate pipeline network. No EPA office was identified that tracked routine pipeline activities.

3.3.1.9. Roofing Tars

For the purposes of this study it was assumed that roofing tars (roofing cement) are primarily used by professional roofers. Sullivan Environmental staff contacted a distributor of roofing cement to request the Materials Safety Data Sheet on several products in this category. The purpose was to obtain approximate ranges (in percent) of each hazardous constituent. Based on review of this information, it was found that the hazardous ingredients on the Material Safety Data Sheets did not match any pollutants listed as the 189 HAPS, and that the volatile fraction was primarily composed of mineral spirits or petroleum distillates. Attempting to identify the full range of product types was infeasible within the context of the BATS study for source categories such as roofing tars (and driveway sealers). If there is continued interest in these source categories, more detailed review would be recommended in the future to more fully develop emission factors for this category.

3.3.1.10 Driveway Sealers

An approach similar to the roofing tars was used for driveway sealers. Two manufacturers were identified to cover materials suitable for concrete and asphalt driveways. Material safety data sheets were requested from each to identify ranges of constituent percentages in each category. Again, this is just a limited assessment. It would be beyond the scope of the BATS to evaluate subcategories, such as concrete driveway sealers designed strictly to coat the surface compared with products designed to penetrate deeper into the concrete. If the information provided by these manufacturers allows for estimation of emissions from this category, support from MDE would be needed to estimate roughly the throughput of driveway sealers as a function of a county, and preferably as a function of concrete or asphalt driveways. As with roofing tars, EPA speciation factors were not identified for these categories. Initial review of the currently available data shows petroleum distillate as the solvent, which is not included in the list of 189 HAPS and would not be anticipated to be a high priority toxic based on its TLV value. Unless information is received to alter this initial conclusion, it would not recommend that additional follow-up be provided for driveway sealers.

3.3.1.11 Street Paving

The MDE VOC emissions inventory for the Baltimore metropolitan area shows zero emissions of VOC from cutback asphalt, and minor amounts from emulsified asphalt (e.g., 0.01 to 0.02 pounds/day). Since the use of cutback asphalt operations is restricted in the metropolitan area, it would not be recommend that this category be further evaluated at this time.

3.3.1.12 Swimming Pools

Review of available EPA data bases showed that EPA does not have an emission factor for this source category. Chloroform concentrations in indoor pools have been as high as 400 $\mu\text{g}/\text{m}^3$ in the breathing zone (Spengler, 1994), which suggests that this could be a significant source category.

Contact with Kate Chun of the South Coast Air Quality Management District of California provided some estimates of chloroform emissions from swimming pools (Rogozen, 1988). California studies have used an annual average emissions rate of 22.3 $\mu\text{g}/\text{m}^2/\text{min}$. This is based on a weighted average considering 12 $\mu\text{g}/\text{m}^2/\text{min}$ for an undisturbed pool, and 320 $\mu\text{g}/\text{m}^2/\text{min}$ for an agitated pool. In the BATS study it was assumed that pools are agitated between the hours of 9:00 A.M. and 9:00 P.M., with outdoor pools in use from Memorial Day through Labor Day. Indoor pools were assumed to be used throughout the year.

To address this issue, MDE staff would need to compile information on the total surface area of both indoor and outdoor pools on a county level basis. This information could then be incorporated into AIMS to account for these emissions. Since the Maryland Department of Health is responsible for inspecting public pools, data should be available to approximate the total capacity of pools in each county. Since each pool has a specified maximum loading based on size criteria, estimating total surface area of pools within each county by totaling the swimmer capacities across all public pools in the county was possible for MDE staff. By relating square footage per swimmer allocated in the capacity requirements to total swimmers, getting an approximation of total square feet of pools was possible. When these inputs are available, AIMS can be used to evaluate swimming pool emissions relative to other source categories.

3.3.1.13 Offroad Mobile Sources

Offroad sources include lawn and garden equipment, recreational marine equipment, commercial marine vessels, construction equipment, industrial equipment, agricultural equipment, recreational land equipment, motorcycles, railroads, airport service equipment, commercial aviation, general aviation, and military aviation. The emissions from the offroad sources are very variable as a function of time of day and season. It is, therefore, particularly important that scalars to represent emissions variability be incorporated into the analysis. For example, lawn mowing most frequently occurs during the daytime hours in the summer season. Pleasure boating would be similar, but commercial fishing and general shipping would have different use patterns.

Table 3-4

Area Source Type	Emission Scalar
1 Home Heating	Hourly Degree Day Factor
2 Mobile Sources	Hourly Grams/Sec Scalars Divided by the Annual Average Based on VMT Data by Grid Block Using Seasonal/Holiday Data
3 Industrial / Commercial 5-day Operations	Based on 8 Hours/Day 5 Days/Week Operations
4 Industrial / Commercial 6-day Operations	Based on 8 Hours/Days 6 Days/Week Operations From May-September
5 Lawnmowers and Farm Equipment	Daylight Hours of Operation From May-October
6 Swimming Pools	Indoor/Outdoor Agitated/Undisturbed And Seasonal Considerations
7	Continuous = 1.0 for All Hours

The currently available VOC inventory for the Baltimore metropolitan area shows a high percentage from offroad sources; excluding biogenic emissions, this category is estimated to contribute 11 percent. Offroad mobile sources were not being emphasized because stationary sources

were the primary area of review for the BATS study, but offroad sources were included for completeness and perspective.

MDE has county-wide estimates of offroad emissions of VOCs as a function of category. These emissions were estimated by using EPA methodologies and procedures. Two apportionments are needed for these data to be included in this study: (1) apportion the VOC and PM_{10} emissions into each modeling grid from the U.S. Geological Survey land use data, and (2) estimate emissions of specific toxic air pollutants based on either pollutant apportionment factors or direct emission factors. The land use data (see Table 3-6) were used to identify the percentage of land use within each cell that contains navigable water, i.e., streams, lakes, reservoirs, and bays (for the boating categories), residential (for lawn mowing), and so forth.

Contacts were made with the EPA Office of Mobile Sources in Ann Arbor, Michigan to identify the most suitable emission factors for lawnmowers and marine vessels, and it was determined that specific speciation data were not available for two-stroke engines. As a default procedure, these sources were speciated based on data available for four-stroke engines, as recommended by the EPA Office of Mobile Sources in a Memorandum from Joe Summers on April 9, 1992 regarding nonroad inputs needed for OAQPS inventories.

3.3.1.14 Drinking Water Volatilization

Data were obtained on water consumption rates and average chloroform concentrations from the MDE staff. Sullivan Environmental staff has estimated annual average VOC emissions (mostly chloroform) for each of the eight counties assuming that seventy-five percent of THM is as chloroform. Data were obtained for five of the eight counties by the MDE staff. For the counties where specific water consumption data was not readily available Carroll, Harford, and Kent, a water consumption per capita factor was applied (see Table 3-5). This factor was derived by Sullivan Environmental from those counties in which water consumption data were available, divided by the total county population and then averaged over the five counties. The resulting average water consumption factor was then multiplied by the county population to estimate drinking water consumed for each county.

The results of the estimate water consumption rates and chloroform emissions are provided in Table 3-5.

Table 3-5

Tabulation of County-Level Drinking Water Consumed in the Baltimore Study Region

County	Water Consumed (ft ³)	Consumption Rate Factor (ft ³ /person)	Chloroform Emissions (g/sec)
Anne Arundel	1,470,700,000	3.442	0.04
Baltimore	4,104,792,500	5.931	0.11
Baltimore City	5,113,074,000	7.640	0.14
Carroll	845,395,102		0.02
Harford	1,248,042,512		0.03
Howard	849,588,960	4.535	0.02
Kent	122,260,638		0.00
Prince Georges	9,272,095,000	12.714	0.25
Average		6.852	

3.3.1.15 Polycyclic Organic Matter (POMS) Emissions

The inclusion of Polycyclic Organic Matter (POM) into the BATS AIMS system was primarily based on available emission factor data found in an EPA draft report for estimating emissions from sources of POMS (USEPA, 1995a). The draft report identified eight major categories of compounds, as defined by EPA, that is the class of pollutants known as POMS. Emission factors were defined for only one of these classes of POMS, defined as Polycyclic Aromatic Hydrocarbons (PAHs). The draft report further subdivided the PAHs into two groups: 7-PAH and 16-PAH. As a result, only the two PAH groups were integrated into the AIMS system and not the total POM emission. Presently, enough data do not exist to estimate what percentage these two PAH emission groups represent of the total POMS emissions.

Presently, the AIMS data base files contain PM₁₀ emissions data for the manufacture of metal cans, commercial and industrial heating, lawn mowers, forest fires, recreational marine vehicles, motor vehicles (note: the PM₁₀ emission factors for motor vehicles were recently estimated using

EPA's PART5 model (USEPA, 1995b). The estimated county PM_{10} emissions for motor vehicles, based on vehicle miles traveled were then inserted into the appropriate data files within AIMS, and home heating. Of these sources, PAH emission factors were available for commercial and industrial heating, forest fires, motor vehicles, and home heating. Table 3-6 summarizes the available emission factors for the PAHs and PM_{10} for all applicable area sources.

The method chosen for the inclusion of the PAHs into the data base system, in its current prototype phase, was to relate simply the PAH emission factors to the original PM_{10} emission factors used in the emissions data base files. The exception was for the utility and incinerator sources where only the actual PAH emissions, calculated based on available heat input and fuel consumption for each stack, were estimated for direct incorporation into the data base. Ratios of the PAH emission factors over the PM_{10} emission factors were calculated for all available area sources of PM_{10} contained in the AIMS data base and where emission factors were identified in the POMS draft report (USEPA, 1995a).

The ratios of the PAHs over the PM_{10} emission factors were derived for the area sources so that they could be easily inserted into the PM_{10} speciation data file within AIMS. Table 3-7 provides a summary of those ratios. As can be noted, the ratios for both the home heating and commercial and industrial heating sources were subdivided into county level categories since AIMS accounts for the variance of fuel types found to occur for each county.

Procedures were more complicated for the commercial / industrial and home heating sources in estimating the emissions factor ratios of PAHs over PM_{10} . The complication was due to the delineation of emission factors based on the fuels being burned. For example, home heating POMS emission factors are given for the combustion of wood, natural gas, distillate oil, and coal (bituminous and anthracite)(USEPA, 1995a). The final emission factor ratios for these sources were based on a weighted average of these emission factors based on the current PM_{10} emissions from these fuels within AIMS.

Table 3-6

Available POMS and PM₁₀ Emission Factors for All Applicable
Area Source Categories Within AIMS

Source Category/Fuel	Emission Factors		
	7-PAH	16-PAH	PM ₁₀
Home Heating			
Wood	0.035 lb/ton	0.517 lb/ton	34.6 lb/ton
Natural Gas ¹	3.55e-17 lb/ft ³	2.26e-15 lb/ft ³	1.10e-05 lb/ft ³
Distillate Oil	5.63e-04 lb/kgallons	6.97e-03 lb/kgallons	0.3 lb/kgallons
Coal	0.0335 lb/ton	0.108 lb/ton	6.2 lb/ton
Commercial & Industrial Heating			
Natural Gas	Not Available	5.56e-06 lb/mmcf	5.8 lb/mmcf
Coal ²	5.36e-05 lb/ton	2.72e-03 lb/ton	5.0 lb/ton
Residual Oil ³	2.40e-08 lb/kgallons	3.23e-05 lb/kgallons	11.0 lb/kgallons
Distillate Oil ⁴	8.37e-10 lb/kgallons	7.02e-06 lb/kgallons	2.0 lb/kgallons
Motor Vehicles	2.40e-08 lb/vmt	2.10e-07 lb/vmt	1.74e-04 lb/vmt
Forest Fires	0.02 lb/ton	0.053 lb/ton	2.626 lb/ton

1 Original PAH factor units of lb/1E+12 Btu converted by using 1 Btu = 1,050 ft³

2 Industrial PAH factors used since a majority of PM₁₀ emissions come from this area

3 Original PAH factor units of lb/MMBtu converted by using 1 kgal = 150 MMBtu

4 Original PAH factor units of lb/MMBtu converted by using 1 kgal = 140.5 MMBtu

Table 3-7

Ratios of PAH Emission Factors over PM_{10} For Area Sources

Source Category	7-PAH / PM_{10}	16-PAH / PM_{10}
Home Heating¹		
Anne Arundel	0.0009664	0.0129660
Baltimore	0.0005466	0.0062726
Baltimore City	0.0005066	0.0051259
Carroll	0.0011613	0.0147188
Harford	0.0011131	0.0135807
Howard	0.0008243	0.0109114
Kent	0.0015619	0.0147300
Prince Georges	0.0007261	0.0096706
Commercial and Industrial Heating¹		
Anne Arundel	0.0000075	0.0013720
Baltimore	0.0000064	0.0015891
Baltimore City	0.0000073	0.0013504
Carroll	0.0000098	0.0007765
Harford	0.0000092	0.0009190
Howard	0.0000053	0.0019148
Kent	0.0000101	0.0007080
Prince Georges	0.0000054	0.0017471
Motor Vehicles	0.0001378	0.0012057
Forest Fires	0.0076161	0.0201828

¹ Weighted average factors for PAH based on the PM_{10} emissions for each county by fuel type.