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2011 Base Year Emissions Inventory

For The

Maryland Portion of the Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD 2008 Ozone NAAQS Nonattainment Area (Cecil County, MD)

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Maryland Department of the Environment
2011 Base Year Emissions Inventory and QA/QC Plan for the Maryland Portion of the Philadelphia-Wilmington-Atlantic City, PA-NJ-DE-MD 2008 Ozone NAAQS Nonattainment Area

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1.0 Introduction

1.1 Overview and Background

This document contains a detailed explanation of the 2011 base year emissions inventory for stationary, area, nonroad, and mobile anthropogenic sources as well as biogenic sources in the Maryland portion of the Philadelphia–Wilmington–Atlantic City, PA-NJ-DE-MD 2008 ozone National Ambient Air Quality Standards (NAAQS) nonattainment area. The inventory will be included as part of the region's State Implementation Plan (SIP) to meet the above NAAQS. Annual anthropogenic emissions were estimated for volatile organic compound (VOC), nitrogen oxide (NO_X), carbon monoxide (CO), fine particles ($PM_{2.5\text{-}PRI}$), sulfur dioxide (SO_2), and ammonia (NH_3). Typical ozone season day emissions were developed for VOC, NOX, and CO.

The federal Clean Air Act (CAA), 42 U.S.C.A § 7401 et seq, as amended by the Clean Air Act Amendments of 1990, P.L. 101-549, (referred to hereafter as the Act), requires all areas of the nation to attain and maintain compliance with the NAAQS. These federal standards are designed to protect the public health and welfare from six criteria pollutants, one of which is ozone.

The Philadelphia–Wilmington–Atlantic City, PA-NJ-DE-MD 2008 ozone NAAQS nonattainment area was designated as a marginal nonattainment area by the United State Environmental Protection Agency (EPA) effective July 20, 2012 (Federal Register, Vol. 77, No. 98, May 21, 2012). This base year inventory is required by the Act at §7502(c)(3):

> (3) **Inventory** – Such plan provisions shall include a comprehensive, accurate, current inventory of actual emissions from all sources of the relevant pollutant or pollutants in such area, including such period revisions as the Administrator may determine necessary to assure that the requirements of this part are met.

The Maryland Department of the Environment (MDE) prepared the inventory. MDE used EPA's nonroad mobile emissions model, NONROAD2008a (embedded in NMIM2008) to develop all nonroad emissions except for commercial marine vessels, aircraft, and locomotives. These three sectors were developed separately. MDE developed the 2011 onroad mobile inventory using EPA's MOVES2010a model.

EPA's estimates for biogenic emissions for the NEI2011 effort were accepted for the purposes of submission of the base year 2011 biogenic inventories. Methodology for developing biogenic inventories is described in detail in the Technical Support Document for the NEI2011 effort.[1]

Emissions inventory data is used in annual trends reports, SIP submittals, compliance demonstrations, emissions trading, emissions fee programs, and in modeling activities designed to evaluate ambient air concentrations encountered by the general public. For the SIP program, the emission inventory is a fundamental building block in developing an air quality control and maintenance strategy. Regulatory agencies rely on emission inventories as indicators of air quality changes and for setting permit requirements.

The end use of emission inventories requires that they be of the highest quality obtainable.

1 EPA NEI2011 Web-site - http://www.epa.gov/ttnchie1/net/2011inventory.html

These data are the foundation of air quality decisions. Inventory quality is critical to defining realistic regulations and attainment strategies.

1.2 2008 Ozone NAAQS Nonattainment Area Geography

EPA designated the following Maryland jurisdictions in the Philadelphia–Wilmington–Atlantic City, PA-NJ-DE-MD area as nonattainment for the 2008 ozone NAAQS.

- Cecil County, Maryland

1.3 Temporal Resolution

Another step of inventory development is the temporal allocation of emissions. The temporal allocation is an accounting of emission variations over time. The simplest temporal allocation is for a steady-state emissions source that continually releases emissions at the same rate throughout the year. Under actual conditions, however, steady-state emission sources are quite rare. Instead, under actual conditions, emissions sources may operate only in the winter, not operate on Sundays, or their activity may peak during certain hours of the day. The temporal allocation of emissions must reflect as accurately as possible the reality of emissions occurring to the atmosphere. Ozone formation depends on the presence of ozone precursors as well as the amount of sunlight and other meteorological impacts. Since ozone is typically a summertime pollutant, emissions during the summer months are more important to air quality than are emissions during other times of the year. For these reasons, ozone precursor base year emissions are represented as typical ozone season daily emissions (ozone season tons per day).

The planning period for the 2008 ozone NAAQS emissions inventory covers the ozone season defined as May through September. For the purpose of submitting the base year 2011 SIP inventory to EPA, annual emissions are estimated for VOC, NO_X, CO, $PM_{2.5\text{-}Pri}$, SO_2, and NH_3. Ozone season day emissions are estimated for the ozone precursors of VOC, NO_X, and CO.

1.4 Quality Assurance Policy and Objectives

In order to provide data of sufficient quality for attainment and maintenance planning needs, quality assurance (QA) and quality control (QC) procedures are part of the inventory process. The procedures address data quality objectives of accuracy, completeness, comparability, and representativeness. The target goals for each objective are listed below.

Accuracy: All estimates must be calculated and documented using acceptable methods. Individual source requirements and availability of data and resources will affect the estimation method selection.

Completeness: Completeness is addressed by ensuring that all applicable source categories are included in the inventory and that all information required to estimate emissions is present.

Comparability: Data will be compared to the most recent base year inventory: 2011 National Emissions Inventory (NEI) for VOC, NO_X, and CO. Any discrepancies (data outliers) must be verified or corrected.

Representativeness: Actual 2011 annual and the typical ozone season day emissions will be calculated for the base year inventory. Local data will be used in inventory calculations wherever possible.

1.5 Plan Information Sources

This plan draws upon inventory, quality assurance, and emissions projections guidance available from state and federal agencies and partnerships. The effort also draws upon experience gained during previous emission inventory reviews.

A primary source of emissions inventory data is the 2011 NEI, which was submitted to EPA by the state air agencies

1.6 Summary of the Base Year Emissions Inventory

Summaries of the ozone precursor emissions in tons per day (TPD) and tons per year (TPY) for the Maryland portion of the Philadelphia–Wilmington–Atlantic City, PA-NJ-DE-MD 2008 ozone NAAQS nonattainment area are shown in Table 1-1. Summaries relating to the individual sections of the inventory, such as point sources, may be found at the beginning of the respective section. Slight differences between the executive summary table and the section tables are due to rounding.

Table 1-1: 2011 Base Year SIP Emission Inventory Summary
Cecil County, MD Portion of the Philadelphia–Wilmington–Atlantic City, PA-NJ-DE-MD 2008 Ozone NAAQS Nonattainment Area

Source Category	Ozone Season Daily			Annual					
	VOC (tpd)	NO_X (tpd)	CO (tpd)	VOC (tpy)	NO_X (tpy)	CO (tpy)	$PM_{2.5\text{-}PRI}$ (tpy)	SO_2 (tpy)	NH_3 (tpy)
Point	0.301	2.63	0.44	64.91	76.19	43.36	6.91	6.20	0.00
Area	2.863	0.31	1.96	937.78	242.02	1,235.06	210.84	210.84	456.50
Nonroad	5.127	2.01	22.55	1,054.93	529.02	4,941.79	56.97	1.44	0.74
Onroad	2.29	7.50	25.81	791.98	2,730.44	9,421.97	94.74	11.04	52.21
M-A-R	0.030	0.46	0.32	11.03	167.97	115.08	3.51	24.54	0.00
Anthropogenic Subtotal	**10.611**	**12.904**	**51.077**	**2,860.625**	**3,745.633**	**15,757.255**	**372.974**	**254.058**	**509.455**

1.7 Document Contents

Chapter 2 Presents the methodology for developing the 2011 ozone precursor emissions from point sources.

Chapter 3 Presents the methodology for developing the 2011 ozone precursor emissions from quasi-point sources.

Chapter 4 Presents the methodology for developing the 2011 ozone precursor emissions from area/nonpoint sources.

Chapter 5 Presents the methodology for developing the 2011 ozone precursor emissions from nonroad mobile sources.

Chapter 6 Presents the methodology for developing the 2011 ozone precursor emissions from onroad mobile sources.

Chapter 7 Presents the QA/QC plan for the 2011 ozone precursor emissions inventory.

The point, quasi-point, area, nonroad, and onroad source emissions inventory development documentation; detailed emissions by source classification code (SCC); and nonroad and onroad model input and output files are presented in Appendices A through E of this document.

2.0 Point Sources

2.1 Introduction

This section documents the development of the Maryland portion of the Philadelphia–Wilmington–Atlantic City, PA-NJ-DE-MD 2008 ozone NAAQS nonattainment area stationary point source emissions inventory. This section characterizes the point source component of the emissions inventory by describing the 2011 ozone season day and annual emissions estimation techniques. The point source inventory consists of actual emissions for a typical ozone season day and for the entire period in the year 2011. The inventory includes sources located within Cecil County, Maryland.

2.2 Compilation and Documentation of Point Source Emissions

MDE maintains a substantial database of both small and large air emission sources. The list of point sources in this inventory was developed by applying the appropriate thresholds to the emission levels in the databases to differentiate between point and area stationary sources. Sources with emission levels greater than the threshold or sources previously included in Periodic Emissions Inventory submittals are by definition point sources while sources with emissions levels less than the thresholds are by definition area sources.

Temporal allocation of emissions from annual to ozone season day was accomplished using EPA's generally accepted emissions calculation techniques for all point sources other than those units reporting emissions and activity data to the Clean Air Markets Division (CAMD) database under 40 CFR Part 75. For units reporting to CAMD, the hourly average NO_X emission rate for hours operated during the summer months of 2011 (May through September) was multiplied by 24 hours per day to calculate a typical ozone season daily rate in tons per day.

Appendix A contains a detailed explanation of methodologies and quality assurance/quality controls used to develop the 2011 base year emissions inventory for the area. Appendix B provides a detailed description of the total point source emissions for the Cecil, MD2008 ozone NAAQS nonattainment area.

2.3 Summary of Emission Results

Table 2-1 lists emissions for Cecil County, MD area.

Appendix A contains a detailed explanation of methodologies and quality assurance/quality controls used to develop the 2011 base year emissions inventory for the area. Appendix B provides a detailed description of the total point source emissions for the Cecil, MD area.

Table 2-1: 2011 Base Year SIP Point Source Emissions Inventories
Cecil County, MD Portion of the Philadelphia–Wilmington–Atlantic City, PA-NJ-DE-MD 2008 Ozone NAAQS Nonattainment Area

Point Source Emissions – 2011 Base Year SIP Emission Inventory		
Tons per Ozone Season Day		
Pollutant	**Cecil County**	**Cecil NAA Total**
VOC	0.301	0.301
NO_X	2.633	2.633
CO	0.438	0.438

Point Source Emissions – 2011 Base Year SIP Emission Inventory		
Tons per Year		
Pollutant	**Cecil County**	**Cecil NAA Total**
VOC	64.91	64.91
NO_X	76.19	76.19
CO	43.36	43.36
$PM_{2.5\text{-}PRI}$	6.91	6.91
SO_2	6.20	6.20
NH_3	0.00	0.00

3.0 Quasi-Point Sources

3.1 Introduction

This section documents the development of the Maryland portion of the Philadelphia–Wilmington–Atlantic City, PA-NJ-DE-MD 2008 ozone NAAQS nonattainment area stationary quasi-point source emissions inventory. The Maryland Department of the Environment Air and Radiation Management has identified several facilities that due to size and/or function are considered quasi-point sources. These establishments contain a wide variety of air emission sources, including traditional point sources, on-road mobile sources, off-road mobile sources and area sources. For each particular establishment, the emissions from these sources are totaled under a single point source and summary documents include these "quasi-point" sources as point sources.

MDE has not identified any facilities that meet these requirements within Cecil County, MD.

4.0 Area/Nonpoint Sources

4.1 Introduction and Scope

This section documents the non-point (area) source emission inventory for volatile organic compounds (VOCs), carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxides (SOx), ammonia (NH3), and particulate matter ($PM_{2.5}$). Non-point sources include stationary sources and nonroad sources that are too small or too numerous to be treated individually as point sources. Non-point sources are instead tracked as a group or a category.

Major categories are divided into subcategories that contain: Standard Classification Code; a brief description of emission sources within the category or subcategory, and a specific description of the emissions being calculated; method and data sources; emission, seasonality and activity factors used; equation(s) used and example calculation; and summary table of emissions by county. Appendices containing examples of source data are located at the end of the entire inventory document.

4.2 Emission Estimation Approach

In general, one of four emission factor-based estimation approaches was used to calculate area source emissions: (1) per-capita emission factors, (2) commodity consumption-related emission factors, (3) level-of-activity-based emission factors, and (4) employment-related emission factors. Most of the emission estimates are made using procedures described in the EIIP[2] area source methods guidance documents or guidance approved by EPA and developed by state agency member groups, such as, ERTAC or MARAMA.

Activity level data and commodity level data are obtained from the appropriate publications and letter communications with individual companies listed in the Appendices. All emission factors except where noted are from EPA methodology guidance documents. Additional methods of emissions estimation can be found on EPA's Clearinghouse for Emission Inventories and Emission Factors (CHIEF site: http://www.epa.gov/ttn/chief/eiinformation.html).

EXCEL® spreadsheets and Microsoft Access were utilized to perform the calculations. In most cases, calculations are carried to three significant figures. For area sources with extremely small emissions, emissions are displayed to 4 or more decimal places. Numbers are rounded in the spreadsheet columns and then summed. Emissions are summed first by county and then by region: the Baltimore nonattainment region, the Maryland counties in the Washington, D.C. nonattainment region, the Kent and Queen Anne's nonattainment region, The Philadelphia nonattainment area (represented in Maryland by Cecil County), and the region comprising the remaining counties of Maryland in attainment for ozone referred to as the balance of the (Northeast Ozone) Transport Region.

Point source emissions had to be subtracted from the area source totals for some smaller but similar source categories to avoid double counting and over estimating. Examples include graphic arts and bakeries, and industrial coating operations. The threshold for a major source at the time most of these factors were developed varies by county. These sources are included in the point source inventory and must be subtracted to avoid doubling their emissions.

2 Emission Inventory Improvement Program

Annual emissions are in tons per year. If rule effectiveness, rule penetration and control efficiency factors are necessary, the values and use are delineated in the method description. Non-point source emissions have been calculated using seasonal and temperature adjusted emission factors to reflect conditions expected in 2011.

Quality assurance procedures were performed in accordance with the Quality Assurance Plan included in the Inventory Preparation Plan. These procedures will be explained in Section 7.0 Quality Assurance.

Area source procedures, emissions factors and equations are subject to revision if necessary to comply with future guidance or comments issued by USEPA.

4.3 Summary of Emission Results

Table 4-1 lists emissions for Cecil County, MD area. Appendix A contains a detailed explanation of methodologies and quality assurance/quality controls used to develop the 2011 base year emissions inventory for the area. Appendix C provides a detailed description of the total area/nonpoint source emissions for the Cecil, MD area.

Table 4-1: 2011 Base Year SIP Area Source Emission Inventories
Cecil County, MD Portion of the Philadelphia–Wilmington–Atlantic City, PA-NJ-DE-MD 2008 Ozone NAAQS Nonattainment Area

Area Source Emissions – 2011 Base Year SIP Emission Inventory		
Tons per Ozone Season Day		
Pollutant	Cecil County	Cecil NAA Total
VOC	2.863	2.863
NO_X	0.305	0.305
CO	1.963	1.963

Area Source Emissions – 2011 Base Year SIP Emission Inventory		
Tons per Year		
Pollutant	Cecil County	Cecil NAA Total
VOC	937.78	937.78
NO_X	242.02	242.02
CO	1,235.06	1,235.06
SO_2	210.84	210.84
$PM_{2.5\text{-}PRI}$	456.50	456.50
NH_3	477.15	477.15

5.0 Nonroad Sources

This section contains the nonroad source emission inventory for volatile organic compounds (VOCs), nitrogen oxides (NOx), carbon monoxide (CO), sulfur oxides (SO_x), particulate matter (PM2.5 and PM10), ammonia (NH3), and toxic air pollutants. Nonroad mobile sources include motorized vehicles and equipment that are normally not operated on public roadways to provide transportation. Nonroad mobile sources are broken up into the following categories:

Nonroad Model NMIM Categories

- Lawn and garden equipment
- Airport service equipment
- Recreational land vehicles or equipment
- Recreational Marine Equipment
- Light commercial equipment
- Industrial equipment
- Construction equipment
- Agricultural or farm equipment
- Logging equipment

Marine-Air-Rail Categories

- Railroads
- Commercial aviation
- Air taxis
- General aviation
- Military aviation
- Commercial marine vessels

The Department used two methodologies approved by the EPA for developing the 2011 emissions inventory for nonroad categories. One of the methodologies used consisted of employing EPA's, National Mobile Inventory Model (NMIM-April 5, 2009), which is similar to its NONROAD Emission Inventory Model. In a memorandum[3], dated June 16, 2003, EPA allowed the use of the draft NONROAD Model and associated default inputs in the development of inventories supporting State Implementation Plans (SIPs). The second methodology entailed the use of EPA emission factors.

5.1 Nonroad Model Sources

Nonroad model sources include a varied collection of equipment using power from engines for purposes other than locomotion on highways. Nonroad emissions result from the use of fuel in this diverse collection, which includes vehicles and equipments in the following categories:

- Recreational vehicles, such as all-terrain vehicles and off-road motorcycles;
- Logging equipment, such as chain saws;
- Agricultural equipment, such as tractors;
- Construction equipment, such as graders and backhoes;
- Industrial equipment, such as fork lifts and sweepers;
- Residential and commercial lawn and garden equipment, such as leaf and snow blowers.

3 USEPA Memorandum, dated June 16, 2003, from Gene Tierney or the Air Quality and Modeling Center and Leila H. Cook of the Transportation and Regional Programs Division; to Regional Mobile Source Program Manages and Staff.

5.1.1 Emission Estimation Approach

Except for equipment in the MAR category, the inventory for nonroad mobile sources was developed using the most current version of EPA's NONROAD model as embedded in the National Mobile Inventory Model (NMIM). The NONROAD model includes more than 80 basic and 260 specific types of nonroad equipment and further stratifies equipment types by horsepower rating. Fuel types include gasoline, diesel, compressed natural gas (CNG), and liquefied petroleum gas (LPG).

EPA's NMIM2008 software (version NMIM20090504), the revised NMIM County Database (NCD20130531_nei2011v1), and the NONROAD2008a model (July 2009 version) were used to estimate the 2011 annual and average ozone season day emissions for VOC, NO_X, CO, SO_2, $PM_{2.5}$-PRI, and NH_3 for the purposes of creating the base year 2011 emissions inventory. The NONROAD2008a model estimates emissions for each specific type of nonroad equipment by multiplying the following input data estimates:

- Equipment population for the base year, distributed by age, power, fuel type, and application;
- Average load factor expressed as average fraction of available power;
- Available power in horsepower;
- Activity in hours of use per year; and
- Emission factors reflecting deterioration and/or new standards.

The emissions are then temporally and geographically allocated using appropriate allocation factors.

Several input files provide necessary information to the model. These input files include information such as: emission factors, base year equipment population, activity, load factors, average lifetime, scrappage function, growth estimates, and geographic and temporal allocations. Default values are provided for all input files. The user may replace the default data files when better information becomes available, either from EPA for national defaults or from local sources for locality-specific data.

The NMIM2008 software was run for all twelve months in 2011 to develop average ozone season day and annual emissions for the Cecil County MD area. All emissions sources in the software were included in the run. Average ozone season day emissions were estimated by dividing total emissions in July by the total number of days (31) in July. Emissions for all twelve months in 2011 were added together to develop annual emissions. Model inputs (temperature, fuel, and other parameters) used in this analysis were included in the NMIM county database mentioned above and were the same as the inputs used in developing the 2011 NEI for the NMIM model sources. The above NMIM county database was acquired from EPA's website (file name '2011nei_supdata_nonroad.zip' under "Supporting data and summaries") for the NEI 2011(ver 1) effort.[4] The 2011 NEI Technical Support Document (ver 1) available on the above website provides details of the development of various inputs included in the database.

4 EPA NEI 2011 Website - http://www.epa.gov/ttn/chief/net/2011inventory.html#inventorydoc

5.1.2 Summary of Emission Results

Table 5-1 lists emissions for Cecil County, MD area. Detailed NMIM2008 software input and output files are being provided separately in electronic format as Appendix D of this document.

Table 5-1: 2011 Base Year SIP Nonroad Model Source Emission Inventories Cecil County, MD Portion of the Philadelphia–Wilmington–Atlantic City, PA-NJ-DE-MD 2008 Ozone NAAQS Nonattainment Area

Nonroad Model Source Emissions – 2011 Base Year SIP Emission Inventory		
Tons per Ozone Season Day		
Pollutant	**Cecil County**	**Cecil NAA Total**
VOC	5.127	5.127
NO_X	2.006	2.006
CO	22.551	22.551

Nonroad Model Source Emissions – 2011 Base Year SIP Emission Inventory		
Tons per Year		
Pollutant	**Cecil County**	**Cecil NAA Total**
VOC	1,054.93	1,054.93
NO_X	529.02	529.02
CO	4,941.79	4,941.79
$PM_{2.5\text{-}PRI}$	56.97	56.97
SO_2	1.44	1.44
NH_3	0.74	0.74

5.2 Marine Vessels, Airport, Railroad Locomotives

5.2.1 Emission Estimation Approach

Marine-Air-Rail (M-A-R) emissions were calculated by collecting data directly from surveyed sources, or activity from state and federal reporting agencies. EPA emission factors were applied using EPA guidance / methodologies or the best engineering method.

Detailed documentation for the development of MAR emissions were provided by the state air agencies. The state-specific documentation may be found in Appendix B1, B2, and B3, respectively.

5.2.2 Summary of Emission Results

Table 5-2 lists emissions for Cecil County, MD area. Detailed emissions breakdowns may be found in electronic format in Appendix B4 of this document.

Table 5-2: 2011 Base Year SIP M-A-R Emission Inventories
Cecil County, MD Portion of the Philadelphia–Wilmington–Atlantic City, PA-NJ-DE-MD 2008 Ozone NAAQS Nonattainment Area

M-A-R Source Emissions – 2011 Base Year SIP Emission Inventory		
Tons per Ozone Season Day		
Pollutant	Cecil County	Cecil NAA Total
VOC	0.030	0.030
NO_X	0.460	0.460
CO	0.315	0.315

M-A-R Source Emissions – 2011 Base Year SIP Emission Inventory		
Tons per Year		
Pollutant	Cecil County	Cecil NAA Total
VOC	11.03	11.03
NO_X	167.97	167.97
CO	115.08	115.08
$PM_{2.5\text{-}PRI}$	3.51	3.51
SO_2	24.54	24.54
NH_3	0.00	0.00

6.0 Onroad Mobile Sources

6.1 Introduction

The purpose of this technical document is to explain how Maryland estimates emissions from highway vehicles for inclusion in its emission inventories and State Implementation Plans (SIP). This section of the document deals only with the 2011 base year inventory for onroad mobile sources.

6.2 Emission Estimation Approach

In accordance with the standard methodology for the development of highway vehicle emissions inventories, all of the emissions estimates documented herein are based on emission factors developed using the United States Environmental Protection Agency's (U.S. EPA's) latest version of the MOVES emissions factor model and appropriate activity levels i.e., VMT estimates developed from the vehicle count data maintained by the State Highway Administration (SHA) of the Maryland Department of Transportation (MDOT).

On-road mobile sources include all vehicles registered to use the Maryland's public roadways. The predominant emission source in this category is the automobiles, although trucks and buses are also significant sources of emissions. In theory, only three primary entities are required to compile reasonably accurate emission estimates for the pollutant(s) of interest: (1) vehicle emission factors, (2) vehicle activity, and (3) vehicle population. Estimation of highway vehicle emissions is a very complex process of assessing emissions from various vehicle makes/models of all ages, moving at different speeds with varying operating conditions over a roadway network of various rural and urban classifications, for a definite period of time.

The MOVES2010a model was used for developing the onroad mobile annual and average ozone season day base year 2011 emissions for the Cecil County, MD area. Appendix D1 provides more detailed documentation on data sources and methodologies used to develop different inputs. MOVES2010a input files, external input files, and output files are provided separately in electronic format as Appendix D2.

This on-road mobile emissions analysis process is very similar to the process used during the development of previous base year inventories.

6.3 Summary of Onroad Mobile Source Emissions

The table below summarizes the typical ozone season day emissions for VOC, NO_X, and CO and annual emissions for VOC, NO_X, CO, $PM_{2.5\text{-}Pri}$, SO_2, and NH_3 in the Cecil County, MD area.

Table 6-1: 2011 Base Year SIP On-road Model Source Emission Inventories Cecil County, MD Portion of the Philadelphia–Wilmington–Atlantic City, PA-NJ-DE-MD 2008 Ozone NAAQS Nonattainment Area

On-road Mobile Source Emissions – 2011 Base Year SIP Emission Inventory		
Tons per Ozone Season Day		
Pollutant	**Cecil County**	**Cecil NAA Total**
VOC	2.29	2.29
NO_X	7.50	7.50
CO	5.33	25.81

On-road Mobile Source Emissions – 2011 Base Year SIP Emission Inventory		
Tons per Year		
Pollutant	**Cecil County**	**Cecil NAA Total**
VOC	791.98	791.98
NO_X	2,730.44	2,730.44
CO	9,421.97	9,421.97
$PM_{2.5\text{-}PRI}$	94.74	94.74
SO_2	11.04	11.04
NH_3	52.21	52.21

7.0 Quality Assurance Procedures

Several quality assurance checks were employed by the MDE or, given resource constraints, regionally to address the data quality objectives discussed in Chapter 1.4 related to accuracy, completeness, comparability, and/or representativeness: reality/peer review checks, sample calculations, sensitivity analysis, and range checks. Details on each check are provided below.

7.1 Reality Check/Peer Review Check

Independent review was conducted by knowledgeable staff to ensure that data, assumptions, and procedures are reasonable. The objective of these checks is to ensure accuracy, completeness, comparability, and representativeness.

Reasonableness of methods, assumptions, and emissions estimates was assessed by 1) comparing data sources used in the final inventory to those used for the 2011 NEI; 2) relying on reviewer expertise; and 3) comparing emissions estimates to other inventory efforts, particularly the 2002 base year inventory, 2007 attainment year inventory, and the 2011 NEI (Version 1).

7.2 Sample Calculations

Sample calculations provide verification of values by replicating calculations. The benefit is to ensure that calculations are done correctly. The objective is accuracy.

Emissions calculations were duplicated to spot check the accuracy of the arithmetic and, therefore, the resulting emissions estimates. Priority was given to those categories identified as the largest emissions contributors.

For nonroad and onroad emissions estimates, sample calculations were not used as a quality assurance mechanism. Preparing sample calculations for these sectors was not possible since the emissions estimates were generated using EPA-approved models. Rather, these data, which were generated by MWAQC and TPB modeling staff, were checked by comparing the results of similar modeling runs conducted by other agencies such as state air agencies, state transportation agencies, or MARAMA to ensure the results included herein were reasonable.

7.3 Sensitivity Analysis

Sensitivity analysis is the systematic study of how changes in parameters affect data. The benefit is to identify the parameters that have the greatest effect on data. All data quality objectives are addressed using these checks.

A sensitivity analysis in the form of source category emissions rankings by pollutant was performed. The ranking helped determine where efforts should be concentrated.

7.4 Standard Range Checks

Standard range checks address the data quality objective of comparability. The benefit is to identify the source categories that have the greatest change in emission levels from previous emission estimates. All data quality objectives are addressed using these checks.

The 2011 base year inventory was compared to the most recent inventories (base year 2002, attainment year 2007 inventory, and the 2011 NEI Version 1). Any discrepancies (data outliers) were verified or corrected.

7.5 Corrective Action Plan

Corrective and follow-up actions identified during the quality checking process were noted and referred to the appropriate staff.

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Appendix B – Point Source Inventory Files

Appendix C – Area/Nonpoint Sources

Appendix D – Nonroad Mobile Files

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Appendix E – Onroad Source Files

Appendix E1 – MOVES2010a (Onroad Mobile Model) Input & Output Files

Appendix F – Public Hearing Notices, Comments, and Responses

Appendix A
Emission Inventory Methodology Documentation

MARYLAND DEPARTMENT OF THE ENVIRONMENT

AIR AND RADIATION MANAGEMENT ADMINISTRATION

State Implementation Plan

2011 Base Year SIP Emissions Inventory Methodologies

Prepared for:

U.S. Environmental Protection Agency

Prepared By:

Maryland Department of the Environment

Maryland Department of the Environment
2011 Base Year Emissions Inventory Methodologies

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1.0 INTRODUCTION

In 2012, U.S. EPA designated area nationwide as nonattainment for the new 8-Hour Ozone National Ambient Air Quality Standard (NAAQS). The 1990 Clean Air Act Amendments (CAAA) requires all states to revise and submit State Implementation Plans (SIP) for areas classified as nonattainment of the NAAQS for ozone.

As part of designation of nonattainment areas for the 8-hour ozone standard, a new attainment demonstration SIP will be necessary. A key element in the overall SIP planning process is the need for an updated emissions inventory. This document presents the 2011 Base Year Ozone SIP Emissions Inventory for Maryland as required by the CAAA of 1990. It includes NOx and VOC emissions for all anthropogenic emissions for the State of Maryland. Theses emissions are categorized as point, quasi-point, area, biogenic, on-road mobile and non-road mobile.

This technical report documents the procedures and methodologies that were used in the development of summer day volatile organic compound (VOC) and nitrogen oxides (NOx) emissions for all counties in Maryland. This report describes the following:

1. Identification of stationary and mobile sources included in the inventory;
2. Sources of data, and data collection methods used in the development of the inventory;
3. Methods and procedures used to estimate emissions
4. Assumptions considered in the development of the emissions inventories.

The intent of this report is to describe how the inventory was prepared and what information was considered in the inventory development.

This document is comprised of six sections, one section for each source category type.

2.0 POINT SOURCES

2.1 INTRODUCTION

The Maryland Department of the Environment Air and Radiation Management Administration (ARMA) is the lead agency responsible for compiling the point source emissions inventory, including identification of sources, documenting the method used to calculate emissions from each source, and presenting the findings. In order to provide EPA with a written documentation of emissions calculations for major point sources, confidential information was included in the documentation. It is included with the understanding that EPA is also bound to respect the confidentiality of the information, including appropriate storage of the information. Any contractors employed by EPA to review the inventory are also subject to confidentiality provisions, or the EPA must remove the confidential material before submitting the document for review. This information does not appear in copies prepared public review.

The Maryland stationary point source inventory is the result of efforts to characterize air emissions sources since the early 1970's. This section describes data collection, verification and emission estimation methods used to estimate point source emissions from stationary sources. For the 2011 Periodic Emissions Inventory, point sources are defined as stationary commercial or industrial operations that emit more than 10 tons per year of volatile organic compounds (VOC); 100 tons per year of carbon monoxide (CO), sulfur oxides (SO_x), particulate matter with an aerodynamic diameter less than 10 micrometers (PM_{10}), and total suspended particulates (TSP); or 25 tons per year of oxides of nitrogen (NO_x. In addition, stationary sources included in previous PEI submissions were included herein regardless of the amount of air pollutants emitted. These emissions criteria are more commonly referred to as “emissions thresholds” or simply, “thresholds.”

2.2 COMPILING THE POINT SOURCE LIST

Maryland has a substantial database of both small and large air emission sources compiled over the last eighteen years. Since the thirteen central counties of Maryland and Baltimore City have been nonattainment for ozone since before 1982 and 80% of the state's population and major industrial sources lie within these counties, the database of over 10,700 sources (both above and below the point source thresholds) is reasonably complete. The list of point sources in this inventory was developed by applying the appropriate thresholds to the emission levels in the database to differentiate between point and area stationary sources. Sources with emission levels greater than the threshold or sources previously included in PEI submittals are by definition point sources while sources with emissions levels less than the thresholds are by definition area sources.

Several methods of source identification are used by ARMA to ensure the point source inventory is as complete as possible. The primary data source is the Permitting Program, which overseas the registration requirements found in Title 26, Subtitle 11, Chapter 02, Code of Maryland Regulations (COMAR). The Compliance Program identifies other point sources though annual facility inspections and through investigations conducted in response to citizen complaints.

The primary means of new source identification is the steady influx of permit applications and equipment registrations. Many sources are required by COMAR 26.11.02, Permits, Approvals and Registration, to register with ARMA. From 700 to 1,000 new sources are registered with the Department each year.

Most of these sources are not considered to be point sources as defined for inventory purposes, even though they require permits. As an example, emissions from some sources can be less than one ton per year. However, all sources that are registered with the Department are tracked until the Department receives notification that the equipment or emission source has ceased operations. An emissions source or its equipment is not permanently deleted from the registration database until the installation is demolished.

The Department has established a Small Business Assistance Program as required by the Clean Air Act Amendments to acquaint the owners of potential sources with the State's permitting requirements, including air quality permits. The Department has also published a guidebook, Environmental Regulation: A Business Guide to the Maryland Department of the Environment's Permitting Process as part of its outreach program.

A secondary means of new source identification are the emission sources identified by Compliance Program staff during annual field inspections of major point sources. During these inspections, unregistered equipment is sometimes discovered. Statewide response to the Air Pollution Report and the Air Quality Complaint Hotline, has also led to the discovery of previously unidentified emissions sources. Sources discovered in this manner may be the result of the citizen complaints, or the result of further investigation of visual evidence such as buildings, storage yards, visible emissions, etc., sighted elsewhere during the response.

2.2.1 EMISSION CALCULATIONS

The ARMA technical staff uses one of the following methodologies to calculate criteria pollutant emissions:

- EPA-supplied emission factors
- EPA-supplied emission models
- Material balances
- Emissions based on source test data
- Agency or company-generated emission factors

The Compliance Program facility inspectors calculate annual emissions estimates following their annual facility inspections. The results are then entered into ARMA's Registration Files for Facilities and Equipment, which lists facilities by premise numbers and equipment by registration numbers under each facility. Both the stack and fugitive emissions, from all registered equipment at a specific facility are summed to yield the annual facility emissions estimate. This total facility estimate is used to determine whether the facility satisfies the criteria for classification of as a point source.

The estimation of emissions on a facility-wide basis can result in emissions from equipment in some subcategories, such as boilers, being obscured. For example, boiler emissions are included in the Amerada Hess Corporation's total emissions. Therefore, these boiler emissions are included with emissions from gasoline storage and handling operations and included in the Storage, Transportation and Marketing of Petroleum Products and Volatile Organic Liquids source category rather than in External Combustion Sources category.

Emissions from specific subcategories of sources can be extracted from the inventory to estimate possible reductions from various control strategies. However, the emissions from specific equipment subcategories cannot be excluded from the facility-wide emissions because of the limitations of the software used to create the Registration File. Therefore, subcategories of equipment emissions are not included in the inventory as separate line items for to do so would result in the double counting of those emissions.

The estimates prepared by the facility inspectors following the annual inspection of each facility are compared to the annual emissions reported by each facility in its Annual Emissions Certification. A person who owns or operates a major facility as defined in COMAR 26.11.01.05-1 must submit to the Department an emissions statement by April 1 of each year for the previous calendar year. The owner or operator of the facility must further certify that the emissions statement is accurate to the best of the owner/operator's best knowledge. After the certified emissions statements are logged in, they are thoroughly reviewed by the assigned facility inspectors. Each inspector compares their emissions estimate to that prepared by the respective company for consistency of methodology and final emissions estimate results. The facility inspectors resolve any discrepancies between the two estimates with the owner/operator of the facility in question. When all discrepancies are resolved to the satisfaction of MDE, the final emissions estimates are then submitted as an update to ARMA's Registration File for Facilities and Equipment.

2.2.1.1 **Seasonal Adjustments**

ARMA has collected extensive data for the temporal allocation of emissions.

For CAMD sources MDE summed the ozone season pollutant emissions (in tons) and divided by the sum of the ozone season operating time (in hours) and divided by 24 hours in a day.

In cases where the facilities did not provide peak ozone season emission estimates, the peak ozone season emissions were calculated by the following method and are included in the emissions summary tables, by county, at the end of this section:

1) Annual emissions in tons per year were converted into tons per day emissions by dividing annual emissions by operating days,
2) Tons per day emissions were then multiplied by a seasonality factor,
3) The seasonality factor was based on the quarterly percentage of operations estimated by the company adjusted for June, July, and August.
4) The ratio obtained in Step 3 was multiplied by the daily emissions calculated in Step 1 to generate the seasonally adjusted emissions.

3.0 QUASI - POINT SOURCES

3.1 INTRODUCTION

The Maryland Department of the Environment Air and Radiation Management has identified several facilities that due to size and/or function are considered point sources. These establishments contain a wide variety of air emission sources, including traditional point sources, on-road mobile sources, off-road mobile sources and area sources. For each particular establishment, the emissions from these sources are totaled under a single point source and summary documents include these “quasi-point” sources as point sources.

3.2 ABERDEEN PROVING GROUNDS

Description

Aberdeen Proving Ground (APG) occupies more than 72,500 acres in Harford County, Md. Its northernmost point is marked by the confluence of the Susquehanna River and the Chesapeake Bay. On the south the Gunpowder River borders it.

The installation comprises two principal areas, separated by the Bush River. The northern area is known as the Aberdeen Area, and the southern sector, formerly Edgewood Arsenal (established in November, 1917 - as a chemical weapons research, development and testing facility), is the Edgewood Area. The two areas were administratively combined in 1971.

Aberdeen Proving Ground is home to 66 tenants and a host of satellite activities. Among the major tenants are the U.S. Research, Development and Engineering (RDECOM), U.S. Army Ordnance Center and Schools, U.S. Army Developmental Test Command, U.S. Army Aberdeen Test Center, U.S. Army Center for Health Promotion and Preventive Medicine, Northeast Region Civilian Personnel Operations Center, U.S. Army Medical Research Institute of Chemical Defense, Program Manager for Chemical Demilitarization and major elements of the Army Research Laboratory.

As a center for Army materiel testing, laboratory research and military training, the post is a key element in the nation's defense. All tanks and wheeled vehicles which have served U.S. forces for the past 50 years have been tested for performance and durability at APG - from the M4 Sherman tank of World War II to the M1 tank and High Mobility Multipurpose Wheeled Vehicle and Family of Stryker Vehicles of today.

Known as the "Home of Ordnance," APG has been training Army ordnance personnel since 1918. The Army's ordnance training was consolidated at the proving ground during World War II, and today the U.S. Army Ordnance Center and School provides mechanical maintenance training for more than 20,000 U.S. and foreign personnel each year. APG is the regimental headquarters for the Army's Chief of Ordnance.

APG's Edgewood Area has been a center for chemical warfare research and development since it was established. From the trenches of France and Belgium in World War I to the desert battlefields of Iraq nearly 80 years later, the work done at APG has contributed to the defense and safety of American forces threatened by chemical weapons.

More than 7,500 civilians work at Aberdeen Proving Ground, and more than 5,000 military personnel are assigned there. In addition, there are nearly 3,000 contractors and private business employees working on the proving ground.

There are 2,148 military family members living on the post and another 155 off post. The post supports more than 16,000 military retirees and retiree family members. The post is Harford County's largest employer and one of the largest employers in the state of Maryland.

U.S. Army Garrison, Aberdeen Proving Ground, provides general, administrative and logistical support to the post's tenants and satellite activities, and is responsible for the management and operation of the entire installation, which in many ways is like a small city.

Environmental stewardship is an essential component of all activity at APG. The installation and its tenants are actively involved in a wide variety of environmental compliance, pollution prevention, conservation, and restoration programs. In FY 2004 APG spent a total of $31 million on environmental programs, installation programs and installation restoration activities.

Pollutants

VOC, NOx, CO, PM, Toxics

Emission Source Categories

MDE staff reviewed emission estimates prepared for Aberdeen Proving Grounds by a private contractor. These emission estimates included data for the following source categories:

- Mobile On-Road Source Emissions
    - Mobile - LDGV Emissions
    - Mobile - LDGT 1&2 Emissions
    - Mobile - LDGT 3&4 Emissions
    - Mobile - HDGV
    - Mobile - LDDT 1-4
    - Mobile - HDDV
    - Mobile - HDDV Exhaust
    - Mobile – HDDB
    - Mobile - HD CNG Trucks
    - Mobile - LD CNG Trucks

- Mobile Nonroad Source Emissions
    - 2-Stroke Gas Eng; Lawn & Garden Equip; Other Equipment
    - 4-Stroke Gas Eng; Recreational Equip; Golf Carts
    - 4-Stroke Gas Eng; Recreational Equip; Specialty Vehicles/Carts
    - 4-Stroke Gas Eng; Construction & Mining Equip; Off-Highway Trucks
    - 4-Stroke Gas Eng; Industrial Equip; Forklifts
    - 4-Stroke Gas Eng; Lawn & Garden Equip; Chain Saws
    - 4-Stroke Gas Eng; Lawn & Garden Equip; Leaf blowers/Vacuums

- 4-Stroke Gas Eng; Lawn & Garden Equip; Rear Eng Riding Mowers
- 4-Stroke Gas Eng; Lawn & Garden Equip; Front Mowers
- 4-Stroke Gas Eng; Lawn & Garden Equip; Other Lawn & Garden Equip
- 4-Stroke Gas Eng; Commercial Equip; Generator Sets
- LPG Eng; Construction & Mining Equip; Off-Highway Trucks
- Diesel Eng; Construction & Mining Equip; Rollers
- Diesel Eng; Construction & Mining Equip; Cranes
- Diesel Eng; Construction & Mining Equip; Graders
- Diesel Eng; Construction & Mining Equip; Off-highway Trucks
- Diesel Eng; Construction & Mining Equip; Tractors/Loaders/Backhoes
- Diesel Eng; Construction & Mining Equip; Other Construction Equip
- Diesel Eng; Industrial Equip; Forklifts
- Diesel Eng; Industrial Equip; Sweepers/Scrubbers
- Diesel Eng; Lawn & Garden Equip; Front Mowers
- Diesel Eng; Agricultural Equip; Agricultural Tractors
- Diesel Eng; Commercial Equip; Generator Sets
- Recreational marine 4-stroke gasoline equipment
- Recreational marine diesel compression ignition equipment
- Aircraft

- Area Source Emissions
  - Emissions from aircraft refueling.
  - Construction Welding
  - Solvent-based architectural surface coatings.
  - Water-based architectural surface coatings.
  - Cold cleaning solvents.
  - Solvent Utilization - Miscellaneous
  - Commercial/consumer solvents.
  - Open Burning Detonation
  - Landfills - All Categories
  - Munitions Detonation
  - Firefighting Training
  - Industrial Process - Miscellaneous
  - Commercial/institutional distillate oil combustion.
  - Commercial/institutional natural gas combustion.

- Point Source Emissions
  - MDE staff also reviewed and included emission estimates from emission certification reports prepared by Aberdeen Proving Grounds and submitted on an annual basis to MDE's Compliance and Enforcement Program. These emission estimates include major sources.

Emission Estimation Methodologies

Emission estimation methodologies varied by source category. A brief synopsis of the methodologies is presented below.

Mobile On-Road Source Emissions

Information on the privately owned vehicles for APG was estimated from a 2001 traffic study conducted for all gates at both Aberdeen and Edgewood.

Emissions for the on-road vehicles were calculated only for the estimated miles and hours of on-base vehicle operation. Miles traveled off the base were not included in the emission calculations. *AP-42, Volume 11, Fifth Edition* includes the emission factors for NOx, CO, and VOC, which were calculated using EPA's MOVES2010b model for gasoline and diesel operated vehicles. AP-42 has been updated with NOx, CO, and VOC emission factors from the latest version of EPA's MOVES2010b model, which also includes emission factors for PM-10, PM-25, S02, and HAPS. Therefore, the emission factors for on-road vehicles were obtained by running the MOVES2010b model.

APG government-owned vehicles were grouped into vehicle categories according to vehicle type, gross vehicle weight (GVW), and fuel type. The CY 2011 mileage for each vehicle, came from a 2014 traffic study provided by the APG Department of Public or was an estimate of on-base mileage or a percentage of the total miles per vehicle that were driven on the base. If the mileage data was not available, it was estimated based on mileage for similar types of vehicles from other organizations or from estimates provided by organization personnel.

Emission estimates for privately owned vehicles (POVs) are based on traffic studies for CY 2000 and CY 2001. Each traffic study tracked incoming vehicles at all gates at both Aberdeen and Edgewood over a three-week period. The average number of vehicles counted at each gate over both years was used to estimate the number of POVs entering each day. The average values were 7,680 POVs per day at Aberdeen and 5,277 per day at Edgewood.

POV miles traveled were determined by using the distance from each gate to a central location at both Aberdeen and Edgewood. Each POV that entered a specific gate was assumed to drive that distance each day. The daily on-base mileage was determined by multiplying the number of POVs by the round-trip distance to a specific gate. The POV vehicles from the traffic study were conservatively estimated to be in the above-referenced vehicle categories.

Emissions of NOx, CO, VOC, PM-10, PM-2.5, and SO2 from daily employee POVs were estimated by multiplying the annual on-base mileage of each vehicle category with the emission factors obtained from the MOVES2010b. Since the model years of POVs traveling on the base would vary greatly, it is impractical to estimate the emissions from each vehicle in that model year range. Instead the year 2000 was considered the average vehicle model year, and the emission factors for the 2000 model year vehicles were used. The emission factors were used in the following equation to estimate annual emissions:

$$E = V * F * C$$

Where:

E = Annual emissions of particular pollutant from each vehicle category (lb/yr)

V = Vehicle miles traveled on-base per year for each vehicle category (mi/yr)

F = Average model year emission factor in the applicable vehicle category (g/mi)
C = Conversion factor (2.205 x 10 lb/g)

The information on the vehicles tested and miles driven on unpaved test tracks at APG was obtained from 2011 logs for each track. The test vehicles were divided equally into the HDDV and HDGV vehicle classes.

Mobile Nonroad Mobile Source Emissions

APG gathered information about the number of vehicles, model year, horsepower rating, fuel type, engine cycle type, and estimated operating hours for CY 2011. In the majority of instances, horsepower ratings and operating hours were not readily available and have been assumed based on the typical horsepower of similar types equipment.

Criteria pollutant emission factors were obtained from *Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations, United States Air Force Institute for Environment, Safety & Occupational Health Risk Analysis (IERA), January 2002,* which includes the emission factors used in EPA's NON-ROAD 2002 model. Emission factors to estimate PM-2.5 from PM-10 emissions were obtained from EPA's NON-ROAD 2002a model. The Non-road model incorporates research results from *U.S. EPA 's Non-road Engine and Vehicle Emission Study (NEVES), November* 1991, as well as from the California Air Resources Board's off-road model, test results, and regulatory emission standards. These factors were used to estimate the emissions from non-road vehicles and equipment.

Emission factors for stationary internal combustion engines were used to estimate criteria pollutant emissions for the non-mobile equipment. These factors are found in *Table* 3.3-1, *AP-42 Section* 3.3, *Gasoline and Diesel Industrial Engines.* Emissions were calculated by multiplying the power output by the emission factors applicable to the type of fuel used by the non-mobile equipment, either gasoline or diesel. The power output was calculated by multiplying the power of the equipment in horsepower times the estimated hours of operation. Net workdays were derived from the equipment rental records. It was assumed that the light towers were used 8 hours per day and that all other equipment was used 10 hours per day.

The total emissions for all non-road vehicles and equipment were separated into emissions for Aberdeen and Edgewood. In cases were vehicles were used at both Aberdeen and Edgewood the total emissions were divided equally.

Aircraft operations are conducted at Phillips Airfield at Aberdeen and Weide Heliport at Edgewood. These operations include landings and takeoffs (LTOs), touch and go's (T&Gs), low approaches (LAs), and trim and power checks (T&Ps). Emissions from aircraft operations were estimated using the EDMS (version 5.1) model.

Emissions of criteria pollutants for watercraft were calculated using factors provided in *AP-42, Volume 11.* Inboard emissions were calculated based on fuel consumption or operating time. Outboard emissions were calculated using factors related to fuel consumption. Fuel consumption was rarely known, so a generic fuel usage of 3 gallons per hour was used to calculate consumption from operating time.

The inventory of watercraft includes APG vessels, privately owned boats, and rental boats. The inventory included the size of vessels, whether the boat has an inboard or outboard motor, whether the boat uses gasoline or diesel, on-site fuel usage, and on-site estimated usage.

Many assumptions were necessary to calculate emissions from the limited information known about many of the watercraft. The number of memberships to the private boat clubs located at APG and number of permits to launch boats at APG was known, but no information as to the size and type of boats was, nor the time or distance they traveled within the boundaries of APG. All privately owned boats launched in the Aberdeen Area were considered outside of the APG boundary once in the water, so no emissions were counted from these boats. For privately owned watercraft it was assumed that 80% have outboard motors and 20% have inboard and that all are gasoline fueled. An assumption was made that privately owned watercraft were used 5 times per year and spent 2 hours on site each usage for a total of 10 hours each. For rental outboards it was assumed that they were used 3 hours on-site per rental weekend and that there were 40 rentals in 2002.

Area Source Emissions

Emissions from the various area source categories were estimated using a variety of methods, including population based, fuel consumption, and mass balance. Emission factors were derived from the EPA document titled 'Emission Inventory Improvement Program', and AP-42. Landfill losses as VOC were calculated for Michaelsville landfill using *Landfill Gas Emissions Model (LandGEM) version 3.02* available through the EPA. LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of waste in municipal solid waste landfills.

Activity

An activity level of 7 days a week with no seasonal adjustment factor was used.

Emission Factors

Emission factors were derived from the Emission Inventory Improvement Program (EIIP); AP-42, Volume 11, Fifth Edition; EPA's NMIM model; EPA's MOVES2010b model; and the Landfill Gas Emissions Model (LandGEM).

Point Source Adjustments

Collecting all emissions estimates under one facility effectively creates a single point source for all of the emissions. No other point sources were subtracted from the area source inventory to avoid double counting.

Adjustment for Controls

Controls were applied when applicable to a particular source category.

Spatial and Temporal Allocations

Spatial
Spatial allocation of the emission estimates to specific areas within APG is not available.

Temporal
Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

3.3 BALTIMORE-WASHINGTON INTERNATIONAL AIRPORT (BWI)

Description

Baltimore-Washington International Airport (BWI) is located in Anne Arundel County, Maryland, approximately 9 miles south of the City of Baltimore and approximately 30 miles northeast of Washington, D.C. BWI Airport is generally bounded on the north, east, and west by Aviation Boulevard (MD Route 170 and MD Route 162) and on the south by Dorsey Road (MD Route 176). Interstate 195 (I-195) is a four-lane divided highway that serves as the primary access point to the airport terminal area. Elm Road and Aviation Boulevard provide secondary access to the terminal and cargo facilities.

BWI is operated by the Maryland Aviation Administration, Maryland Department of Transportation. BWI Airport encompasses 3,596 acres of land. The passenger terminal contains 1.4 million square feet; 4 concourses (3 domestic, 1 international/swing); 69 jet gates with 12 gates dedicated to commuter aircraft.

The emission sources at BWI include aircraft, aircraft ground support service equipment, motor vehicles (on roadways, in parking facilities, and at terminal curbsides), the heating plant, fuel storage and handling, and training fires.

Pollutants

VOC, NOx, CO, PM, Toxics

Emission Source Categories

MDE staff reviewed emission estimates prepared for BWI Airport by a private contractor. These emission estimates included data for the following source categories:

- Mobile Onroad Source Emissions
  - Mobile - LDGV Emissions
  - Mobile - Parking Facility Emissions
  - Mobile - LDGT 1&2 Emissions
  - Mobile - LDDT 1-4
  - Mobile – HDDV

- Mobile Nonroad Source Emissions
  - Emissions from airport service diesel compression ignition equipment
  - Emissions from military aircraft LTOs
  - Emissions from commercial aircraft LTOs
  - Emissions from general aviation aircraft LTOs
  - Emissions from aircraft auxiliary power units

- Mobile Nonroad Source Construction Equipment Emissions
    - 2-Stroke Gas Eng; Construction & Mining Equip; Paving Equip
    - 4-Stroke Gas Eng; Construction & Mining Equip; Plate Compactors
    - 4-Stroke Gas Eng; Construction & Mining Equip; Concrete/Industrial Saws
    - Diesel Eng; Construction & Mining Equip; Pavers
    - Diesel Eng; Construction & Mining Equip; Rollers
    - Diesel Eng; Construction & Mining Equip; Scrapers
    - Diesel Eng; Construction & Mining Equip; Signal Boards/Light Plants
    - Diesel Eng; Construction & Mining Equip; Trenchers
    - Diesel Eng; Construction & Mining Equip; Excavators
    - Diesel Eng; Construction & Mining Equip; Cranes
    - Diesel Eng; Construction & Mining Equip; Graders
    - Diesel Eng; Construction & Mining Equip; Off-highway Trucks
    - Diesel Eng; Construction & Mining Equip; Rubber Tire Loaders
    - Diesel Eng; Construction & Mining Equip; Tractors/Loaders/Backhoes
    - Diesel Eng; Construction & Mining Equip; Crawler Tractor/Dozers
    - Diesel Eng; Industrial Equip; Aerial Lifts
    - Diesel Eng; Industrial Equip; Forklifts
    - Diesel Eng; Industrial Equip; Sweepers/Scrubbers
    - Diesel Eng; Commercial Equip; Generator Sets
    - Diesel Eng; Commercial Equip; Air Compressors
    - Diesel Eng; Commercial Equip; Welders

- Mobile Onroad Source Emissions
    - Firefighting Training

- Point Source Emissions
    - MDE staff also reviewed and included emission estimates from emission certification reports prepared by BWI and submitted on an annual basis to MDE's Compliance and Enforcement Program. These emission estimates include major sources.

Emission Estimation Methodologies

Emission estimation methodologies varied by source category. A brief synopsis of the methodologies is presented below.

Emissions and Dispersion Modeling System (EDMS) Version 5.1

- **Aircraft**

FAA's EDMS computer program contains a database of aircraft engine emission factors based on engine make and model and four engine operation modes (taxi/idle, takeoff, climb out, and approach). EDMS also contains a database of emission factors for an aircraft's auxiliary power units (APUs). Time-in-mode data is also used as an input into the emission inventory. EDMS time-in-mode data include the time that aircraft spend in each of the four operating modes.

- **Ground Support Equipment**

FAA's EDMS computer program contains a database of the ground support equipment (GSE) used to service specific types of aircraft. Also included in the database are the emission factors for each piece of GSE, as well as the time that each piece of equipment spends servicing the aircraft.

- **Roadways**

FAA's EDMS computer program uses EPA's MOVES2010b model to estimate on-road mobile vehicle emissions.

- **Parking Facilities**

FAA's EDMS computer program uses EPA's MOVES2010b model to estimate on-road mobile vehicle emissions from parking facilities.

- **Training Fires**

FAA's EDMS computer program contains a database of emission factors for five fuel types (JP-4, JP-5, JP-8, Tekflame and Propane). Training fire emissions are estimated by choosing the fuel type and specifying the amount of fuel consumed in the training exercise.

Nonroad Mobile Source Emissions

- **Construction Equipment**

Emissions from construction activities were estimated based on the construction activity schedule, including the number and types of construction vehicles and equipment units and their utilization rates. Emission rates were taken from EPA's NONROAD2008a program, AP-42 guidance, and MOVES2010b. Emissions from several components of construction activities were calculated, specifically: onsite construction equipment (backhoes, bull dozers, graders, etc.), haul vehicles idling onsite (cement trucks, dump trucks, etc.), and haul vehicles and construction worker vehicles accessing the site. An industry-wide, representative mix of the number and types of construction equipment, average power rating (horse power), and equipment load factors was used in the analysis. Construction-related motor vehicles (dump

trucks, pick-up trucks, etc.) were assumed to travel a round trip on-site distance of 5 miles while on the Airport construction site.

Activity

An activity level of 7 days a week with no seasonal adjustment factor was used.

Emission Factors

Emission factors were derived from FAA's EDMS computer program (Version 5.1.3). Vehicular emission factors contained in EDMS are obtained from the EPA's MOVES2010b model. Construction emission factors were derived from EPA's NONROAD2008a Model.

Point Source Adjustments

Collecting all emissions estimates under one facility effectively creates a single point source for all of the emissions. No other point sources were subtracted from the area source inventory to avoid double counting.

Adjustment for Controls

Controls were applied when applicable to a particular source category.

Spatial and Temporal Allocations

Spatial

Spatial allocation of the emission estimates to specific areas within Baltimore Washington International Airport is not available.

Temporal

Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

3.4 PORT OF BALTIMORE

Description

The Maryland Port Administration (MPA) works hand and hand with the Port of Baltimore to help the marine terminal in there day to day operations. Maryland has seven main terminals and several tenant port terminals. The main terminals are:

Dundalk Marine Terminal
Seagirt Marine Terminal
South Locust Point
North Locust Point
Masonville Marine Terminal
Fairfield Marine Terminal
Hawkins Point Marine Terminal

The following summary descriptions come from the MPA.

Dundalk Marine Terminal:
With 13 berths, nine container cranes, and direct rail access, the 570-acre (230 ha) Dundalk Marine Terminal remains the largest and most versatile general cargo facility at the Port of Baltimore.

Dundalk handles containers, automobiles, farm equipment, construction and other Roll-on/Roll-off (Ro/Ro) equipment, wood pulp, steel, break-bulk, project cargo, and other various types of equipment.

Ports America operates a private container terminal within Dundalk. Baltimore's proximity to the Midwest's major farm and construction equipment manufacturers has helped the Port become the leading U.S. port for combines, tractors and hay balers, and in importing excavators and backhoes.

Reaffirming our position as the top U.S. Ro/Ro port, Baltimore recently signed a 20-year, 150-acre agreement to serve as the East Coast hub for the largest Ro/Ro carrier in the world, Wallenius Wilhelmsen, with service from Dundalk Marine Terminal.

Seagirt Marine Terminal:
Opened in 1990, Seagirt features the latest in cargo-handling equipment and systems. Seagirt is operated by Ports America Chesapeake under a 50-year public-private partnership signed in 2010 with the MPA. Under the agreement, Ports America is constructing a new 50-foot container berth to be accompanied by four state-of-the-art super Post Panamax cranes. At that point, the Port of Baltimore will be only the second East Coast port with both a 50-foot channel and a 50-foot berth, allowing it to accommodate some of the largest container ships in the world.

South Locust Point:
South Locust Point has Interstate 95 – which is direct access to the East Coast bypassing its entrance. In 1988, the MPA completed a major expansion of South Locust Point, doubling the size of the terminal to almost 80 acres. In 2005, MPA created a 300,000-foot paper shed and a 100,000-foot shed.

In 2006, the MPA proudly opened its new, dedicated 60,000-foot Cruise Ship terminal at the South Locust Point terminal. The structure used for the passenger terminal was formerly a paper-shed building situated on 14 acres of land with easy access from either side of I-95. There were 81 total cruises in 2009 and 92 total calls for 2010.

North Locust Point:
North Locust Point was used in the pass to welcome immigrants, served as a cargo pier for the Baltimore & Ohio Railroad, and handled many different types of break-bulk, as well as liquid and drybulk cargoes.

Today, the 90-acre (36.1 ha) terminal has been redeveloped to enhance the Port's forest products capabilities. The addition of a 45-long-ton (45.7 mt) container crane, coupled with on-dock rail access, allows for the smooth loading and discharge of steel directly between vessel and rail car.

Masonville Marine Terminal:
Located near Maryland's I895 Masonville Terminal specializes in the import, export, and processing of automobiles. It covers 61 acres, with a trucks loading inside the terminal. It also has two piers (Pier 4 – 832 ft (253.6 m); Depth: 49 ft. (14.9 m), and CSX spur adjacent. Entire terminal leased to ATC Logistics.

Fairfield Marine Terminal:
Located also near Maryland's I895 Fairfield Marine Terminal specializes in the import, export, and processing of automobiles. It is over 104 acres load truck inside and outside fenced terminal. Fairfield has two piers; Pier 4 - 832 ft. (253.6 m) / Depth - 49 ft. (14.9 m), and an and CSX spur adjacent. Entire terminal leased to Daimler-Chrysler (Mercedes-Benz).

Hawkins Point Marine Terminal:
The **Maryland Port Administration** is trying to acquire 171 acres of land, Hawkins Point, which is the old Sparrows Point. The site contains a manufacturing operation that has been in existence since 1954. The Port Administration is looking for land in this area to use for a dredged material containment facility.

Pollutants

VOC, NOx, CO, PM, SO2, Toxics

Emission Source Categories

Mobile Nonroad Source Emissions:

1. Included in the Cargo Handling Equipment (CHE) category are:

- Ship to shore (STS) and other mobile cranes
- Rubber-tired gantry (RTG) cranes
- Forklifts
- Top loaders
- Side loaders
- Yard tractors
- Rubber-tired loaders
- Skid steer loaders
- Roll-on, roll-off (RoRo) equipment (e.g., self-propelled construction equipment, motorized farm equipment, and trailered items; e.g., watercraft)
- Vehicle cargo (automobiles, SUVs, and trucks that are driven off and onto ships)
- Auto processing (i.e., paint booths used for minor repairs)
- Maintenance, construction vehicles, and similar equipment
- Conveyor systems for dry bulk material
- Yard vehicles (unlicensed trucks and/or autos used for transportation purposes on port property only)
- Generators
- Employee traffic on site (includes cruise passenger vehicle traffic on site)

Emissions Calculation

Nonroad emissions were calculated using emission factors and load factors for non-road equipment developed by EPA and are available by their SCC code through the NONROAD model).

2. Heavy Duty Diesel Vehicles (HDDVs): are the on-road semi-trailer trucks that pick up and deliver cargo to the terminals.

3. Rail locomotive: Switching engine operations

4. Marine Vessels Port: Port vessel emissions are calculated for each port as described in section 5.6 Marine Vessels. The ports within the Baltimore Nonattainment Area (BNAA) are used in this section and represent a quazi point as a whole. Hoteling, maneuvering, cruise, and slow cruise emissions are estimated for all non-ocean going activity and movement within the waterways surrounding the BNAA ports.

Mobile Onroad Source Emissions:

1. LDGV and LDDV - Vehicle cargo (Autos, SUVs, and Trucks) SCC: 2201001250 and 2230001250
2. LDGV and LDDV - Employees SCC: 2230001250 and 2201001250
3. LDGV, HDGV, LDDT, and LDGT - Yard vehicles SCC: 2270003070, 2201070250, 2230060250, 2201020250, and 2201001250.

Emissions Calculation

Mobile emissions were calculated use EPA's MOBILE6 Model.

Spatial and Temporal Allocations

Spatial

Divided cruise emissions out to counties along travel route.

Temporal

Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

Emissions Calculation

On-road emissions were estimated for vehicles moving and idling. Emission factors from EPA's MOBILE6 Model were used to calculate emissions. Emission factors for on-road vehicles are represented in units of grams per mile (g/mi), while idling emission factors are expressed in grams per hour (g/hr). Distance or vehicle miles traveled (VMT) was used to calculate emissions for moving vehicles, and time, hours running, was used to estimate idling emissions.

4.0 AREAS SOURCES

4.1 EMISSION ESTIMATION METHOD BY CATEGORY

4.1.1 PETROLEUM DISTRIBUTION LOSSES

Evaporative emissions occur at all points in the gasoline distribution process. These operations, generally inventoried as area sources, are gasoline dispensing outlets and gasoline tank trucks in transit. Bulk terminals and gasoline bulk plants, which are intermediate distribution points between refineries and outlets, have been inventoried as point sources. Most gasoline dispensing

outlets emit less than 10 tons of VOC per year and therefore have been inventoried using area source methods.

VOC emissions from gasoline dispensing outlets result from vapor losses during tank truck unloading into underground storage tanks, vehicle fueling (boat fueling at marinas), and underground storage tank breathing. Evaporative losses from each activity in this source category have been tabulated separately so that various emission reduction control measures could be easily evaluated.

Emissions from vehicle fueling, including spillage during fueling, were calculated with the MOVES model and the methodology is described in Section 5.0 Mobile Sources. Tank truck unloading, underground tank breathing, tank trucks in transit and aircraft refueling were calculated using emissions factors from AP-42 and EIIP.

4.1.1.1 **Tank Truck Unloading**

SCC: 25 01 060 053
25 01 060 051

Description:

Emissions from tank truck unloading are affected by whether the service station tank is equipped for submerged, splash or balance filling. Therefore calculations were based on the filling method used and gallons sold.

Pollutants

VOC and HAPs

Method and Data Sources:

The method used to calculate emissions (all VOC), is presented in EIIP[1], Chapter 11, Gasoline Marketing, which extracts the emission factors from AP-42, Volume I, Table 5.2-7.

Activity

The Maryland Comptroller of the Treasury, Gasoline Tax Division (see Appendices) provided annual gallons of gasoline and diesel fuel sold. This data includes taxable and non-taxed gasoline purchased by the U.S. Government. State and local government sales are included in the taxable sales data. The statewide total of gallons of fuel sold was allocated to the county level proportional to the number of registered vehicles within the county. Vehicle registration data was collected from the Maryland Department of Transportation, Motor Vehicle Administration that supplied the data to MDE's Mobile Sources Control Program (see Appendices). Diesel fuel powered vehicle totals were subtracted from the Maryland and county registration numbers.

Percentages of submerged, balanced submerged and splash-fill tanks were determined with the assistance of MDE Waste Management. MDE staff reported no splash filling at Maryland service stations in 2011. All underground storage tanks within the nonattainment areas of the State of Maryland are required to use vapor-balance submerged filling methods. Waste Management's underground tank inspection program and regulations concerning underground storage tanks have eliminated splash-fill tanks in the state. A recent SSCD study determined that the rule effectiveness factor for vapor balance controls was 91%.

An activity level of 7 days per week was used, based on observations by MDE staff of unloading at Maryland retail gas stations. A rule effectiveness of 91% was determined from a study of Stage I compliance performed in Regions III and IV by the MDE/ARMA enforcement program in 1991. In the attainment counties outside of Regions III and IV, a

[1] Emission Inventory Improvement Program

default rule effectiveness of 80 % was used. This survey data was used to determine the penetration of each filling technology. The total fuel sales in the county were multiplied by the fraction using each filling technology. The AP-42 technology-specific emission factors were then used to estimate emissions from submerged filling and balanced submerged filling. The emissions from each filling technology were summed to estimate total emissions.

Filling Method	**Non-Attainment Area**	**Transport Region**	**Attainment Area**
Submerged	9%	9%	20%
Balanced Submerged	91%	91%	80%
Splash	0%	0%	0%

Emission Factors

Emission factors are affected by true vapor pressure and temperature. Emissions from loading petroleum liquid can be estimated (with a probable error of ±30 percent) using the following expression[2]:

$$L_L = 12.46 * \frac{S * P * M}{T}$$

Where:

L_L = loading loss, pounds per 1000 gallons (lb/10^3 gal) of liquid loaded (The loading loss is equivalent to an emission factor)

S = a saturation factor (see Table 5.2-1)

P = true vapor pressure of liquid loaded, pounds per square inch absolute (psia) (see Figure 7.1-5, Figure 7.1-6, and Table 7.1-2)

M = molecular weight of vapors, pounds per pound-mole (lb/lb-mole) (see Table 7.1-2)

T = temperature of bulk liquid loaded, °R (°F + 460)

Table 5.2-1 from AP-42 shows that the saturation factor (S) is a constant for a specific petroleum liquid, carrier and type of loading service

The true vapor pressure (P) can be estimated from the Reid vapor pressure using the following equation:

$$P = \exp\left\{\left[0.7553 - \left(\frac{413.0}{T+459.6}\right)\right] S^{0.5} * \log_{10}(RVP) - \left[1.854 - \left(\frac{1042}{T+459.6}\right)\right] S^{0.5} + \left[\left(\frac{2416}{T+459.6}\right) - 2.013\right] \log_{10}(RVP) - \left(\frac{8742}{T+459.6}\right) + 15.64\right\}$$

The molecular weight varies slightly with temperature and pressure, however for this analysis it is assumed to be constant.

[2] AP42, Chapter 5.2: Transportation and Marketing of Petroleum Liquids

Proportioning the loading factors yields

$$\frac{LL2}{LL1} = \frac{12.46 * S2 * P2 * M2 / T2}{12.46 * S1 * P1 * M1 / T1} = \frac{P2 * T1}{P1 * T2} \qquad LL2 = LL1 * \frac{P2 * T1}{P1 * T2}$$

The loading factor or emission factor is directly proportional to true vapor pressure and inversely proportional to temperature in degrees Rankin.

LL1 = 0.3 at RVP of 10 and 60 F; this yields LL1 =0.3; P =5.186; T=520 R

To calculate LL2 at RVP of 6.7 and 81.8 F or P = 5.094; T = 541.8 R

$$LL2 = LL1 * \frac{P2 * T1}{P1 * T2} = 0.3 * \frac{5.094 * 520}{5.186 * 541.8} = 0.2828$$

Initial emission factors of 0.3 lb $_{VOC}$ per 1000 gallons throughput for balanced submerged filling and 7.3 lb $_{VOC}$ per 1000 gallons throughput for submerged filling were used in all Maryland counties. These factors were then adjusted with county-specific monthly average temperature and true vapor pressure values using the above technique.

Filling Method	**Base Emission Factor** Lb. $_{VOC}$ per 1,000 gallon
Balanced Submerged	0.3
Submerged	7.3
Diesel Fuel Unloading	0.014

Point Source Adjustments

Emissions from Andrews Air Force Base were subtracted from Prince Georges County emission totals.

Adjustment for Controls

Controls for this source category are reflected in the emission factors.

Spatial and Temporal Allocations

Spatial

Spatial allocation source data was base on vehicle registration data that was provided through the Maryland Department of Transportation, Motor Vehicle Administration and source data supplied to MDE's Mobile Sources Control Program (see Appendices). Diesel

fuel powered vehicle totals were subtracted from the Maryland and county registration numbers.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

The equation for estimating emissions from tank truck unloading is:

$$E_{fj} = \frac{(G_i \times F_{i\,(fm)} \times EF_{fm}) + (G_i \times F_{i\,(fm)} \times EF_{fm})}{2000}$$ Where:

E_{fj} = Emissions of VOC in tons per day from tank truck unloading per county i

G_i = Gallons of gasoline sold in county i during 2011

$F_{i\,(fm)}$ = Fraction of gasoline dispensed per county i per filling method (balanced submerged or submerged) during 2011

EF_{fm} = Emission factor per filling method for tank truck unloading adjusted by RVP and temperature:
(0.3 lb. VOC/1000 gallon throughput or 7.3 lb. VOC/1000 gallon throughput)

<u>Tank Truck Unloading Sample Calculation (Carroll County)</u>

To calculate fuel usage for Carroll County:

Filling Method	**Carroll County Adjusted Emission Factor** Lb. $_{VOC}$ per 1,000 gallon
Balanced Submerged	0.2486
Submerged	6.0503
Diesel Fuel Unloading	0.014

Total fuel sold in Maryland in 2011[3] = 2,446,714,344 gallons

Allocate gallons of fuel sold to the county level by the 2011 county vehicle registration proportion:

$$\frac{\text{Carroll County vehicle registration}^{4}}{} = \frac{160{,}603}{} = 0.0356$$

[3] Annual sales of gasoline from Maryland Comptroller of the Treasury, Gasoline Tax Division (see Appendices)

Total MD vehicle registration 4,512,010

G = 2,446,714,344 **x** 0.0356 = **87,089,715** gallons sold in Carroll County

EM = (G * Market % * EF adjusted / 1000) / 2000
EMbs = balanced submerged emissions
EMs = submerged emissions

EMbs = (**87,089,715** * 91% * 0.2486 / 1000) / 2000 = 9.85 tons $_{VOC}$ per year
EMs = (**87,089,715** * 9% * 6.0503 / 1000) / 2000 = 23.71 tons $_{VOC}$ per year

[4] State of Maryland Motor Vehicle Administration and MDE Mobile Sources Control Program (see Appendices).

4.1.1.2 **Stage II Refueling**

SCC: 25 01 060 100

Description

Emissions from Stage II refueling are substantially less than those from Stage I because gasoline vapors that ordinarily might have escaped during vehicle fueling are re-circulated by a special nozzle back into the pump. The start year for Stage II refueling in all Maryland ozone nonattainment areas was 1993. Gasoline stations were required to have Stage II nozzles installed by November of that year. Calculations were based on the filling method used and gallons sold.

Pollutants

VOC

Method and Data Sources

EPA recommends that the MOVES model be used to generate refueling (Stage II) emission factors for highway vehicle emission inventories (EPA, 2003). The model, designed to support the evaluation of air pollution from gasoline- and diesel-fueled vehicles, generates emission factors for tailpipe emissions and refueling activities.

Activity

The MOVES model produces estimates of refueling emissions in units of grams per mile. These values are multiplied by fuel economy (in units of miles per gallon) and total gasoline sales (in units of gallons purchased/sold) in the study area resulting in refueling emissions in terms of grams. It should be noted that MOBILE makes use of improved predictive equations to calculate refueling emission factors, including sensitivity to temperature and Reid vapor pressure (RVP), and these have not yet been incorporated into published AP-42 factors for refueling. Additionally, the user may provide information on local Stage II emission controls to develop an emission factor for controlled emissions.

Refueling emissions have two mechanisms of introducing emissions to the environment: (1) vapor displacement from the vehicle fuel tank during refilling; and (2) gasoline spillage during refueling. The MOBILE user may request either a single emission factor that combines the two mechanisms or separate emission factors for displacement and spillage. Because both mechanisms should be taken into account when estimating refueling emissions, the preferred approach is to request the combined emission factor.

Emission Factors

ARMA mobile sources staff ran the MOVES2010b model to estimate the refueling emissions using the grams per mile (g/mile) methodology described above. The emission estimates were converted from grams to tons.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

Controls for this source category include Stage II Vapor Recovery Systems and Onboard Refueling Vapor Recovery (ORVR) systems. The controls are reflected in the emission estimates produced by the (MOVES2010b) model.

Spatial and Temporal Allocations

Spatial

The MOVES2010b model spatially allocates input files specify state county-level gasoline sales data to spatially allocate emission estimates.

Temporal

The MOVES2010b model allocates monthly activity data per state county-level and national level estimates.

Emissions Calculation

The equation for estimating emissions from tank truck unloading is:

$$E_{StII} = \frac{(G_i \times EF_{StII} \times MPG \times SAF)}{2000}$$

Where:

E_{StII} = emissions of VOC in tons per day from stage II refueling

G_i = gallons of gasoline sold in county i during 2011

EF_{StII} = emission factor for stage II refueling from the MOVES2010b model (grams/mile)

MPG = average fuel economy (miles/gallon)

SAF = seasonal adjustment factor to reflect summer weekday emissions

<u>Stage II Refueling Sample Calculation</u>

Since all calculations are included in the MOVES2010b model output, a sample calculation is not available for this source category.

4.1.1.3 **Underground Tank Breathing**

SCC: 25 01 060 201

Description:

Underground tank breathing occurs when gasoline is drawn out of the tanks and into the pump lines. During this process air moves into the tank evaporating gasoline and emitting vapors.

Pollutants

VOC and HAPs

Method and Data Sources:

The method used to calculate emissions (all VOC), is presented in EIIP[5], Chapter 11, Gasoline Marketing, which extracts the emission factors from AP-42, Volume I, Table 5.2-7.

Activity

The Maryland Comptroller of the Treasury, Gasoline Tax Division (see Appendices) provided annual gallons of gasoline and diesel fuel sold. This data includes taxable and non-taxed gasoline purchased by the U.S. Government. State and local government sales are included in the taxable sales data. The statewide total of gallons of fuel sold was allocated to the county level proportional to the number of registered vehicles within the county. Vehicle registration data was collected from the Maryland Department of Transportation, Motor Vehicle Administration that supplied the data to MDE's Mobile Sources Control Program (see Appendices). Diesel fuel powered vehicle totals were subtracted from the Maryland and county registration numbers.

Emission Factors

An emission factor of 1.0 lbs. VOC per 1000 gallons throughput was used. The emission factor was taken from EIIP, Chapter 11, Gasoline Marketing, which extracts the emission factors from AP-42, Volume I, Table 5.2-7. Factors were adjusted with county-specific monthly average temperature and true vapor pressure values.

MDE used the same sources for gasoline sales and car registration as in tank truck unloading (see Appendices).

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

[5] Emission Inventory Improvement Program

Adjustment for Controls

Controls for this source category are reflected in the emission factors.

Spatial and Temporal Allocations

Spatial

Spatial allocation source data was base on vehicle registration data that was provided through the Maryland Department of Transportation, Motor Vehicle Administration and source data supplied to MDE's Mobile Sources Control Program (see Appendices). Diesel fuel powered vehicle totals were subtracted from the Maryland and county registration numbers.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

The equation used to estimate emissions from underground tank breathing is:

$$E_{utb} = \frac{(G_i \times EF_{utb})}{2000}$$ Where:

E_{utb} = emissions of VOC in tons per day from underground tank breathing and emptying

G_i = gallons of gasoline sold in county i during 2011

EF_{utb} = emission factor for underground tank breathing (1.0 lbs. $_{VOC}$/1000 gallon throughput)

<u>Underground Tank Breathing Sample Calculation (Carroll County)</u>

To calculate fuel usage for Carroll County:
Total fuel sold in Maryland in 2011[6] = **2,668,913** kgallons
Allocate gallons of fuel sold to the county level by the 2011 county vehicle registration proportion:

[6] Annual sales of gasoline from Maryland Comptroller of the Treasury, Gasoline Tax Division (see Appendices)

$$\frac{\text{Carroll County vehicle registration}^{7}}{\text{Total MD vehicle registration}} = \frac{160{,}603}{4{,}512{,}010} = 0.0356$$

Gcarr = **2,668,913 x** 0.0356 = **95,013** kgallons sold in Carroll County in 2011.

EF_{utb} = **0.8288**lbs. $_{VOC}$/1000 gallon

$$E_{utb} = \frac{(93{,}983 \times 1000 \times \mathbf{0.8288 / 1000})}{2000}$$

E_{utb} = 39.37 tons $_{VOC}$ per year

4.1.1.4 Gasoline Tank Trucks in Transit

SCC: 25 05 030 120

Description

Breathing losses from tank trucks during the transport of gasoline are caused by leaking delivery trucks, pressure in the tanks, and thermal effects on the vapor and on the liquid. A worst case situation arises if a poorly sealed tank has been loaded with gasoline and pure air becomes saturated. During the vaporization process, pressure increases and venting occurs. Emissions from this source category include the evaporation of petroleum vapor from:

- loaded tank trucks during transportation of gasoline from the bulk plant/terminal to the service station or other dispensing outlet, and
- from empty tank trucks returning from service stations to bulk plant/terminals

Pollutants

VOC

Method and Data Sources

The method used to calculate emissions (all VOC), is presented in EIIP[8], Chapter 11, Gasoline Marketing (Stage I & Stage II), and dated September 1997.

Activity

Emission Factors

EPA documents the emission factors in AP-42, Table 5.2-5 and EIIP states the emission factors within the above-referenced document in Table 11.3-1. The AP-42 emission factors represent a typical range of values. EIIP averages the "typical range values" within

[7] State of Maryland Motor Vehicle Administration and MDE Mobile Sources Control Program (see Appendices).
[8] Emission Inventory Improvement Program

AP-42 and arrives at average emission factor values of 0.055 and 0.005 lbs. $_{VOC}$ per 1000-gallon gasoline, respectively for emissions from empty tank trucks and emissions from full tank trucks.

Emission Source	**EIIP Table 11-3.1 Lb/1000 gallon "Average"**	**AP-42 Table 5-2.5 Lb/1000 gallon "Typical Range"**
Gasoline Tank Trucks in Transit		
Empty Tank Trucks	**0.055**	**0 - 0.11**
Full Tank Trucks	**0.005**	**0 - 0.01**

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

MDE used the same sources for gasoline sales and car registration as in tank truck unloading (see Appendices). MDE used the emission factors from EIIP, Volume I, and Table 5.2-5, of 0.06 pounds VOC per 1000 gallons throughput (combines 0.005 lb $_{VOC}$ /1000 gallon full tank truck delivery and 0.055 lb $_{VOC}$ /1000 gallon empty tank return). MDE also used a bulk facility throughput adjustment factor of 1.09 and calculated throughput by a ratio of county retail sales and state retail sales times state fuel sales.

Emission Factors:

Full tank truck delivery	0.005 lbs. $_{VOC}$ per 1000 gallons
Empty tank truck return	0.055 lbs. $_{VOC}$ per 1000 gallons
Combined (full & empty)	0.060 lbs. $_{VOC}$ per 1000 gallons

Bulk Facility Throughput Adjustment Factor: 1.09

Equation:

$$E_{tt} = \frac{(G_i \times 1.09 \times EF_{tt})}{2000}$$ Where:

E_{tt} = emissions of VOC in tons per day from tank trucks in transit

G_i = thousand gallons of fuel sold in county i

EF_{tt} = Combined (full & empty) tank trucks in transit emission factor

<u>2011 Gasoline Tank Trucks in Transit Sample Calculation (Carroll County)</u>

To calculate fuel usage for Carroll County:
Total on-road and non-road fuel sold in Carroll County **=** **98,329** kgallons

G = **98,329** kgallons sold in Carroll County

$$E_{tt} = \frac{(98{,}329 \times 1.09 \times 0.06)}{2000}$$

E_{tt} = **3.22** tons $_{VOC}$ per year emitted from tank trucks in transit in Carroll County.

4.1.1.5 **Aviation Gasoline Distribution Stage 1 and Stage 2**

SCC: 25 01 080 050
25 01 080 100

Description

In Stage I aviation gasoline (also called "AvGas") used in small reciprocating piston-engines is shipped to airports for use in civil aviation. AvGas is first placed into bulk terminals, and then into tanker trucks. These filling processes will cause the displacement of vapors into the atmosphere during the transfer of gasoline from tank trucks to storage tanks, and vice versa.

Stage II is the transfer of fuel from the tanker trucks into general aviation aircraft; during this process vapors are also displaced into the atmosphere.

Pollutants

VOC, Pb (Lead), and HAPs

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

No adjustments for controls.

Spatial and Temporal Allocations

Spatial
County-level AvGas fuel distributions reported through Energy Information Administration -EIA was spatial allocated for this sources.

Temporal
Annual county-level emissions from PAD-level AvGas consumption from EIA, Petroleum Supply Annual 2011 reports were temporally allocated for this sources. SAF was applied to emissions and were averaged according to period of operation to a daily estimate. See section 2.2.1.1

Method and Data Sources

MDE staff used the methodology developed from the PECHAN/ERTAC Study, 2007, base on terminals using AvGas fuel activity assumptions data.

Activity

MDE used selected data from the Department of Energy's State Energy Data System obtain fuel consumption data. MDE used airport survey data and the Maryland Aviation Administration's 2011 Operations Count for Public-Use Airports to obtain operational counts. A few airports, such as Andrews Air Force Base, provided their own operations count (see Appendices).

Fuel Type	Fuel Consumption (1,000 Gallons)
Commercial Jet	123,900
Aviation Gasoline	1,806
Military Jet	1,239

Emission Factors

Emission factors for AvGas distribution from came from the (TRC Environmental Corporation's ***Estimation of Alkylated Lead Emissions, Final Report***, which was prepared for the U.S Environmental Protection Agency, Office of Air Quality Planning and Standards. RTP, NC 1993.

The emissions factors are separated by emissions source such as

EFtf = Aviation Gasoline from Tank Fill

EFst = Aviation Gasoline from Storage Tank

EFc = Aviation Gasoline from Composite

EFbl = Aviation Gasoline from Breathing Losses

Factors Not Used:

EFv = Aviation Gasoline from Valves (There are NO AvGas Facilities/Tank Farms in MD)

EFp = Aviation Gasoline from Pumps (There are NO AvGas Facilities/Tank Farms in MD)

EF Type	VOC Emission Factors	Units
Tank Fill	0.009021383	LB/GALLON AvGas
Storage Tank	0.003605215	LB/GALLON AvGas
Composite	0.010306575	LB/GALLON AvGas
Breathing Losses	0.001694117	LB/GALLON AvGas
Valves Not Used	0.573201882	LB/VALVE*DAY
Pumps Not Used	5.952481079	LB/SEAL*DAY
EFsum (Sum of Factors Used)	0.024627290	LB/GALLON AvGas

Tanker to Truck Transfer Stage II 0.0136 LB/GALLON AvGas

Emission Estimate Equation: County Level

EM =	EFsum	**x**	Fraction of LTOs	**x**	Amount of Aviation Gasoline
EM_i =	EFsum	**x**	(CA_i / SA_i)	**x**	F_i

Where:

F_i = County aircraft fuel use
CA_i = County aircraft activity (LTO)
SA_i = State aircraft activity (LTO)
$EFsum_i$ = **Sum of Factors Used**
EM_i = specific county (i) emissions from aircraft refueling in tons VOC per year

<u>2011 Sample Calculation for Stage I AvGas Distribution (Allegany County)</u>

$F_{_Allegany}$ = 1,806,000 gallons

$$\text{Fraction of LTOs} = \frac{CA_{_Allegany}}{SA} = \frac{15{,}561}{882{,}301} = 0.0176$$

$EFsum_{_Allegany\ Stage\ I}$ = 0.0246272899 lb/gal AvGas

$EM_{_Allegany}$ = (0.0246272899 **x** 0.0176 **x** 1,806,000)/2000 = 0.39 tons $_{VOC}$ /year

<u>2011 Sample Calculation for Stage II AvGas Distribution (Allegany County)</u>

$F_{_Allegany}$ = 1,806,000 gallons

$$\text{Fraction of LTOs} = \frac{CA_{_Allegany}}{SA} = \frac{15{,}561}{882{,}301} = 0.0176$$

$EFsum_{_Allegany\ Stage\ II}$ = **0.0136** lb/gal AvGas

$EM_{_Allegany}$ = (0.0136 **x** 0.0176 **x** 1,806,000)/2000 = **0.22** tons $_{VOC}$ /year

4.1.1.6 **Petroleum Vessel Unloading Losses**

SCC:

2505020030	**crude oil**
2505020090	**distillate oil**
2505020120	**Gasoline**
2505020150	**Jet naphtha**
2505020060	**residual oil**
2505020180	**kerosene**

Description

Petroleum liquids are transported via ships and barges, and on-land transportation. The procedures discussed below relate to marine transport of petroleum liquids. This category does not include emissions from fuel consumed by vessels while in transit or in port. Evaporative VOC emissions from ocean going ships and barges carrying petroleum liquids result from loading losses, ballasting losses and transit losses. Petroleum liquids are classified into groups which are represented by crude oil, gasoline, jet naphtha, distillate oil/kerosene, or residual oil. Loading and ballasting losses do not occur with pipeline transport of petroleum products (AP-42, Section 5.2).

Loading losses occur as organic vapors in "empty" cargo tanks are displaced to the atmosphere by the liquid being loaded into the tanks. These vapors are a composite of vapors formed in three ways:

- Vapors which are formed in the "empty" tank by evaporation of residual product from previous loads;
- Vapors transferred to the tank from a vapor balance system that was used when the previous load was being unloaded; and
- Vapors generated in the tank as the new product is being loaded.

Loading losses are usually the largest source of evaporative emissions from petroleum vessels (EPA, 1996).

Ballasting losses are associated with the unloading of petroleum liquids at marine terminals and refinery loading docks. It is common practice to load several cargo tank compartments with sea water after the cargo has been unloaded. This water, called "ballast," improves the stability of the empty tanker during the subsequent voyage. Ballasting emissions occur as vapor-laden air in the empty cargo tank is displaced to the atmosphere by ballast water being pumped into the tank.

Transit losses are similar to breathing losses associated with petroleum storage. Transit loss is the expulsion of vapor from a vessel compartment through vapor contraction and expansion, which are the result of changes in temperature and barometric pressure. This loss may be accompanied by slight changes in the level of the liquid in the tank due to liquid expansion or contraction due to the temperature change. Some ships are equipped with controls for these losses.

Pollutants

VOC

Method and Data Sources

Activity

The method used to calculate emissions (all VOC) is presented in EIIP[9], Chapter 12, Marine Vessel Loading, Ballasting and Transit, dated May 1998.

A significant part of the emissions from this source are from the Eastern Shore of Maryland because petroleum products are delivered to this area by barge rather than by pipeline as in the rest of the state. To compile emissions MDE used guidance in EIIP, Chapter 12, Marine Vessel Loading, Ballasting and Transit and emissions factors from EIIP Table 12.4-5, Waterborne Commerce of the United States, Waterways and Harbors Atlantic Coast, Part 1, 2010 data, and AP-42, Table 7.1-2 liquid densities. Waterborne Commerce supplied tonnage and type of petroleum products delivered to the various ports in Maryland for the year 2010 (see Appendices). Tonnages of petroleum delivered were converted into Kgal.s (1000 gallons) and then used to calculate emissions.

Factors

UNCONTROLLED VOC EMISSION FACTORS FOR PETROLEUM CARRYING MARINE VESSELS (EPA, 1996)

Petroleum Liquid	**Ship/Ocean Vessel Loading (Lbs. VOC per 1,000 gallons Transferred)**	**Barge Loading (Lbs. VOC per 1,000 gallons Transferred)**	**Ballasting (Lbs. VOC per 1,000 gallons Transferred)**	**Transit (Lbs. VOC per 1,000 gallons Transferred)**
Crude Oil	0.61	1	1.1	1.3
Gasoline	1.8	3.4	0.8	2.7
Jet Naphtha / Other	0.5	1.2	NA	0.7
Distillate Oil / Kerosene	0.005	0.012	NA	0.005
Residual Oil	4×10^{-5}	9×10^{-5}	NA	3×10^{-5}

[9] Emission Inventory Improvement Program

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

SAF was applied to emissions and were averaged according to period of operation to a daily estimate. See section 2.2.1.1

Data obtained from sources such as the *Waterborne Commerce of the United States* are typically provided in terms other than 1,000 gallons (Mgal) as is required in EIIP Equation 12.4-1 and must be converted. Equation 12.4-3 can be used to convert units from 1,000 ton (Mtons) to Mgal. Where:

$PP_V = (PP_M / d) \times (2{,}000 \text{ lb/ton}) \times (\text{Mgal}/1{,}000 \text{ gallons}) \times (1{,}000 \text{ tons/Mtons})$

PP_V = Amount of petroleum liquid (Mgal)
PP_M = Amount of petroleum liquid (Mtons)
d = Density of petroleum liquid; see Table 7.1-2 in AP-42 (lb/gallon)

	Density[10] (lb/gal)
Distillate Oil	7.10
Residual Oil	7.90
Gasoline	5.60
Kerosene	7.00
Crude Oil	7.10
Jet Naphtha	6.40

If controls exist, then control efficiency can be calculated:

$PP_C = PP_U \times (1 - CE/100)$

Where:

PP_C = Controlled emissions (tons)
PP_U = Uncontrolled emissions (tons)
CE = Control efficiency (%)

[10] AP-42, Table 7.1-2

Equation:

$$PV_P = \frac{[(SOEF_P \times PP_{S,P}) + (BREF_P \times PP_{B,P}) + (BLEF_{P,U} \times 0.20 \times PP_{BL,P}) + (TREF_P \times PP_{T,P})]}{2000}$$

Where:

PV_P : Total VOC emissions from petroleum vessel loading, ballasting, and transit for each of the petroleum liquids (p) transported: crude oil, gasoline, kerosene, distillate oil, and residual oil (tons)

$SOEF_P$: Ship/ocean vessel loading emission factor (pounds VOC per 1,000 gallons transferred)

$PP_{S,P}$: Amount of petroleum liquid (p) loaded into ships and ocean vessels in the inventory region (1,000 gallons)

$BREF_P$: Barge vessel loading emission factor (pounds VOC per 1,000 gallons transferred)

$PP_{B,P}$: Amount of petroleum liquid (p) loaded into barges in the inventory region (1,000 gallons)

$BLEF_{P,U}$: Ballasting emission factor (pounds VOC per 1,000 gallons water ballasted)

$PP_{BL,P}$: Amount of petroleum liquid (p) unloaded from vessels that are ballasted (1,000 gallons)

$TREF_P$: Vessel transit emission factor (pounds VOC per week per 1,000 gallons transferred)

$PP_{T,P}$: Amount of petroleum liquid (p) transported by marine vessels in the inventory region (1,000 gallons)

2011 Petroleum Vessel Unloading Losses Sample Calculation (Gasoline – Baltimore City

Gallons (in Thousands) of Petroleum Shipped in Baltimore Harbor						
	Crude Oil	**Distillate Oil**	**Gasoline**	**Jet Naphtha**	**Residual Oil**	**Kerosene**
Baltimore City	**5,634**	**10,986**	**329,286**	**625**	**405,316**	**241,143**

Tonnage of distillate oil shipped in Baltimore Harbor (from Waterborne Commerce of the U.S., 2010) were converted in thousands of gallons (Kgal.s) and then used to calculate emissions.

Vessel Loading Emissions

For vessel loading operations, 90 percent of the total throughput was loaded at terminals with a control system of 95 percent efficiency. According to the local port authorities, transit time in the inventory area is two days (2/7 of a week). Emissions for each emission point are calculated

using Equation 12.4-1 and the emission factors from Table 12.4-5. In this example, emissions for each emission point are calculated separately and then totaled. Note that CE is applied to vessel loading emissions, and transit emissions are apportioned to two days per week by multiplying emissions by 2/7.

Baltimore City:
Vessel Loading gas = 0.00 Kgal
Barge Loading gas = 0.00 Kgal
Ballasting gas = 0.00 Kgal
Transit gas = 329,286 Kgal
Baltimore gas Total = (0.00 + 0.00 + 0.00 + 329,286) = 329,286 Kgal

Vessel Loading (gasoline) emissions are calculated:
PV_{GAS} = [(1.8 lbs $_{VOC}$/Kgal) x (0.00 Kgal/yr) x {0.10 + [0.9 (1 – 95/100)]}÷ 2,000 lb/ton
PV_{GAS} = 0.00 tons/year

Barge Loading emissions are calculated:
PV_{GAS} = [(3.4 lbs $_{VOC}$/Kgal) x (0.00 Kgal/yr)] ÷ 2,000 lb/ton
PV_{GAS} = **0.00** tons/year

Ballasting emissions are calculated:
PV_{GAS} = [(0.8 lbs $_{VOC}$/Kgal) x (0.00 Kgal/yr) x (0.20)] ÷ 2,000 lbs/ton
PV_{GAS} = **0.00** tons/year

Note that the calculation for ballasting emissions in the equation includes a correction term of 0.20. This correction term reflects the practice of loading a ship or barge at some fraction of *capacity* when *ballasting*.

Transit emissions are calculated:
According to the Maryland Port Authorities transit time is 6 hours out of 24 or 25% during a week (7 days).

PV_{GAS} = (2.7 lbs $_{VOC}$/Kgal) x (329,286 Kgal/yr) x (0.25/7wk) ÷ 2,000 lbs/ton
PV_{GAS} = **15.88 voc** tons/year

Total VOC emissions are calculated as follows:
Total $_{VOC}$ = **0.00** tons/year + **0.00** tons/year + **0.00** tons/year + **15.88** tons/year
Total $_{VOC}$ = **15.88** tons/yr

4.1.1.7 **Portable Fuel Containers**

SCC: 25 01 011 011 (Residential – Permeation)
25 01 011 012 (Residential – Diurnal)
25 01 011 013 (Residential – Transport)
25 01 011 014 (Residential – Refiling At The Pump - Vapor Displacement)
25 01 011 015 (Residential – Refiling At The Pump - Spillage)
25 01 012 011 (Commercial – Permeation)
25 01 012 012 (Commercial – Diurnal)
25 01 012 013 (Commercial – Transport)
25 01 012 014 (Commercial – Refiling At The Pump - Vapor Displacement)
25 01 012 015 (Commercial – Refiling At The Pump - Spillage)

Description

Portable fuel containers (PFCs) store and transport fuel from gasoline service stations to residential homes and businesses. Emissions from PFC use include:

- ***Permeation Emissions***, which are produced after fuel has been stored long enough in a can for fuel molecules to infiltrate and saturate the can material.
- ***Diurnal Emissions***, which result when stored fuel vapors escape to the outside of a gas can through any possible openings while the gas can is subjected to daily cycle of increasing and decreasing ambient temperatures. Diurnal emissions are dependent on the closed- or open-storage condition of a gas can.
- ***Transport Emissions*** arise when fuel escapes (e.g., spills, etc.) from gas cans that are in transit.
- ***Equipment Refueling Emissions*** results when fuel escapes (e.g., spillage, vapor displacement) during the refueling of nonroad equipment; however these emissions are handled by EPA's NONROAD model. Activity data from the NONROAD model were used to estimate these emissions (described below).

Both residential and commercial PFCs are included. The SCCs for PFCs are also new and are shown above.

Pollutants

VOC

Method Data
Sources and

The method used to calculate emissions (all VOC), is adopted from a CARB[11] survey and methodology adopted by OTC[12].

[11] ARB's Mailout MSC 99-25, "Public Meeting to Consider Approval of CA's Portable Gasoline-Container Emissions Inventory, " (ARB, 199b)
[12] Control Measure Development Support Analysis of Ozone Transport Commission Model Rules, E.H. PECHAN & Associates, Inc. 5528-B Hempstead Way, Springfield, VA 22151, March 31, 2001.

Portable fuel container emissions are calculated by accounting for emissions from five different components related to gas container use: permeation, diurnal, transport-spillage, refueling spillage and refueling vapor displacement emissions. The permeation, diurnal emissions (associated with storage) and transport-spillage (associated with filling the can) emissions are included in the area source inventory. The equipment refueling spillage and refueling vapor displacement emissions are calculated from the non-road model and are included in the non-road inventory

Activity

The following input data is required to calculate emissions for this source category.

1. Rather than assuming that the numbers of PFCs per household and per business were consistent across the entire State, MDE used EPA's non-road emissions model (NONROAD2005) to estimate nonroad consumption of gasoline by county by source category classification (SCC) code. Each SCC code has a unique usage (commercial versus residential), a unique ratio of the percent of fuel dispensed from PFCs * The previous draft version of this report (EPA420-D-06-003) was based on estimates from the draft NONROAD2004 model.(versus from fuel pumps), and a unique spillage rate (grams per gallon).
2. Number of commercial businesses[13] 2002 expected to have at least one gas can by county, NAICS 11, 23, 31, 32, 33, 411, 447, 45299, 484, 488, 493, 53131, 5321, 532291, 5323, 5324, 54132, 54162, 54169, 56173, 71391, 71393, 7212, 811, and 81293.
3. MDE was able to estimate by county by source category classification (SCC) code the total quantity of gasoline supplied from PFCs as well as the total spillage (from using the PFCs to refuel the individual pieces of equipment) for residential usage and for commercial usage. For example, running the NONROAD2005 model for calendar year 2011 produced the following estimates (obtained by summing the individual state-by-state estimates).

Emission Factors

Separate emission factors were developed for permeation, diurnal, transport and spillage emissions for PFC (both for commercial and residential PFCs). These emission factors were derived from CARB's survey data (CARB, 1999).

Point Source Adjustments

None need

[13] Total 2011 employment and business establishments by 6 digit NAICS code and by county, County Business Patterns

Adjustment for Controls

Maryland's COMAR 26.11.13.07 rule regulates control adjustments of VOC emissions from portable fuel containers (PFC's) that requires performance standards for PFCs and/or spouts that will reduce emissions do to storage, transport, and refueling activities. (2011 control efficiency of 65% and a control factor of 35.75%). COMAR web link: http://www.dsd.state.md.us/comar/title_search/Title_List.aspx

Spatial and Temporal Allocations

Spatial

For the residential PFC SCCs, emissions were allocated to the local area level based on a housing surrogate. Commercial PFC emissions were allocated to the local area level based on commercial and industrial business location.

Temporal

Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

Emissions Calculation

The equation used to estimate emissions from portable fuel containers is:

Equation:

The residential-gas-can population is calculated as follows:

$$Pop_R = (N)*(A)*(Count_R) \quad \text{(Eq. 1)}$$

where:

Pop_R	=	Statewide Residential-Gas-Can Population
N	=	Number of Occupied-Housing Units in OTC State
A	=	Percentage of Households with Gas Cans (46%)
$Count_R$	=	Average Number of Residential-Gas Cans per Household

Statewide residential-gas-can-permeation emissions are computed as follows:

$$HC_{PR} = \Sigma\ (Pop_R)*(S)*(EF_P)*(B_R)*(Size_R)*(Level)/CF \quad \text{(Eq. 2)}$$

where:

HC_{PR}	=	Permeation Emissions in tons per day (tpd)
Pop_R	=	Statewide Residential-Gas-Can Population
EF_P	=	Appropriate Permeation-Emission Factor (g/gal-day)

S	=	Percentage of Gas Cans Stored with Fuel (70%)
B_R	=	Percentage of Cans Stored in Closed Condition with respect to Material (Plastic 53%; Metal 13%)
$Size_R$	=	Weighted Average Capacity of Residential-Gas Cans (2.34 gal.)
Level	=	Weighted Average Amount of Stored Fuel (49%)
CF	=	907,184.5844 g/ton

Diurnal emissions from both open- and closed-system-residential-gas cans are calculated as follows:

$$HC_{DR} = (Pop_R)*(S)*(EF_D)*(B_R)*(Size_R)*(Level) \quad \text{(Eq. 3)}$$

Where:

HC_{DR}	=	Diurnal Emissions (tpd) for Residential-Gas Cans with respect to Storage Condition (Open or Closed) and Material (Plastic or Metal)
Pop_R	=	Statewide Residential-Gas-Can Population
S	=	Percentage of Gas-Can Population Stored with Fuel (70%)
EF_D	=	Appropriate Diurnal-Emission Factor with respect to Storage Condition and Material (g/gal-day or g/day)
B_R	=	Percentage of Gas-Can Population with respect to Storage Condition and Material
$Size_R$	=	Weighted Average Capacity of Residential-Gas Cans (2.34 gal.)
Level	=	Weighted Average Amount of Stored Fuel (49%)
CF	=	907,184.5844 g/ton

Residential-transport-spillage emissions are determined as:

$$HC_{TR} = (Pop_R)*(S)*(Refill_R)*(EF_T)*(B_R) \quad \text{(Eq. 4)}$$

Where:

HC_{TR}	=	Residential-Gas-Can-Transport-Spillage Emissions (tpd)
Pop_R	=	Statewide Residential-Gas-Can Population
S	=	Percentage of Gas Cans Stored with Fuel (70%)
$Refill_R$	=	Average Number of Residential-Gas-Cans-Pump-Refills per Day per Can (refill/day from survey)
EF_T	=	Transport-Emission Factor with respect to Storage Condition (g/refill)
B_R	=	Percentage of Gas Cans with respect to Storage Condition and Material
CF	=	907,184.5844 g/ton

The commercial-gas-can population is calculated as follows:

$$Pop_C = (N_C)*(Count_C) \quad \text{(Eq. 5)}$$

Where:

Pop_C	=	Statewide Commercial-Gas-Can Population

N_C = Number of Occupied Businesses in State
$Count_C$ = Average Number of Gas Cans per Business

Statewide commercial-gas-can-permeation emissions are computed as follows:

$$HC_{PC} = \Sigma\ (Pop_C)*(S)*(EF_P)*(B_C)*(Size_C)*(Level) \qquad \text{(Eq. 6)}$$

Where:
HC_{PC} = Permeation Emissions (tpd)
Pop_C = Statewide Commercial-Gas-Can Population
EF_P = Appropriate Permeation-Emission Factor (g/gal-day)
S = Percentage of Gas Cans Stored with Fuel (70% for Residential Survey)
B_C = Percentage of Applicable Gas Cans Stored in Closed Condition
$Size_C$ = Weighted Average Capacity of Commercial-Gas Cans (3.43 gal)
Level = Weighted Average Amount of Stored Fuel (49% from Residential Survey)
CF = 907,184.5844 g/ton

The amount of diurnal emissions from both open- and closed-system commercial-gas cans is calculated as follows:

$$HC_{DC} = (Pop_C)*(S)*(EF_D)*(B_C)*(Size_C)*(Level) \qquad \text{(Eq. 7)}$$

Where:
HC_{DC} = Diurnal Emissions (tpd) for Commercial-Gas Cans with respect to Storage Condition (Open or Closed) and Material (Plastic or Metal)
Pop_C = Statewide Commercial-Gas-Can Population
EF_D = Appropriate Diurnal-Emission Factor with respect to Storage Condition and Material (g/gal-day or g/day)
S = Percentage of Gas Cans Stored with Fuel (70% from Residential Survey)
B_C = Percentage of Gas Cans with respect to Storage Condition and Material
$Size_C$ = Weighted Average Capacity of Commercial-Gas Cans (3.43 gal.)
Level = Weighted Average Amount of Stored Fuel (49% from Residential Survey)
CF = 907,184.5844 g/ton

The non-lawn-and-garden-equipment commercial-gas-can refills at the pump is derived as follows:

$$REFILL_C = \left[\frac{\left(\sum Fuel\right)}{(SIZE_C)*(POP_{NON})*(S)} \right] \qquad \text{(Eq. 8)}$$

Where: $Refill_C$ = Average Number of Non-Lawn-and-Garden Equipment Commercial-Gas-Cans Pump Refills per Day per Can (refill/day)

Fuel = Non-Lawn-and-Garden Equipment Fuel Consumption (gal/day) for 2000

$Size_C$ = Weighted Average Capacity of Commercial-Gas Cans (3.43 gal/can-refill)

POP_{NON} = Statewide Commercial-Gas-Can Population with respect to Non-Lawn-and-Garden Businesses

S = Percentage of Gas Cans Stored with Fuel (70% from Residential Survey)

CF = 907,184.5844 g/ton

The commercial-transport-spillage emissions are determined as:

$$HC_{TC} = (Pop_C)*(S)*(B_C)*(Refill_C)*(EF_{TC}) \qquad \text{(Eq. 9)}$$

Where: HC_{TC} = Commercial-Gas-Can-Transport-Spillage Emissions (tpd)

Pop_C = Statewide Commercial-Gas-Can Population

S = Percentage of Gas Cans Stored with Fuel (70% from Residential Survey)

B_C = Percentage of Gas Cans with respect to Storage Condition and Material

$Refill_C$ = Average Number of Gas-Cans Pump Refills per Day per Can

EF_{TC} = Transport-Spillage Emission Factor (g/refill) with respect to Storage Condition

CF = 907,184.5844 g/ton

The total area source portable fuel container emissions are summed as follows:

$$E_{PFC - A} = HC_{PR}+HC_{DR}+HC_{TR}+HCPC+HC_{DC}+HC_{TC}$$

$$E_{PFC - SD} = E_{PFC - A} *SAF//ADDF$$

Where:

$E_{PFC - A}$ = (tons/yr) for an annual emission of pollutant by county

$E_{PFC - SD}$ = (tons/day) for a typical summer day emission of pollutant

AADF = Annual activity day factor (WAF * 52 weeks/year)

SAF = Seasonal adjustment factor

4.1.2 STATIONARY SOURCE SOLVENT APPLICATION

4.1.2.1 **Dry Cleaners**

SCC: 24 20 000 000

Description

Dry-Cleaning facilities utilize solvents in their cleaning process which causes the emission of VOCs into the air.

Pollutants

VOC

Method and Data Source

Emissions from the dry-cleaning process were estimated by taking county employment and adjusted employment numbers from dry-cleaning and multiplying them by a given per capita emission factor for VOCs.

Activity

The County Business Patterns reports employment data for the counties of Maryland. Employment data is listed by the North American Industrial Classification Standard (NAICS) code(s) (81231, 81232, and 81233) that are used to determine county-level employment. Employment data collected was allocated to each county using *County Business Patterns* employment data for 2010 for the counties of Maryland. County Business Patterns internet addresses (http://censtats.census.gov/cgi-bin/cbpnaic/cbpsel.pl). Midpoint adjustments were determined for counties which had employment given a letter range.

Emission Factor

Emission factors for dry cleaning came from 2008 Emission Inventory Data & Documentation (http://www.epa.gov/ttn/chief/net/2008inventory.html) Nonpoint section for Dry Cleaning: in Table 2, created by EPA and ERTAC committee through a joint study.
VOC = 10 lbs per person.

Point Source Adjustments

None

Adjustments for Controls

None

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

Emissions Calculation

Emissions are calculated for each county using emission factors and activity as:

$$E_{x,y} = EMP_x \times EF_y$$

where:

$E_{x,y}$ = annual emissions for county x and pollutant y
EMP_x = employment data associated with county x
EF_y = emission factor for pollutant y

<u>2011 Sample Calculation Dry-Cleaning Emissions (Anne Arundel County)</u>

$E_{Allegany} = EMP_{Allegany} \times EFvoc$
$E_{Allegany} = 440$ person $\times$ 10 lbs voc/person
$E_{Allegany} = 4{,}400$ lbs. voc
$E_{Allegany} = 2.2$ tons voc per year

4.1.2.2 **Industrial and Institutional Cleaning**

SCC: 24 15 300 000

Description

Industrial and Institutional Cleaning (Cold Cleaning Degreasing) is seen primarily at auto repair stations or manufacturing facilities, where solvents at room temperature (or slightly warmed) are used to clean parts via immersion or rinsing.

Industrial and Institutional Cleaning are usually individually small emission sources and because they are widely scattered and frequently used, they are most easily treated as area sources. If they are collocated at a major source, they may be included in the point source inventory and those emissions will need to be subtracted from the area source estimate.

There are two basic types of cleaning machines: batch and in-line cleaning machines (also called continuous cleaning machines). Both of these equipment types are designed to use solvent to clean parts. The solvent is either used to clean in its non-vapor liquid form (at a temperature below the boiling point, referred to as cold cleaning), or heated to a temperature above its boiling point (referred to as vapor cleaning). Other solvent cleaning operations involve the use of solvent in wipe-cleaning and equipment cleanup. Emissions from solvent cleaning machines can also be considered to be point sources; therefore, the estimation process for the source category must take this into account to prevent double counting of emissions. Additionally, emissions from solvent cleanup may be included as a part of an industry- or process-specific emission estimate.

Pollutants

VOC and HAP (Trichloroethylene – 79016)

Method and Data Source

MDE staff used the methodology developed from the PECHAN/ERTAC Study, 2007, base on emplacement activity data and method documented in EIIP[14], Chapter 6, Solvent Cleaning, dated September 1997 to emission estimation for this source category.

Activity

The County Business Patterns reports employment data for the counties of Maryland. Employment data is listed by the North American Industrial Classification Standard (NAICS) code(s) that are used to determine county-level employment. Employment data collected was allocated to each county using *County Business Patterns* employment data for 2010 for the counties of Maryland. County Business Patterns internet addresses (http://censtats.census.gov/cgi-bin/cbpnaic/cbpsel.pl).

[14] Emission Inventory Improvement Program

An activity level of 6 days a week with no seasonal adjustment factor was used as recommended in the EIIP document. Solvent storage and recycling centers such as Safety Kleen are included in the point source inventory. The 2010 County Business Patterns employment data for Maryland by county is listed in the appendices. A 2002 reduction factor (Phase II Attainment Plan for the Baltimore Nonattainment Area and Cecil County) of 53.60% was applied to the calculated emissions. This factor combines reductions from technology rules and good housekeeping practices and the application of rule effectiveness as shown below:

Reduction factor = (control efficiency) x (rule effectiveness) x (rule penetration)

Reduction factor = 0.67 x 0.80 x 1.00

Reduction factor = 0.5360

Emission Factor

Table 6.5-2 of the EIIP document lists a total emission factor of 87 lbs. VOC per employee per year for solvent cleaning operations. The emission factor for the HAPs Trichloroethylene – 79016 was developed from the PECHAN/ERTAC Study, 2007. The study included a HAP Trichloroethylene emission factor base on a percent weight factor of total solvent VOC which is 0.00686. This percent weight factor of total solvent VOC was multiply by the total emission factor of 87 lbs. VOC per employee per year and divided by 100 that resulted in Trichloroethylene emission factor of 0.59685 lbs. **Trichloroethylene** /yr/employee.

Factors

E_{cc} = 87 lbs $_{VOC}$ per employee per year for cold cleaning degreasers
CE_{cc} = 67%
RE_{cc} = 80%
RP_{cc} = 100%

Note:

Emissions from this source category have increased because of a change in the emission factor and emission estimation methodology. In previous emission inventories, only cold cleaning degreasing operations were considered an area source and open top and conveyor degreasing operations were considered point sources that were listed in the MDE/ARMA registration files. No point source emissions were then subtracted from the area source inventory. MDE previously used an emission factor from AP-42, Section 4.6 – Solvent Degreasing, Table 4.6-1[15]. This table reports a 4.0 lbs. VOC per capita emission factor that includes 25 percent non-reactive VOCs, yielding an effective emission factor of 3.0 lbs. VOC per capita. A 1996 reduction factor of 0.70 was applied to the calculated emissions (rule effectiveness was not applied). This factor

[15] Non-methane VOC Emissions from small cold cleaning degreasing operations

combines reductions from technology rules and good housekeeping practices. In effect, MDE increased the emission factor from 3.0 to 4.3.

Point Source Adjustments

Solvent cleaning emissions from facilities identified as point sources were subtracted from the area source inventory to avoid double counting.

Adjustment for Controls

Maryland has adopted a cold and vapor degreasing regulation (COMAR 26.11.19.09). The regulation mandates that all cold degreasing material must have a vapor pressure less than or equal to 1 mm Hg at 20 degrees centigrade after May 15, 1996. The regulation also requires that good operating practices be implemented to minimize VOC losses. MDE estimates a 67 percent control efficiency for this control.

Spatial and Temporal Allocations

Spatial

CBP employment data was spatial allocation for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

The equation used to estimate emissions from cold cleaning/degreasing is:

<u>Equation:</u>

$$E_{CC} = \left\{ \frac{EMPL_j * EF_{cc}}{2000} * \left[1 - (CE_{CC} * RE_{CC} * RP_{CC})\right] \right\} - E_{PtSourceCC}$$

Where:

E_{cc}	=	Emissions of VOC in tons/day from cold cleaners
$EMPL_j$	=	2010 employment of county j
EF_{cc}	=	VOC emissions factor for cold cleaning degreasing
CE_{cc}	=	Control efficiency for cold cleaning degreasing
RE_{cc}	=	Rule Effectiveness for cold cleaning degreasing

RP_{cc} = Rule Penetration for cold cleaning degreasing
$E_{PtSourceCC}$ = Point Source Emissions from cold cleaning degreasing

<u>2011 Sample Calculation for Cold Cleaning Degreasing Products Industrial and Institutional (Baltimore County)</u>

(22,809[16] employee x 87 lbs. $_{VOC}$ /employee/year)/(tons/2000 lbs.) = 992 tons $_{VOC}$ /year emitted.

Converting to tons per day: 992 / (312 operating days per year[17]) = 3.18 tons $_{VOC}$ per day emitted (there is no seasonal adjustment[18]).

To adjust for controls
992 tons $_{VOC}$ /year **x** [1 – (0.67 x 0.80 x 1.00)] **= 460.38 tons $_{VOC}$** / year emitted with 2002 controls applied

[16] *County Business Patterns* 2010 employment data for Maryland by Counties (see appendices)
[17] 6 days per week operation from EIIP
[18] No seasonal adjustment from EIIP

3.3.2.3 Surface Coating

Surface coating includes paints, enamels, varnishes, lacquers and other product finishes. Some of those coatings contain a solvent-based liquid carrier; others use a water-based liquid carrier but still contain a small portion of solvents. Solvents are also used to clean up painting equipment. The primary types of surface coating applications are architectural coatings, automobile refinishing and traffic paints.

4.1.2.3 **Architectural Surface Coating**

SCC: 24 01 002 000 (Solvent-based)
SCC: 24 01 003 000 (Water-based)

Description

Architectural surface coating is an area source that occurs from homeowners and contractors painting homes, buildings and signs.

Pollutants

VOC

Method and Data Sources

MDE staff used an alternative per capita emission estimation method documented in EIIP[19], Chapter 3, Architectural Surface Coating, dated November 1995. The document provides an outline for developing a per capita usage factor, and for using that usage factor and an emission factor to calculate a VOC emission estimate.

Activity

Determine the per capita usage factor by dividing the national total architectural surface coating quantities[20] for solvent- and water-based coatings by the U.S. population[21] for that year.

Per Capita Usage Factor Development

The table below shows a portion of Table 2 from the U.S. Bureau of Census MA325F(10)-1 - Paint and Allied Products 2010. This section of the table summarizes the market information available on architectural coatings for the year of 2010. In the table, types of

[19] Emission Inventory Improvement Program
[20] Total national coating usage is compiled by the Bureau of the Census, Report MA325F—Paint and Allied Products, available on the Census Bureau Bulletin Board, (301)457-2310.
[21] Population data from the U.S. Bureau of the Census, Population Estimates Branch (see Appendices).

paints are identified as being either solvent- or water-based paints, except for the two types listed as Architectural Lacquers and Architectural Coatings N.S.K. These latter types of paints can be assumed to be entirely solvent-based coatings. The calculation to obtain the number of gallons of solvent based paints totals the gallons for Exterior Solvent Type, Interior Solvent Type, Architectural Lacquers and Architectural Coatings N.S.K:

Solvent-Based Paints = 113,964 thousand gallons of paints

The calculation to obtain the number of gallons of water based paints totals the gallons for Exterior Water Type and Interior Water Type:

Water-Based Paints = 510,560 thousand gallons of paints

The per capita usage factor is calculated by dividing the total usage of solvent based paints by the U.S. population, and the total usage of water based paint by the U.S. population.

$$\text{Per Capita Solvent Based Usage Factor} = \frac{\text{Gallons of Solvent Based Paints}}{\text{U. S. Population}} = \frac{113{,}964{,}000}{311{,}591{,}917} = 0.3657$$

$$\text{Per Capita Water Based Usage Factor} = \frac{\text{Gallons of Water Based Paints}}{\text{U. S. Population}} = \frac{510{,}560{,}000}{311{,}591{,}917} = 1.6386$$

Table 2. Quantity and Value of Shipments of Paint and Allied Products: 2010 and 2009

Product code	Product description	Year	Quantity
3255101	Architectural coatings	2010	643,900
		2009	634,874
3255101111	Exterior, solvent thinned paints and tinted bases, including barn and roof paints	2010	33,847
		2009	33,571
3255101115	Exterior, solvent thinned enamels and tinted bases, including exterior-interior floor enamels	2010	17,367
		2009	14,755

3255101119	Exterior, solvent thinned undercoaters and primers	2010	6,816
		2009	6,448
3255101121	Exterior, solvent thinned clear finishes and sealers	2010	4,028
		2009	4,054
3255101125	Exterior solvent thinned stains, including shingle and shake	2010	13,618
		2009	12,096
3255101129	Exterior, other solvent thinned coatings, including bituminous paints	2010	1,578
		2009	1,671
3255101131	Exterior, water thinned paints and tinted bases, including barn and roof paints	2010	92,625
		2009	93,665
3255101135	Exterior, water thinned exterior-interior deck and floor enamels	2010	10,583
		2009	10,727
3255101139	Exterior, water thinned undercoaters and primers	2010	10,587
		2009	10,725
3255101141	Exterior, water thinned stains and sealers	2010	21,501
		2009	20,678
3255101145	Exterior, other exterior water thinned coatings	2010	9,035
		2009	8,980
3255101211	Interior, flat solvent thinned wall paint and tinting bases, including mill white paints	2010	1,155
		2009	1,288
3255101215	Interior, gloss and quick drying enamels and other gloss solvent thinned paints and enamels	2010	3,983
		2009	3,389
3255101219	Interior, semigloss, eggshell, satin solvent thinned paints and tinting bases	2010	9,870
		2009	9,691
3255101221	Interior, solvent thinned undercoaters and primers	2010	**21,702**
		2009	(D)
3255101225	Interior, solvent thinned clear finishes and sealers	2010	(S)

		2009	(S)
3255101229	Interior, solvent thinned stains	2010	1,309
		2009	1,216
3255101231	Interior, other solvent thinned coatings	2010	(D)
		2009	(D)
3255101235	Interior, flat water thinned paints and tinting bases	2010	144,394
		2009	142,894
3255101239	Interior, semigloss, eggshell, satin, and other water thinned paints and tinting bases	2010	183,428
		2009	176,562
3255101241	Interior, water thinned undercoaters and primers	2010	38,407
		2009	42,781
3255101245	Interior, other interior water thinned coatings, stains, and sealers	2010	5,119
		2009	5,250
3255101249	Architectural lacquers	2010	4,086
		2009	4,126
3255104	Product finishes for original equipment manufacturers (OEM), excluding marine coatings	2010	329,931
		2009	285,070
3255104111	Automobile, light truck, van, and sport utility vehicle finishes	2010	43,172
		2009	31,580
3255104121	Automobile parts finishes	2010	2,792
		2009	1,929
3255104131	Heavy duty truck, bus, and recreational vehicle finishes	2010	5,757
		2009	5,352
3255104141	Other transportation equipment finishes, including aircraft and railroad	2010	5,369
		2009	4,187
3255104211	Appliance, heating equipment, and air-conditioner finishes	2010	3,990
		2009	4,266

3255104215	Wood furniture, cabinet, and fixture finishes	2010	34,578
		2009	32,500
3255104219	Wood and composition board flat stock finishes	2010	7,135
		2009	6,274
3255104221	Metal building product finishes (including coatings for aluminum extrusions and siding)	2010	36,455
		2009	35,303
3255104225	Container and closure finishes	2010	40,164
		2009	35,647
3255104229	Machinery and equipment finishes, including road building equipment and farm implement	2010	10,151
		2009	9,462
3255104231	Non-wood furniture and fixture finishes, including business equipment finishes	2010	22,155
		2009	20,710
3255104235	Paper, paper board, film, and foil finishes, excluding pigment binders	2010	(S)
		2009	10,854
3255104239	Electrical insulating coatings	2010	1,015
		2009	866
3255104241	Thermoset general decorative, appliance powder coatings **1/**	2010	8,951
		2009	6,933
3255104245	Thermoset general decorative, automotive powder coatings **1/**	2010	3,765
		2009	2,437
3255104249	Thermoset general decorative, architectural powder coatings (such as aluminum extrusions) 1/	2010	1,096
		2009	959
3255104251	Thermoset general decorative, lawn and garden powder coatings **1/**	2010	999
		2009	890
3255104255	Thermoset general decorative, general metal finishing powder coatings **1/**	2010	19,806
		2009	16,225

3255104259	Thermoset functional powder coatings (for pipe, rebar, electrical insulation, etc.) **1/**	2010 2009	(D) (D)
3255104261	Thermoplastic powder coatings (all) **1/**	2010 2009	(D) (D)
3255104263	Other powder coatings	2010 2009	(D) (D)
3255104265	Other industrial product finishes	2010 2009	23,378 20,774
3255107	Special purpose coatings, including all marine coatings	2010 2009	168,326 158,575
3255107111	Industrial new construction and maintenance paints, interior	2010 2009	35,570 34,704
3255107115	Industrial new construction and maintenance paints, exterior	2010 2009	16,571 13,886
3255107121	Traffic marking paints (all types; shelf goods and highway department)	2010 2009	37,335 35,047
3255107131	Automotive, other transportation and machinery refinish paints and enamels, including primers	2010 2009	55,899 52,504
3255107141	Marine paints, ship and off-shore facilities and shelf goods for both new construction and marine refinish and maintenance. Excludes spar varnish	2010 2009	10,924 11,498
3255107151	Marine paints for yacht and pleasure craft, new construction, refinish and maintenance	2010 2009	(D) (D)
3255107161	Aerosol - paint concentrates produced for packaging in aerosol containers	2010 2009	(D) (D)
325510B	Miscellaneous allied paint products	2010 2009	145,119 134,263

325510B111	Paint and varnish removers	2010	(D)
		2009	5,075
325510B121	Thinners for lacquers and other solvent based paint products	2010	(D)
		2009	30,249
325510B131	Pigment dispersions	2010	(D)
		2009	25,877
325510B141	Other miscellaneous allied paint products, including brush cleaners, ink vehicles, putty and glazing compounds, etc.	2010	83,708
		2009	73,062

Emission Factor

Use the emission factors for architectural surface coatings (EPA, 1993A), that are shown in Table 5-2 of the EIIP document and reproduced below:

Coating Type	**VOC Content Lbs / gallon**
Water-based	0.74
Solvent-based	3.87
Total	4.61

This activity occurs 7 days a week and is usually more common in the summer months as indicated by a seasonal adjustment factor of 1.3 (see Table 5.8-1 in Procedures). It should be noted that 99% of solvents in these coatings are VOC.

Point Source Adjustments

Because the application of architectural surface coating is defined as an area source, there is no need to subtract point source emissions from the total, and all emissions estimated for this source are area source emissions.

Adjustment for Controls

EPA surface coating regulation provides a 20% reduction for phase I of the AIM rule and 31% reduction for phase II; this creates a 44.8% control efficiency.

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

The equation used to estimate emissions from architectural surface coatings is:

Equation to calculate solvent-based emissions is:

$$EM_{ASC-SB} = \frac{POP_i \mathbf{x} UF_{ASC-SB} \mathbf{x} EF_{SB} \mathbf{x} [(1-(CE_{ASC} \text{ x } RE_{ASC} \text{ x } RP_{ASC})]}{2000}$$

Where:

EM_{ASC-SB} = VOC emissions in tons per day from solvent-based architectural surface coatings
POP_i = 2011 population of county i
UF_{ASC-SB} = Usage factor for solvent-based architectural surface coatings
EF_{SB} = VOC emission factor for solvent-based architectural surface coatings
CE_{ASC} = Control efficiency[22] for architectural surface coatings
RE_{ASC} = Rule effectiveness[23] for architectural surface coatings
RP_{ASC} = Rule penetration for architectural surface coatings

Equation to calculate water-based emissions is:

$$EM_{ASC-WB} = \frac{POP_i \mathbf{x} UF_{ASC-WB} \mathbf{x} EF_{WB} \mathbf{x} [(1-(CE_{ASC} \text{ x } RE_{ASC} \text{ x } RP_{ASC})]}{2000}$$

Where:

EM_{ASC-WB} = VOC emissions in tons per day from water-based architectural surface coatings
POP_i = 2011 population of county i

[22] An overall 44.8% reduction in emissions is due to EPA's AIM regulation
[23] EPA's AIM regulation is a federal rule applying to architectural surface coatings

UF_{ASC-WB} = Usage factor for water-based architectural surface coatings
EF_{WB} = VOC emission factor for water-based architectural surface coatings
CE_{ASC} = Control efficiency for architectural surface coatings
RE_{ASC} = Rule effectiveness for architectural surface coatings
RP_{ASC} = Rule penetration for architectural surface coatings

2011 Example Calculation Architectural Surface Coating (Allegany County)

Solvent-Based
$POP_{Allegany}$ = 74692 persons
UF_{ASC-SB} = 0.3657 gal/capita
EF_{SB} = 3.87 lbs. $_{VOC}$/gal/year
CE_{ASC} = 44.8%
RE_{ASC} = 100%
RP_{ASC} = 100%

EM_{ASC-SB} = ((74,692 x 0.3657 x 3.87) x [1 – (0.448 x 1.00 x 1.00)]) / 2000
EM_{ASC-SB} = 29.18 tons $_{VOC}$ per year

Water-Based
$POP_{Allegany}$ = 74692 persons
UF_{ASC-WB} = 1.6386 gal/capita
EF_{WB} = 0.74 lbs. $_{VOC}$/gal/year
CE_{ASC} = 44.8%
RE_{ASC} = 100%
RP_{ASC} = 100%

EM_{ASC-WB} = ((74,692 x 1.6386 x 0.74) x [1 – (0.448 x 1.00 x 1.00)]) / 2000
EM_{ASC-WB} = 25.00 tons $_{VOC}$ per year

4.1.2.4 **Auto Refinishing**

SCC: 24 01 005 000

Description

Automobile refinishing is the repainting of worn or damaged automobiles, light trucks and other vehicles. Coating of new cars is not included in this category but falls under industrial coating. In automobile refinishing, lacquers and enamels are usually applied with hand-operated spray guns. Because the vehicles contain heat-sensitive plastics and rubber, the coatings are dried or cured in low-temperature ovens or at ambient conditions. MDE adopted a regulation based upon federal guidance that requires the use of reformulated coatings and equipment with greater transfer efficiency in the application of coatings.

Pollutants

VOC

Method and Data Sources

MDE staff used an alternative per employee emission estimation methodology documented in EIIP[1], Chapter 13, Auto Body Refinishing, dated January 2000. The document provides an outline for developing a per employee emission factor using a national VOC emission estimate and national employment data.

Activity

MDE calculated an emission factor of 592.6774 lbs. VOC per employee per year using an estimate of 151.9 million pounds of solvents sold nationally in 2007 and dividing it by 2007 County Business Patterns employment number of 256,331 for NAICS 81112: Automotive Body, Paint, Interior and Glass Repair. The amount of solvent sold was provided by the EPA in conjunction with The Freedonia Group and ERTAC.

EPA had a federal rule already in effect allowing a 37% reduction of emission for auto body refinishing in 2011. Maryland has an auto body regulation this is more stringent than the national rule, which allowed MDE to take an additional 8% reduction.

The autobody refinishing category does not include new car coating.

Emission Factor:

592.6774 lbs of VOC per employee per year

[1] Emission Inventory Improvement Program

Point Source Adjustments

No autobody refinishing emissions from facilities identified as point sources were subtracted from the area source.

Autobody refinishing emissions from facilities identified as point sources were subtracted from the area source inventory to avoid double counting.

Adjustment for Controls

An EPA memo on auto body refinishing allows a 37% reduction for the federal rule. Maryland's auto body regulation allowed MDE to take an additional 8% reduction.

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

The equation used to estimate emissions from automobile refinishing is:

$$E_{AR} = \frac{EMP_J \times EF_{AR} \times [1 - (RE \times RP \times CE)]}{2000} - E_{Point\ Source\ AR}$$

Where:

E_{AR} = VOC emissions in tons per year from auto refinishing

EMP_J = Number of employees in county j for NAICS 811121 (auto refinishing) from County Business Patterns

EF_{AR} = VOC emission factor for auto refinishing

$E_{Point\ Source\ AR}$ = Point source emissions from auto body refinishing

Divided by 2000 lbs. to convert to tons

<u>2011 Example Calculation Auto Refinishing (Baltimore County)</u>

$$E_{AR} = \frac{678 \times 592.6774 \times [1-(1.0 \times 1.0 \times .08)]}{2000} - 0.00$$

E_{AR} = 184.84 Tons $_{VOC}$ / year

4.1.2.5 **Traffic Markings**

SCC: 24 01 008 000 - Traffic paints

Description

Traffic paints are used to mark pavement, the majority of which is used to create dividing lines for traffic lanes. These markings are applied by state or local highway maintenance crews or by contractors. VOC emissions result from the evaporation of organic solvents during and shortly after the application of the marking paint. All traffic paint emissions are included in the area source inventory.

Pollutants

VOC

Method and Data Sources

MDE surveyed city, county, and state agencies for gallons of paint used and the VOC content of the paint used.

Activity

The Maryland State Highway Administration (SHA) keeps data on gallons of traffic marking paint used by district and a few individual counties. For emissions from SHA line painting, each county's proportion of the total district's lane miles was multiplied by total gallons painted in a district to get an estimated amount of gallons used for each county. In a few counties, SHA does all the line painting. Also, data was collected from the Maryland Aviation Administration (MAA) and the Mass Transit Administration (MTA).

MDE was able to gather information on gallons of traffic paint used during the ozone season and during a year. The Material Safety Data Sheets and Environmental Data Sheets were collected for each paint and solvent used by each local jurisdiction and State agency doing the striping. It was necessary to collect data on yellow and white paint separately because the amount of VOCs per gallon is different for each type of paint.

The emission totals are slightly lower than in previous inventories because many jurisdictions have switched to latex (water-borne) paints for traffic marking, and those areas already using latex paints have switched to using a latex paint that is lower in VOC content than what was previously used. The widespread use of latex paints means that

there are no longer any emissions from the solvents used to clean painting equipment when oil based paints are used.

The following information was collected from all public agencies using traffic marking paint in Maryland:

Gallons of yellow traffic paint and solvent used in 2011
Gallons of white traffic paint and solvent used in 2011

The MSDS and Environmental Data Sheets per type of paint provided the following information:

- Percent volatile by weight
- Percent water by weight
- Percent volatile organic compounds by weight
- Total VOC (lbs./gal)
- VOC/gallon less water

Emission Factor

Traffic Paints	VOC Emission Factor (lbs. $_{VOC}$/gallons)
Yellow Paint	0.36 to 0.78
White Paint	0.11 to 0.78

The VOC pound per gallon of paint was obtain from the Material Safety Data Sheet (MSDS) for each color and brand of paint used. The appropriate factor was used for each calculation and the table above shows the range for each color.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

MDE surveyed the various state agencies that apply coatings to road surfaces and transportation projects. MDE collected data on the gallons of paint applied and the VOC content of the paint. MDE made emission estimates based on this data and therefore no controls are available for this source category.

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

Traffic Paint Sample Calculation (Harford County)

(1) Calculate VOC emissions from yellow and white traffic paints for year 2011

a. State Highway Administration (SHA) Traffic Paint Use

Total yellow gallons used in 2011 = 13,107 gallons
Total VOC per gallon of yellow paint used[25] = 0.57 lbs. $_{VOC}$ /gallon
Total white gallons used 2011 = 17,374 gallons
Total VOC per gallon of white paint used[26] = 0.57 lbs. $_{VOC}$ /gallon

$$E_{\text{Yellow Paint}} = \frac{(13{,}107 \text{ gallons}) \times (0.57 \text{ lbs.}_{VOC} \text{/gallon})}{(2{,}000 \text{ lbs./ton})}$$

$$E_{\text{Yellow Paint}} = 3.735 \text{ tons / year}$$

$$E_{\text{White Paint}} = \frac{(17{,}374 \text{ gallons}) \times (0.57 \text{ lbs.}_{VOC} \text{/gallon})}{(2{,}000 \text{ lbs./ton})}$$

$$E_{\text{White Paint}} = 4.952 \text{ tons / year}$$

[25] MSDS from Caroline County's Department of Public Works, Division of Highways
[26] MSDS from Caroline County's Department of Public Works, Division of Highways

$E_{\text{Local Paint Total}} = E_{\text{Yellow Paint}} + E_{\text{White Paint}}$

$E_{\text{Local Paint Total}} = 3.735 + 4.952$

$E_{\text{Local Paint Total}} =$ **8.687** tons / year

b. Maryland Aviation Administration (MAA) Traffic Paint Use

The MAA did not apply any paint in Harford County.

c. Maryland Transportation Administration (MTA) Traffic Paint Use

The MTA did not apply any paint in Harford County.

d. Local Jurisdiction Traffic Paint Use Harford County

Total yellow gallons used in 2011 = 4,320 gallons
Total VOC per gallon of yellow paint used[27] = 0.78 lbs. $_{VOC}$ /gallon
Total white gallons used 2011 = 1,149 gallons
Total VOC per gallon of white paint used[28] = 0.78 lbs. $_{VOC}$ /gallon

$$E_{\text{Yellow Paint}} = \frac{(4{,}320 \text{ gallons}) \times (0.78 \text{ lbs.}_{VOC} \text{/gallon})}{(2{,}000 \text{ lbs./ton})}$$

$E_{\text{Yellow Paint}} = 1{,}685$ tons / year

$$E_{\text{White Paint}} = \frac{(1{,}149 \text{ gallons}) \times (0.78 \text{ lbs.}_{VOC} \text{/gallon})}{(2{,}000 \text{ lbs./ton})}$$

$E_{\text{White Paint}} = 0.448$ tons / year

$E_{\text{Local Paint Total}} = E_{\text{Yellow Paint}} + E_{\text{White Paint}}$

$E_{\text{Local Paint Total}} = 1.685 + 0.448$

$E_{\text{Local Paint Total}} = 2.133$ tons / year

(2) VOC emissions from paint cleaning solvent use were zero. None of the above listed agencies used cleaning solvents.

(3) Total VOC emissions from traffic paint use and paint cleaning solvent use :

$E_{\text{Paint Total}} = E_{\text{SHA Paint Total}} + E_{\text{MAA Paint Total}} + E_{\text{MTA Paint Total}} + E_{\text{Local Paint Total}} + E_{\text{Paint Solvent}}$

[27] MSDS from Caroline County's Department of Public Works, Division of Highways
[28] MSDS from Caroline County's Department of Public Works, Division of Highways

$E_{\text{Paint Total}}$ = **8,687** + 0.0 + 0.0 + **2.133** + 0.0

$E_{\text{Paint Total}}$ = **10,820** tons / year

Yellow Total = 3.735 +1.685 = 542 tons / year
White Total = 4.952 + 0.448 = 5.40 tons / year

4.1.2.6 **Industrial Surface Coating**

SCC: 24 01 015 000 (Finish Wood Product Manufacturing)
24 01 020 000 (Wood Furniture and Fixtures)
24 01 025 000 (Metal Furniture and Fixtures)
24 01 030 000 (Paper, Film, and Foil)
24 01 040 000 (Metal Cans)
24 01 060 000 (Household Appliances Manufacturing)
24 01 065 000 (Electronic and Other Electrical)
24 01070 000 (Motor Vehicles)
24 01 075 000 (Aircraft)
24 01 080 000 (Marine)
24 01 085 000 (Railroads)
24 01 090 000 (Miscellaneous Manufacturing)
24 01 100 000 (Industrial Maintenance Coatings)
24 01 200 000(Other Coatings)

Description

Industrial surface coatings are applied during the manufacture of a wide variety of products, including furniture, cans, automobiles, other transportation equipment, machinery, appliances, metal coil, flat wood, wire and other miscellaneous products. In addition, coatings are used in maintenance operations at industrial facilities but these are considered paint sources.

Pollutants

VOC and HAPs

Method and Data Sources

MDE used the methods and procedures documented in EIIP[29], Chapter 8, Industrial Surface Coatings, dated September 1997. Applicable point source emissions (those within the same NAICS) taken from the MDE/ARMA registration files have been subtracted from the emissions calculated on a per capita and per employee basis; and are presented below.

Activity

The choice between using per capita factors or per employee factors for categories where made based on the quality of data. County Business Patterns (internet address: http://censtats.census.gov/cgi-bin/cbpnaic/cbpsel.pl) lists employee data by North American Industry Classification System (NAICS). Many values are based on actual data. However, some county NAICS list a range for the number of employees through a letter code. In this case the arithmetic average number of employees per letter code per county was adjusted so that the state total employment in a NAICS matched the sum of the number of employees reported per county. For those categories where all or most of the employment data was listed as a range, the per capita factor was assumed to be more reliable and was used to calculate emissions. The U.S. Census Bureau reports population

[29] Emission Inventory Improvement Program

statistics for the counties of Maryland. Population statistics for 2011 for the counties of Maryland were collected from the U.S. Census Bureau Internet address (http://www.census.gov).

Because the emission factors were developed based on NAICS employment data and 2010 was the last year employment data was available per NAICS, MDE used the 2010 County Business Patterns as the source for employment figures.

Emission Factor

Per employee factors were used for the industry surrogate employment SIC and NAICS because they are generally more reliable (see Procedures, Table 4-10.1), and a comparison with per capita emissions in one county showed that for these SICs, the per capita factors led to a large overestimation of emissions. Per capita factors were used for the industry surrogate population SIC and NAICS because they prove to be more reliable for emission calculations than the per employee factor.

Industry	SCC	NAICS	Surrogate
Finish Wood Product Manufacturing	2401015000	321	Employment
Wood Furniture and Fixtures	2401020000	337110, 337121, 337122, 337127, 337129, 337211,337212, 337215, 339111	Employment
Metal Furniture and Fixtures	2401025000	337124, 337127, 337214, 337215, 339111	Employment
Paper, Film, and Foil	2401030000	322222	Employment
Metal Cans	2401040000	33243	Employment
Household Appliances Manufacturing	2401060000	3352	Employment
Electronic and Other Electrical	2401065000	331319, 31422, 331491, 35921, 335929	Employment
Motor Vehicles	2401070000	3361, 3362, 3363	Employment
Aircraft	2401075000	3364	Employment
Marine	2401080000	3366, 488390	Employment
Railroads	2401085000	3365	Employment
Miscellaneous Manufacturing	2401090000	339, 3369	Employment
Industrial Maintenance Coatings	2401100000	NA[a]	Population
Other Coatings	2401200000	NA[a]	Population

Furthermore, NAICS used were the best correspond to SIC for each source category so that emission factors that were generated from EIIP SIC data could be used. EPA provided the correlation between NAICS and SIC. Per employment **e**mission factors are listed in Table 8.5-1 in the EIIP Industrial Surface Coating document and below. As an example, MDE has chosen finish wood product manufacturing for presentation of an

equation and emissions by county. The EIIP document lists no seasonal adjustment factor.

Industrial Maintenance Coatings (NAICS) and **Other Coatings (NAICS)**, per capita emission factors are listed in Table 8.5-2 in the EIIP Industrial Surface Coating document and below.

Industry	Per Employment VOC Emission Factor (lbs. $_{VOC}$/employee/year)	Per Capita VOC Emission Factor (lbs. $_{VOC}$/person/year)
Finish Wood Product Manufacturing	43	NA
Wood Furniture and Fixtures	244	NA
Metal Furniture and Fixtures	772	NA
Paper, Film, and Foil	735	NA
Metal Cans	2,326	NA
Household Appliances Manufacturing	254	NA
Electronic and Other Electrical	24.7	NA
Motor Vehicles	164	NA
Aircraft	15	NA
Marine	198	NA
Railroads	222	NA
Miscellaneous Manufacturing	136	NA
Industrial Maintenance Coatings	NA	0.8
Other Coatings	NA	0.8

Point Source Adjustments

Applicable point source emissions (those within the same NAICS) taken from the MDE/ARMA registration files have been subtracted from the calculated emissions, and their emissions are separated from the totals presented below.

Adjustment for Controls

MDE surveyed the various state agencies that apply coatings to road surfaces and transportation projects. MDE collected data on the gallons of paint applied and the VOC content of the paint. MDE made emission estimates based on this data and therefore no controls are available for this source category.

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

Equation:

$$E_{FW} = \frac{EMPL_i \textbf{ x } EF_{FW}}{2000}$$

Where:

E_{FW} = VOC emissions in tons per year from finish wood product manufacturing.

$EMPL_i$ = employees in county i employed in NAICS 321.

EF_{FW} = VOC emission factor for finished wood which is 43 lbs. $_{VOC}$ per employee per year

2011 Example Calculation Industrial Surface Coating – Finish Wood Product Manufacturing (Baltimore County)

Number of employees in NAICS 321 in Baltimore County (2010 County Business Patterns): 52

Emission factor for finish wood product manufacturing (lbs. VOC/employee/year): 43[30]

5 days per week activity level, no seasonal adjustment factor

$$E_{FW(Baltimore\ Co)} = \frac{(52 \textbf{ x } 43)}{2000}$$

$E_{FW(Baltimore\ Co)}$ = 1.12 tons $_{VOC}$ per year

[30] Table 8.5-1, EIIP Chapter 8 Industrial Surface Coatings

4.1.2.7 **Industrial Adhesives and Sealants**

SCC: 2440020000

Description

Industrial adhesives are the application of a liquid or powder substance, such as solvent type paints, varnishes, and lacquers to a surface for decorative or protective purposes. The substances can be applied by brushing, rolling, spraying, dipping or flow coating. VOCs are released into the air as the substance dries. Powder coatings are applied to a hot surface and then melted; VOCs are released as the powder melts and dries.

Pollutants

VOC and HAPs

Method and Data Sources

MDE staff used EPA's "Solvent Mass Balance" methodology for estimating emissions from nonpoint solvents, which uses the total solvent production and sales for a particular source category to estimate overall emissions then subtracting out emissions due to point sources, waste management, and recycling.

Activity

Per capita activity data was used and downloaded from the US Census Bureau (internet address: http://www.census.gov) July 1, 2011 population statistic estimates for the counties of Maryland[31].

Emission Factor

MDE used the emission factor of 1.10 lbs/capita/year developed by Determination of Reasonably Available Control Technology and Best Available Retrofit Control Technology for Adhesives and Sealants, California Air Resources Board document for adhesives and sealants (CARB RACT/BARCT for Adhesives/ Sealants, Dec 1998)[32].

CARB RACT/BARCT estimated emission factor calculation for adhesives/sealants is as following:

VOC = 45 tons/day estimated in 1994 * 365 days/year * 2000 lbs/ton / 29,760,021 capita where 45 tons/day is the estimated state-wide emissions for industrial adhesives in California, 2000 lbs/ton is a conversion factor, and 29,760,021 capita is the 1990 population of California.

VOC Emf = 1.10 lbs/capita/year of industrial adhesives

[31] 2011 estimated population from U.S. Bureau of the Census, Population Estimation Branch (see Appendices).
[32] Emission factors were developed by CARB RACT/BARCT for Adhesives/ Sealants, Dec 1998.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

Maryland has adopted an industrial adhesive and coatings regulation (COMAR 26.11.19.15). The regulation is similar to the one proposed by the Ozone Transport Commission (OTC) and achieves VOC reductions through two basic components: sale and manufacture restrictions that limit the VOC content of specified adhesives, sealants and primers sold in the state; and use restrictions that apply primarily to commercial/industrial applications.

A reasonably available control technology determination (CARB RACT/BARCT for Adhesives/ Sealants, Dec 1998) prepared by the California Air Resources Board (CARB) in 1998 forms the basis of this model rule. In the years 1998-2001, the provisions of the CARB determination were adopted in regulatory form in various air pollution control districts in California including the Bay Area, Ventura County, Sacramento Metropolitan and San Joaquin Valley.

CARB and OTC estimate a 64.4 percent reduction in emissions from the source category regulation that was fully implemented in Maryland in 2009.

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

Equation:

$$E_{OC} = \frac{POP_i \times EF_{OC}}{2000} \times [1 - (CE \times RE \times RP)]$$

Where:

E_{OC} = VOC emissions in tons per year from industrial adhesives.
POP_i = 2011 population of county i (Appendix A Section 1).
EF_{OC} = VOC emission factor for industrial adhesives.
CE = Control Efficiency
RE = Rule Effectiveness

RP = Rule Penetration

To adjust for control efficiency OTC-PECHAN Control Measure Report:
2011 base year where:
CE = 0.644, RE = RP = 1.

Then new emission control efficiency for 2011 is: [1 – (0.644 x 1 x 1)] = 1

<u>2011 Per Capital Sample Calculation for industrial adhesives in Montgomery County:</u>

2011 U.S. Census Bureau Population Estimate for Montgomery County: 989,794[33]
Emission factor for industrial adhesives (lbs. VOC/person/year): 1.10[34]

5 days per week activity level, no seasonal adjustment factor

<u>Equation:</u>

$$E_{OC} = \frac{POP_i \mathbf{x} EF_{OC}}{2000} \text{ x } [1 - (CE \text{ x } RE \text{ x } RP)]$$

<u>2011 Per Capital Sample Calculation for industrial adhesives in Montgomery County:</u>

989,794 **x** 1.10 lbs. VOC/capita/year x [1 – (0.644 x 1.0 x 1.0)] = 387,603 lbs. $_{VOC}$ per person

Converting to tons per year: 387,603 / 2000 lbs. per year = 193.80 tons $_{VOC}$ per year.

[33] 2011 estimated population from U.S. Bureau of the Census, Population Estimation Branch (see Appendices).
[34] Emission Inventory Improvement Program Vol. III, Ch. 6, September 1997.

4.1.2.8 **Graphic Arts**

SCC: 24 25 000 000 (Screen & Plateless)
24 25 010 000 (Offset Lithography)
24 25 020 000 (Letterpress)
24 25 030 000 (Rotogravure)
24 25 040 000 (Flexography)

Description

Graphic arts include operations that are involved in the printing of newspapers, magazines, books and other printed materials. There are six basic operations used in graphic arts: lithography, gravure, letterpress, flexography, screen printing and metal decorating (plateless). In our calculations screen and plateless printing were paired together and make up a combined 6% market share of all printing. Lithography accounts for nearly half of all graphic arts operations.

Pollutants

VOC

Method and Data Sources

MDE staff used an alternative per capita emission estimation method documented in EIIP[4], Chapter 7, Graphic Arts, dated November 1996. The EIIP methodology recommended an emission factor of 1.3 lbs. $_{VOC}$ per capita per year emission factor (EPA, 1991) for graphic arts sources emitting less than 100 tons VOC per year. Yearly activity was used with no seasonal adjustment factor as recommended in Table 5.8-1 in Procedures. All point source graphic arts facilities (NAICS 11531) in the ARMA registration files for 2011 emissions where subtracted from the area source inventory.

Activity

The estimated percentage of market share, reported in Table 7.2-3 of the EIIP document and reproduced below, was used to allocate the total graphic arts emissions to specific printing types. Maryland has different regulations regarding specific types of printing operations and thus to calculate controlled emissions the estimated percentage that each type of printing operation contributes to the total had to be determined.

Type of Printing (MS_{type}**)**	**Estimated Percentage of Product Market Share**
Rotogravure	18
Flexography	18
Offset Lithography	47
Letterpress	8

[4] Emission Inventory Improvement Program

Screen	3
Plateless	3

Emission Factor

1.3 lbs. $_{VOC}$ per capita per year

Point Source Adjustments

Graphic arts emissions from facilities identified as point sources were subtracted from the area source inventory to avoid double counting.

Adjustment for Controls

Control efficiency is based on Maryland regulations for each type of printing process and has been developed within technical support documents for the graphic arts printing regulations. Rule penetration has been defined as the estimated percentage that each type of printing operation. Rule effectiveness has been assigned the EPA default value of 80 per cent.

	Lithographic	Rotogravure	Letterpress	Flexographic	Screen
Rule Effectiveness (RE)	0.800	0.800	0.800	0.800	0.800
Rule Penetration (RP)	1.000	1.000	1.000	1.000	1.000
Control Efficiency (CE)	0.750	0.630	0.000	0.540	0.350
Reduction factor (RE x RP x CE)	0.600	0.504	0.000	0.432	0.280

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

The equation used to estimate emissions from graphic arts is:

<u>Equation:</u>

$$E_{GA} = \frac{MS_{type} \times POP_i \times EF_{GA}}{2000} \times (1 - RF_{GA})$$

Where:

E_{GA} = VOC emissions in tons per year from graphic arts
MS_{type} = Market share percent of the type of printing
POP_i = 2011 population of county i (Appendix A)
EF_{GA} = VOC emission factor for graphic arts (1.3[35] lbs. $_{VOC}$ per person per year)
RF_{GA} = Reduction Factor for Printing
RF_L = Reduction Factor for Lithographic Printing
RF_{LP} = Reduction Factor for Letterpress Printing
RF_R = Reduction Factor for Rotogravure Printing
RF_F = Reduction Factor for Flexographic Printing
RF_S = Reduction Factor for Screen & Plateless Printing

2011 Example Calculation Graphic Arts (Anne Arundel County)

$$E_{GAL} = \frac{0.47 \times 544{,}403 \times 1.3}{2000} \times (1 - 0.600)$$

$$E_{GALP} = \frac{0.08 \times 544{,}403 \times 1.3}{2000} \times (1 - 0.0)$$

$$E_{GAR} = \frac{0.18 \times 544{,}403 \times 1.3}{2000} \times (1 - 0.504)$$

$$E_{GAF} = \frac{0.18 \times 544{,}403 \times 1.3}{2000} \times (1 - 0.432)$$

$$E_{GAS} = \frac{0.06 \times 544{,}403 \times 1.3}{2000} \times (1 - 0.280)$$

$$E_{GAsum} = (E_{GAL} + E_{GALP} + E_{GAR} + E_{GAF} + E_{GAS})$$

E_{GAsum} = (66.53 + 28.31 + 31.59 + 36.18 + 15.29)
E_{GAsum} = 177.89 tons $_{VOC}$ per person (Totals may be slightly different due to rounding)

[35] Emission factor from EIIP Chapter 7 Graphic Arts

4.1.2.9 **Asphalt Paving and Roofing**

SCC: 24 61 022 000 Emulsified
24 61 020 000 Misc. Application (Road Oil)
24 61 021 000 Cutback
24 61 023 000 Roofing

Description

The two types of asphalt paving used for road paving and repair are cutback asphalt and emulsified asphalt. Cutback asphalt is a liquefied road surface prepared by blending (or "cutting back") asphalt cement with different petroleum distillates or (road oils). The second type, emulsified asphalt, is also a liquefied road surface, but is prepared with a water/soap mixture instead of petroleum distillates. Cutback asphalt emits more VOCs, and its use has been limited in Maryland to the non-ozone period of April 15 to October 15. Asphalt like tar is also used for roofing similar to rubberizing.

Pollutants

VOC

Method and Data Sources

MDE calculated emissions for this category by using a combination of factors from the Sacramento Metropolitan Air Quality Management District (SMAQMD) 1991 Survey, the California Air Resources Board, and EPA's AP-42. It estimated that 80% of all asphalt used in Maryland is for paving, and the remaining 20% is for roofing.

Activity

Total barrels of asphalt used in Maryland was obtained from the Energy Information Administration (EIA) and separated to county level. Maryland used 3,322,000 barrels of asphalt in 2010. Also, 2011 population statistics for the counties of Maryland were collected from the Census Bureau Internet address (http://www.census.gov).

Emission Factors:

Asphalt Related Material	VOC Emission Factors	EF Units
Emulsified	17.9	lbs/ton
Road Oils	70.4	lbs/ton
Cutback	268.3	lbs/ton
Asphalt Roofing	6.2	lbs/ton

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

State of Maryland Department of Environment regulations (COMAR 26.11.11.02B), prohibit use of cutback asphalt paving from April 15 to October 15 so ozone precursor emissions from cutback asphalt application were not calculated. Cutback asphalt is made by blending asphalt cement with petroleum distillates that evaporate when the road surface is "cured" after application. Cutback was given a control efficiency of 100 %, rule effectiveness of 80%, and rule penetration of 100%. All other asphalts had no controls applied. Emulsified asphalt is asphalt cement mixed with a blend of water and an emulsifier, usually soap.

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

Emission estimates were calculated by converting total barrels used to tons of asphalt, multiplying it by appropriate emission factor, and then proportioning them by population to the county level. There is 350 lbs of asphalt in each barrel. Out of all asphalt used in the state, approximately 80% is used for paving and 20% is used for roofing. Paving asphalt usage is further separated below:

Paving Asphalt Percent	
Paving Hot-mix:	**92%**
Paving Emulsified:	**5%**
Paving Road Oils:	**2%**
Paving Cutback	**1%**
Roofing of state total	**20%**

Tons of Paving Asphalt	
Hot-mix:	**427,874**
Emulsified:	**23,254**
Road Oils:	**9,302**
Cutback	**4,651**
Roofing	**116,270**

Hot-mix emissions were calculated by facilities and reported with point source inventory.

The equation used to estimate emissions from asphalt paving is:

$$E_A = \frac{CLA_{Type} \mathbf{x} EF_{Type}}{2000} \times (1 - (RE \mathbf{x} RP \mathbf{x} CE))$$

Where:
E_A = VOC emissions tons
CLA_{Type} = Estimated amount of asphalt type used (tons)
EF_{Type} = emission factor for type of asphalt in lbs. $_{VOC}$ per ton of asphalt per yr
RE = Rule Effectiveness
RP = Rule Penetration
CE = Control efficiency

2011 Emulsified Asphalt Sample Calculations: Anne Arundel County

$$E_A = \frac{CLA_{Type} \mathbf{x} EF_{Type}}{2000} \times (1 - (1 \mathbf{x} 1 \mathbf{x} 0))$$

$$E_{Ann\ Arundel} = \frac{\mathbf{2{,}172\ x\ 17.9}}{2000} \times (1 - (1 \mathbf{x} 1 \mathbf{x} 0))$$

$E_{Ann\ Arundel}$ = 19.44 tons $_{VOC}$

Below is an alternate calculation method and check, by estimating emission for the state and ratioing out Anne Arundel County by county population.

$E_{MDEm\ Total}$ = **23,254** tons of asphalt for all of Maryland.

Total Maryland Population for 2011 was 5,828,289 people.
Anne Arundel County population for 2011 was 544,403.
Usage ratio for Anne Arundel County is USEa = (544,403 / 5,828,289) = 0.0934

$$E_{MDEmulsified} = \frac{\mathbf{23{,}254\ x\ 17.9}}{2000} \times (1 - (1 \mathbf{x} 1 \mathbf{x} 0))$$

$E_{MDEmulsified}$ = 208.12 tons $_{VOC\ Maryland}$

$E_{Ann\ Arundel}$ = (208.12 **x** 0.0934) tons $_{VOC}$

$E_{Ann\ Arundel}$ = 19.44 tons $_{VOC}$

(Similar calculation can be done for each asphalt type for each county)

4.1.2.10 **Synthetic Organic Chemical Storage Tanks**

This category is fully represented in the point source inventory.

4.1.2.11 **Pesticide Application**

SCC: 24 61 800 000

Description

Pesticides are substances or mixtures used to control plant and animal life for the purposes of: agricultural production, public health from pest-borne disease, reducing property damage due to pests, and improving the aesthetic quality of outdoor and indoor surroundings. Agriculture, homeowners, industry, and government agencies use pesticides. The largest usage of pesticides by weight is in agriculture. Agricultural pesticides control weeds, insects, mites, fungi, nematodes, and other threats to the yield, quality, or safety of food production.

Emissions arise from pesticide use because of the volatile nature of many ingredients, solvents, or other additives used in the formulations. Many pesticide formulations use solvents as carriers for more active organic or inorganic ingredients. In pesticide formulations, the organic or inorganic solute is the "active ingredient" (AI), while the solvent carrier is the "inert carrier." Thus, the terms "active" and "inert" in pesticide formulations refer to toxicological action, and are not indicators of photochemical activity. Both the active and inert ingredients in these formulations evaporate and contribute to VOC emissions.

Pollutants

VOC and HAPs

Method and Data Source:

Activity data for 2011 was not available and the Pesticide Regulation Section of the Maryland Department of Agriculture reported that the amount of pesticide usage for the state did not change from 2004. The emissions for this category have remained constant and are the same as our last report; for these reasons the following estimation description is the same as previous.

Maryland Agricultural Statistics service in cooperation with the Pesticide Regulation Section of the Maryland Department of Agriculture compiled information for Maryland's 2000 pesticide statistics document. The document, Maryland Pesticide Statistics for 2000, reported pesticide usage in pounds used in a year by active ingredient for each Maryland County. Along with the pounds of AI applied, the document also listed the form of many pesticides and the formulation of some selected pesticides. From this, MDE used the EIIP's emission inventory reference document titled Pesticides – Agricultural and Nonagricultural, December 1997, Section 9.2.2 to generate the VOC

emissions for the active ingredient and inert carrier of the pesticide. This required assumptions and other references to collect the best information used in the calculations. Emission estimation for 2011 was adapted from 2002 averaged pounds of pesticide per acre.

The EPA method for estimating pesticide emissions uses a six-step procedure as follows:

1. Determine both the application method and the quantity of pesticide product applied.
2. Determine the type of formulation used.
3. Determine the specific AI(s) in the formulation and their vapor pressure(s).
4. Determine the percentage of the AI (or each AI) present.
5. Determine the VOC content of the formulation.
6. Calculate the emissions.

MDE slightly deviated from this method, since information was presented to MDE in pounds of active ingredient. With the active ingredient, the vapor pressure and general application method (surface application or soil incorporation) was determined from the EPA's AP-42 document or The SCS/ARS/CES Pesticide Properties Database For Environmental Decision-Making, by R. D. Wauchope, et al. Then the form (i.e. wet-table powder, emulsified concentrate, granule, etc.) of the most likely pesticide was determined from a list in the Maryland Pesticide Statistics for 2000. Also, the statistics listed some formulations, for example 80% inert, 20% AI. Most of the formulations were assumptions based on the information provided with the form of the pesticide in the Maryland Pesticide Statistics for 2000.

The table below lists the EIIP emissions factors taken from AP-42 (Table 9.2.2-4) used to calculate this category.

Uncontrolled Emission Factors for Pesticide Active Ingredients

Vapor Pressure Range	**Emission Factor**	
(mm Hg at 20° to 25° C)	**kg/Mg**	**lbs./ton**
Surface Application		
1×10^{-4} to 1×10^{-6}	350	700
$> 1 \times 10^{-4}$	580	1160
Soil Incorporation		
$< 1 \times 10^{-6}$	2.7	5.4
1×10^{-4} to 1×10^{-6}	21	42
$> 1 \times 10^{-4}$	52	104

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Equations:

E_{pest} = VOC Emissions from Active Ingredient (AI) + VOC Emissions from the Inert Ingredients (Inert).

VOC Emissions Active Ingredients (AI) = (lbs_{AI} / year) x (lbs_{VOC} / lb_{AI})

VOC Emissions Inert Ingredients = [(lbs_{AI} / year) / % AI] x % Inert Ingredients x % $VOC_{INERT\ INGREDIENTS}$

$$E_{pest} = \frac{\text{(lbs AI/year) x } EF_{AI} \text{ in lbs VOC/ton AI}}{\text{2000 lbs. Per ton}} + \frac{\text{(lbs AI/year)}}{\text{(1 - \% Inert)}} \text{ x (\% Inert) x (\% VOC in Inert)}$$

$$\text{Daily Emissions} = \frac{\text{Annual Emissions}}{\text{312 days / year}} \text{ x Seasonal Adjustment Factor}$$

where:
AI = Active Ingredient (lbs. /yr)
EF_{AI} = Emission Factor (lbs. VOC / ton AI)
% inert = percentage of formulation that contains the Inert Carrier
% VOC in the inert = percentage of VOCs in the Inert Carrier portion of the pesticide
SAF = seasonal adjustment factor of 1.3 to adjust for the summer ozone season

MDE assumed six working days per week and 100% volatilization of the VOC portion of the inert carrier.

Sample Calculations:

The following information was compiled from The Maryland Pesticide Statistics for 2000 and The SCS/ARS/CES Pesticide Properties Database for Environmental Decision-Making:

Table 3-26
Allegany County Pesticide Information

Pesticide	V. Press mm Hg	Application	Formulation Type	Formula (% Inert)	% VOC Inert	EF lbs. VOC/ lbs. A.I.	Alleg. lbs of A.I.	VOC Alleg. Lbs/yr
2,4-D	8E-06	foliar spray	Gas	0.8	0.29	0.35	2,058	3107.580
Acephate	1.7E-06	crop spray	Gas	0.8	0.29	0.35	62	93.620
Alachlor	1.4E-05	soil spray	Gas	0.15	0.29	0.35	19	7.622

Pesticide	V. Press mm Hg	Application	Formulation Type	Formula (% Inert)	% VOC Inert	EF lbs. VOC/ lbs. A.I.	Alleg. lbs of A.I.	VOC Alleg. Lbs/yr
Amitrole	4.40E-07	foliar spray	Gas	0.784	0.29	0.35	6	8.416
Atrazine	2.89E-07	soil surface	Wp	0.8	0.25	0.35	478	645.300
Azinphos-Methyl	2E-07	crop spray	ec	0.35	0.56	0.35	33	21.501
Azoxystrobin		crop spray	gas	0.77	0.29	0.35	1	1.321
Bacillus thuringiensis	neg	crop spray	gr	0.96	0.25	0.35	107	679.450
Benomyl	1E-10	crop spray	wp	0.8	0.25	0.35	9	12.150
Bifenthrin	1.8E-07	crop spray	gas	0.1	0.29	0.35	2	0.764
Boric Acid	0.0001	spray	wp	0.1	0.25	0.35	4	1.511
Captan	8E-08	crop spray	gas	0.5	0.29	0.35	727	465.280
Carbaryl	1.2E-06	crop spray	gas	0.5	0.29	0.35	93	59.520
Carbofuran	6E-07	foliar spray	fog	0.56	0.39	0.35	1	0.846
Chloroneb	0.003	spray	wp	0.35	0.25	0.58	17	12.148
Chlorothalonil	1E-03	crop spray	gas	0.8	0.29	0.58	368	640.320
Chlorpyrifos	1.7E-05	soil incorporation	gas	0.15	0.29	0.021	36	2.598
Clomazone	1.4E-04	soil incorporation	ec	0.3	0.56	0.052	3	0.876
Clopyralid	0	foliar spray	gas	0.8	0.29	0.35	1	1.510
Cyanazine	1.6E-09	crop spray	dust	0.8	0.21	0.35	31	36.890
Cyfluthrin	1.6E-08	crop spray	wp	0.3	0.25	0.35	153	69.943
Cypermethrin	1.4E-09	crop spray	wp	0.3	0.25	0.35	5	2.286
Diazinon	6E-05	crop spray	pellet	0.143	0.27	0.35	21	8.296
Dicamba	0	spray	gas	0.8	0.29	0.35	126	190.260
Dichlobenil	1E-03	crop spray	wp	0.8	0.25	0.58	3	4.740
Dicofol	4E-07	crop spray	wp	0.3	0.25	0.35	25	11.429
Diflubenzuron	9E-10	crop spray	wp	0.25	0.25	0.35	80	34.667
Dimethenamid	> 1.0	soil spray	gas	0.468	0.29	0.35	5	3.026
Diuron	6.9E-08	soil surface	wp	0.8	0.25	0.35	310	418.500
Endosulfan	1.7E-07	crop spray	gas	0.5	0.29	0.35	2	1.280
Esfenvalerate	1.1E-08	crop spray	dust	0.3	0.21	0.35	7	3.080
Fenarimol	2.2E-07	crop spray	wp	0.3	0.25	0.35	1	0.457
Flumetsulam	ND	spray	aq	0.18	0.21	0.35	12	4.753
Fluvalinate	1E-07	crop spray	rtu	0.8	0.2	0.35	69	79.350
Fosamine Ammonium	4E-06	foliar spray	aq	0.8	0.21	0.35	8	9.520
Glyphosate	0	foliar spray	aq	0.8	0.21	0.35	2,610	3105.900
Hydroprene	?	?	gr	0.09	0.25		2	0.049
Imidacloprid	1.50E-09	spray	aq	0.786	0.21	0.35	1,426	1598.986
Iprodione	1E-07	crop spray	wp	0.8	0.25	0.35	24	32.400
Lambda-cyhalothrin	1.50E-09	spray	ec	0.87	0.56	0.35	8	32.782
MCPP	0	foliar spray	aq	0.5	0.21	0.35	49	27.440
Malathion	8E-06	contact spray	ec	0.3	0.56	0.35	7	4.130
Mancozeb	0	crop spray	Fl aq conc	0.8	0.21	0.35	165	196.350
Maneb	0	crop spray	wp	0.8	0.25	0.35	26	35.100
Metalaxyl	5.62E-06	soil spray	wp	0.25	0.25	0.35	7	3.033
Metam-Sodium	20	soil spray	aq	0.8	0.21	0.58	334	474.280
Methoprene	17.5	spray	aq	0.8	0.21	0.58	26	36.920
Methoxychlor	0	spray	wp		0.25	0.35	3	1.050
Methyl Bromide	1824	release of gas	Fl aq conc	0.8	0.21	0.58	58	82.360
Metolachlor	3.135E-05	soil spray	ec	0.3	0.56	0.35	488	287.920

Pesticide	V. Press mm Hg	Application	Formulation Type	Formula (% Inert)	% VOC Inert	EF lbs. VOC/ lbs. A.I.	Alleg. lbs of A.I.	VOC Alleg. Lbs/yr
Metribuzin	1E-05	soil surface	Fl aq conc	0.75	0.21	0.35	3	2.940
Metsulfuron Methyl	2.5E-12	foliar spray	gr	0.2	0.25	0.35	1	0.413
Nicosulfuron	1.20E-16	grass spray	gr	0.162	0.25	0.35	2	0.797
Oryzalin	1E-08	soil spray	wp	0.75	0.25	0.35	77	84.700
PCNB	1.1E-04	soil spray	wp	0.6	0.25	0.58	88	84.040
Paclobutrazol	6.00E-10	spray	wp	0.5	0.25	0.35	13	7.800
Paraquat	0	target spray	aq	0.8	0.21	0.35	124	147.560
Pendimethalin	9.4E-06	soil spray	ec	0.6	0.56	0.35	1,257	1495.830
Permethrin	1.3E-08	crop spray	ec	0.3	0.56	0.35	9,455	5578.450
Petroleum Oils	1.0E-03	spray	ec		0.56	0.58	1,503	871.740
Phosmet	4.9E-07	crop spray	wp	0.5	0.25	0.35	26	15.600
Picloram	Neg	foliar spray	aq	0.8	0.21	0.35	252	299.880
Primisulfuron-methyl	1.50E-05	crop spray	gr	0.49	0.25	0.35	2	1.180
Propachlor	7.90E-05	spray	gr	0.35	0.25	0.35	2	0.969
Propoxur	9.7E-06	crop spray	ec	0.3	0.56	0.35	2	1.180
Quizalofop-ethyl	3E-07	foliar spray	ec	0.2	0.56	0.35	1	0.490
Sethoxydim	1.6E-07	foliar spray	ec	0.3	0.56	0.35	1	0.590
Simazine	2.21E-08	soil spray	wp	0.8	0.25	0.35	776	1047.600
Sulfentrazone		spray	gr	0.25	0.25	0.56	1	0.643
Sulfometuron Methyl	6E-16	soil spray	gr	0.2	0.25	0.35	7	2.888
Sulfur	0	dust	dust	0.2	0.21	0	96	5.040
Terbacil	3.1E-07	soil spray	wp	0.8	0.25	0.35	4	5.400
Thifensulfuron methyl	1.3E-10	foliar spray	gr	0.2	0.25	0.35	1	0.413
Thiophanate-methyl	1E-07	crop spray	wp	0.5	0.25	0.35	37	22.200
Triadimefon	1.5E-08	crop spray	wp	0.8	0.25	0.35	7	9.450
Trichlorfon	2E-06	crop spray	sp	0.8	0.12	0.35	36	29.880
Triclopyr	1.26E-06	foliar spray	ec	0.8	0.56	0.35	454	1175.860
Trifluralin	1.1E-04	soil incorporation	ec	0.015	0.56	0.052	3	0.182
Vinclozolin	120.0099	spray	ec	0.5	0.56	0.58	16	18.240
Zinc Phosphide	0	powder	pellet	0.8	0.27	0	1	1.080
County Total							**24529**	**23472.544**

Emissions are calculated for each pesticide active ingredient per county and then summed.

Example calculation for the emissions from Pendimethalin pesticide used in Allegany county.

$$\text{Emis}_{\text{Pendimethalin}} \quad 1257 \ \frac{\text{Lbs}}{\text{year}} \times 0 \ \frac{\text{lbs.}_{\text{VOC}}}{\text{lbs.}_{\text{AI}}} + \frac{1257}{(1-0.6)} \times 0.6 \times 0.56$$

$$\text{Emis}_{\text{Pendimethalin}} = 1495.83 \text{ lbs.}_{\text{VOC}} / \text{year}$$

$$\text{Emis}_{\text{Pendimethalin}} = 1495.83 \ / \ 2000 = 0.7479 \text{ tons}_{\text{VOC}} / \text{year}$$

$$\text{Emis}_{\text{Pendimethalin}} = \mathbf{0.7479} \text{ tons}_{\text{VOC}} / \text{year}$$

The remaining pesticides used in Allegany County are calculated in a similar manner.

Results:
Since the EPA has released new guidance on the calculation of agricultural pesticide application, the new methodology vastly differs from the method used in 1990. In the Maryland Ozone Precursor Inventory for 1990, Air and Radiation Management, MDE, September 1993, pesticide application for the state totaled 42 tons per day. This method assumed 90% volatilization of the AI. The method also assumed the inert carrier content to be 145% by weight of the AI. Another major assumption is 100% volatilization of the inert carrier.

Since publication, the accuracy of the old pesticide methodology has been debated by different groups. General thoughts from scholars and private industry is that the old methodology over predicts the volatility of the organics in the pesticide. The new methodology, presented here requires many assumptions and uses data that takes account for the different vapor pressures of individual active ingredients. This method, along with some general assumptions, estimated pesticide emissions at 8.7 tons per day for the state. The decrease is due to the change in method, along with a decline in pounds of pesticides applied in the state.
(While the state amount of overall pesticide used in 2011 was similar to 2008, the amount used in each county for 2011 varied base on the number of harvested acres in each county).

4.1.2.12 **Commercial/Consumer Solvent Use**

SCC: **24 60 100 000 (Personal Care)**
24 60 200 000 (Household)
24 60 400 000 (Automotive Aftermarket)
24 60 500 000 (Coatings and Related)
24 60 600 000 (Adhesives and Sealants)
24 60 800 000 (FIFRA - Regulated)
24 60 900 000 (Miscellaneous Products)

Description

Certain commercial/consumer uses of products containing volatile organics cannot easily be identified by questionnaires, surveys or other inventory procedures yielding locale-specific emission estimates. This category includes the following sources: household products, toiletries, aerosol products, rubbing compounds, windshield washing fluid, polishes, waxes, non-industrial adhesives, space deodorants, moth control agents and laundry detergents.

Pollutants

VOC and HAPs

Method and
Data Sources

The recommended emission factor that combines emissions from all these sources is 7.84 pounds VOC per person per year, from EIIP Volume III, Area Sources, Preferred and Alternate Methods (July, 1997). This emission factor excludes non-reactive VOC and takes into account more recent volatility levels based on product reformulation, than does AP-42, Fifth Edition. MDE used an activity level of 7 days a week and no seasonal adjustment factor as suggested in Table 5.8-1 in Procedures.

Activity
The U.S. Census Bureau reports and collects population statistics for the counties of Maryland. U.S. Census Bureau Internet address: (http://www.census.gov).

Emission Factors:
Commercial and Consumer Products (All) 7.84 lbs. $_{VOC}$/person/year

Original EPA Per Capita VOC Emission Factors [36, 37]		
Industry	**SCC**	**1996 Per Capita VOC Emission Factor (lbs. $_{VOC}$/person/year)**
Personal Care Products	2460100000	2.32
Household Products	2460200000	0.79
Automotive Aftermarket Products	2460400000	1.36
Coatings and Related Products	2460500000	0.95
Adhesives and Sealants	2460600000	0.57
FIFRA - Regulated Products	2460800000	178
Miscellaneous Products	2460900000	0.07
Total (All Commercial & Consumer Products) =		7.84

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

Federal regulations provide a 20 percent reduction in emissions from a 3.9 lbs. $_{VOC}$/person subset of the total commercial and consumer products category.

Commercial and consumer products are regulated by three separate category measures. The three control measures are; the original Federal regulations, effective, OTC Phase I controls, effective, and OTC Phase II controls effective. Each of the control measures are discussed briefly below:

Control Set 1: Federal regulations provide a 20 percent reduction in emissions from 3.9 lbs. $_{VOC}$/person subset of the total commercial and consumer products category. This results in following controls per commercial and consumer solvent subcategory:

[36] Source: Adapted from EPA, 1995
[37] Emission factors are based on usage and population data for 1990.

Per Capita VOC Emission Factors After Federal Rule

Product Category	SCC	Emission Factor (lbs. VOC/person/year)c
Personal Care Products	24601000000	2.08
Household Products	24602000000	0.63
Automotive Aftermarket Products	24604000000	1.13
Adhesives and Sealants	24606000000	0.51
FIFRA-Regulated Products	24608000000	1.68
Coatings and Related Products	24605000000	0.95
Miscellaneous Products	24609000000	0.07
Total (All Commercial & Consumer Products) =		7.06

Control Set 2: OTC Phase I rule was based on the five CARB consumer products rules and further emission reductions of 14.20 % beyond federal regulation provided in control set one above. This results in the following controls per commercial and consumer solvent subcategory:

Per Capita VOC Emission Factors After OCT Phase 1

Product Category	SCC	Emission Factor (lbs. VOC/person/year)c
Personal Care Products	24601000000	1.79
Household Products	24602000000	0.54
Automotive Aftermarket Products	24604000000	0.98
Adhesives and Sealants	24606000000	0.43
FIFRA-Regulated Products	24608000000	1.44
Coatings and Related Products	24605000000	0.82
Miscellaneous Products	24609000000	0.07
Total (All Commercial & Consumer Products) =		6.06

Control Set 3 : OTC Phase II rule was based on the five CARB consumer products rules and further emission reductions of 2.0 % beyond federal regulation provided in control set one above. This results in the following controls per commercial and consumer solvent subcategory:

Per Capita VOC Emission Factors After OCT Phase 2

Product Category	SCC	Emission Factor (lbs. VOC/person/year)c
Personal Care Products	24601000000	1.7529695

Household Products	24602000000	0.5268063
Automotive Aftermarket Products	24604000000	0.9571004
Adhesives and Sealants	24606000000	0.4269687
FIFRA-Regulated Products	24608000000	1.4084942
Coatings and Related Products	24605000000	0.8047066
Miscellaneous Products	24609000000	0.0581146
Total (All Commercial & Consumer Products)	=	5.9351604

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

The per capita equation used to estimate emissions from commercial and consumer solvents is:

$$E_{CC} = \frac{[\,POP_i \mathbf{x}\, EF_{CC}\,] - [\,(POP_i \mathbf{x}\, CS_{CC}) \times CE_{CC}\,]}{2000}$$

Where:

E_{CC} = VOC emissions in tons per day from commercial and consumer solvents
POP_i = 2011 population of county i (Appendix A)
EF_{CC} = VOC emission factor for commercial and consumer solvents (7.84 lbs. $_{VOC}$/person)
CS_{CC} = Controlled subset of commercial and consumer solvents (3.9 lbs. $_{VOC}$/person)
CE_{CC} = Control efficiency for controlled subset of commercial and consumer solvents (20%)

<u>2011 Sample Calculation All Commercial/Consumer Solvent Use (Anne Arundel County)</u>

$$E_{CC} = \frac{[\,(544{,}403^{38})\ \mathbf{x}\ (7.84^{39})\,] - [\,(544{,}403 \mathbf{x}\ 3.9^{40}) \times (0.20)^{41}\,]}{2000}$$

E_{CC} = 1,615.560 tons $_{VOC}$ per year

[38] 2011 Population data from U.S. Bureau of Census, Population Estimates Branch (see Appendices)
[39] Emission factor from EIIP Chapter 5 Commercial and Consumer Solvent Use
[40] EPA memo from John Sietz
[41] EPA memo from John Sietz

4.1.2.12.1 Barge, Tank, Tank Truck, Rail Car and Drum Cleaning

SCC: 24 61 160 000

The EPA explained to MDE staff that the agency has not developed an emission factor for this category. The EPA also stated that most barge, tank truck, rail car and drum cleaning is done by steam cleaning and the residue goes to industrial and public waste disposal treatment plants. It is impossible to separate this category's portion of the treatment plant emissions. EPA considers the emissions from this category to be insignificant. Emissions from this category are calculated for the appropriate facilities in the point source inventory.

4.1.3 BIOPROCESS EMISSIONS SOURCES

4.1.3.1 **Bakeries**

SCC: 23 02 050 000

Description

Bakeries emit VOC, primarily ethanol formed by yeast fermentation of bread or dough, during the baking process. Ethanol is emitted through a vent, along with combustion product gases. Large commercial bakeries are inventoried as point sources. In-store and neighborhood bakeries have lower emissions, and thus are considered area sources.

Pollutants

VOC

Method and Data Sources

MDE staff followed methodology described in an EIIP Area Source Category Method Abstract – Bakeries, dated June 1999 and an emission factor of 0.11 tons $_{VOC}$ per employee cited in an April 24, 1992 Technical Memorandum prepared by Radian Corporation for EPA. Applicable point source emissions (those within the same NAICS) taken from the MDE/ARMA registration files have been subtracted from the emissions calculated on a per employee basis; and are presented below.

Activity

Employee numbers were taken from County Business Patterns 2010 - Maryland, NAICS 311812, Bakery Products and 311811, Retail Bakeries (see Appendices). Some county employment data is represented by a letter code indicating a range for the number of employees for that NAICS. In this case the arithmetic average number of employees per letter code per county was adjusted so that the state total employment in a NAICS matched the sum of the number of employees reported per county.

Emission Factor
An emission factor of 0.11 tons $_{VOC}$ per employee cited in an April 24, 1992 Technical Memorandum prepared by Radian Corporation for EPA was utilized.

Point Source Adjustments

Bakery emissions from facilities identified as point sources (NAICS 311812 and 311811) were subtracted from the area source inventory to avoid double counting.

Adjustment for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial
Data for spatial allocation is not available for this source.

Temporal
A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

The equation used to estimate emissions from bakeries is:

Equation:

$$E_{BAK} = EF_{BAK} \times EMPj$$

Where:

E_{BAK} = VOC emissions from small bakeries in tons per year
EF_{BAK} = per employee emission factor for bakeries
EMPj = number of employees at small (less than 20 employees), bakeries in county j

Point Source Adjustments

$E_{BAK\text{-}ADJ}$ = EF_{BAK} **x** $EMPj_{Pt.\ Sources}$[42]

Where:
$E_{BAK\text{-}ADJ}$ = Point source adjusted bakery emissions
EF_{BAK} = Calculated area source bakery emissions
$EMPj_{Pt.\ Sources}$ = Point Source Adjustment was done by subtracting employment for Baltimore City related sources before calculating emissions.

2011 Sample Calculation for Bakery VOC Emissions (Baltimore City):

Employees in NAICS 311811 and 311812 in Baltimore City: 1,362 emp

Employees in Baltimore City Bakeries: 947.16

$EMPj_{Pt.\ Sources}$ = 1,362 - 947.16 emp

E_{BAK} = 220 **x** 510.82 lb.s $_{VOC}$ per person per year

E_{BAK} = 112,380 lb.s $_{VOC}$ per person per year

E_{BAK} = (112,380 / 2000) tons $_{VOC}$ per year

E_{BAK} = 56.19 tons $_{VOC}$ per year

[42] Point Source Reduction from MDE ARMA registration files

4.1.3.2 **Breweries**

SCC: 23 02 070 001

Description

During the fermentation process, breweries emit ethanol and other VOCs. Although large-scale commercial breweries have been inventoried as point sources, there are microbreweries and brewpubs that emit lower levels of VOCs and therefore must be inventoried as area sources. These smaller breweries emit most of their VOCs from the fermentation room, not the brew kettle as is the case with the large breweries.

Pollutants

VOC

Method and Data Sources

MDE/ARMA staff surveyed small brewpubs and microbreweries in Maryland.

Activity
The survey questionnaire asked the brewing facilities to provide MDE/ARMA with the amount of barrels brewed per month for the calendar year 2011. For those facilities that reported only annual production amounts, an average monthly value was used.

Emission Factor
Emissions from the small breweries were calculated using an emission factor cited in a February 5, 1992 Technical Memorandum prepared by Radian Corporation for EPA. This emission factor is 56.743 lbs. $_{VOC}$ per 1000 barrels produced. One barrel equals 31 gallons. Note: Emf conversion is: 56.743 lb VOC/1000 barrels = 0.05674 lb/barrel = 0.0018303 lb/gal.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial
Data for spatial allocation is not available for this source.

Temporal
A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

The equation used to estimate emissions from breweries is:

$$E_{BREW} = \frac{EF_{BREW} \mathbf{x} BPj}{2000}$$

Where:

E_{BREW} = VOC emissions from small breweries in tons per year
EF_{BREW} = emission factor for small breweries
BPj = 2011 beer production in barrels

<u>2011 Sample Calculation for Small Brewery VOC Emissions (Baltimore City)</u>:

Number barrels produced by microbreweries in Baltimore City = 40,394.85

$$E_{BREW} = \frac{0.05674 \mathbf{x} 40{,}394.85}{2000}$$

E_{BREW} = 1.146E-00 tons $_{VOC}$ per year

4.1.3.3 **Wineries**

SCC: 23 02 070 005

Description

Ethanol emissions from wineries occur during the fermentation process. The emissions vary, depending upon the type of wine (red vs. white), the fermentation temperature and the sugar content of the grapes used.

Pollutants

VOC

Method and Data Sources

MDE used the methods and procedures documented in AP-42[43], Chapter 12, Beverages, Section 2, Wines and Brandies dated September 1995. AP42 Chapter 9.12.2

Activity

The U.S. Department of the Treasury's Alcohol and Tobacco Tax and Trade Bureau, State of Maryland Comptrollers Office, and direct survey of most of Maryland's wineries revealed that approximately 351,819 gallons of wine was produced in 2011. The survey suggests that 191,088 gallons of white and 160,731 gallons of red wine were actually produced.

Emission Factor

Table 9.12.2-1 of AP-42 shows that ethanol emissions are 1.8 lbs. $_{VOC}$ per 1000 gallons of white wine fermented and 4.6 lbs. $_{VOC}$ per 1000 gallons of red wine fermented.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

No controls are available for this source category.

[43] AP42, Chapter 9.12.2: Food and Agricultural Industries, Beverages, Wines and Brandies

Spatial and Temporal Allocations

Spatial
Data for spatial allocation is not available for this source.

Temporal
A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

Emission Factors:	**red =**	**0.0046**	**lb.voc/gal.**
	white =	**0.0018**	**lb.voc/gal.**

White wine EMtotal = (191,088 gal. x **0.0018 lb.voc/gal.) / 2000**
White wine EMtotal = 0.172 tons of ethanol

Red wine EMtotal = (160,731 gal. x **0.0046 lb.voc/gal.) / 2000**
Red wine EMtotal = 0.370 tons of ethanol

Using the above figures, the production of wine by all Maryland wineries in 2011 resulted in the production of 0.542 tons of ethanol.

4.1.3.4 **Distilleries**

Description

Ethanol emissions are the largest component of the VOCs emitted from distilleries. Distilleries produce both grain alcohol for industrial and fuel purposes, and distilled spirits such as whiskey and brandy for consumption purposes. The emissions points in the distilled spirits manufacturing process are likely to be the same as in breweries and wineries, with the aging process as an additional source of emissions. During the aging process, ethanol and water seep through the wooden barrels used to age whiskey and evaporate into the air. Aging and barrel emptying are the major sources of VOC emissions from whiskey production.

Pollutants

VOC

Method and Data Sources

MDE staff indicated that no distilleries below the 10 ton per year point source cutoff operated in the inventory area during 2011. Fugitive VOC emissions from the aging process at large distillery operations can be substantial and will be included in the point source inventory.

4.1.4 CATASTROPHIC/ACCIDENTAL RELEASES

4.1.4.1 **Oil Spills**

SCC: 28 30 000 000

Description

Oil spills involve oil tanker accidents, tanker truck accidents, and spills and blowouts from oil rigs or pipelines in coastal and inland areas. Because a wide range of fuel types may be spilled, the nature and quantity of emissions can vary. Emissions are also influenced by the clean-up procedure and by dispersion and weathering processes.

Oil spill evaporation produces local VOC emissions. If spills catch fire, additional SO2, CO, CO2, PM, NOx and VOC emissions may result. Other potentially toxic chemical compounds may also be released as a result of chemical cleanup

Pollutants

VOC

Method and Data Sources

Activity

Data on oil spills in Maryland were obtained from MDE's Oil Control Program. They provided MDE/ARMA staff a yearly report of all oil spills that occurred in Maryland during 2011. Spills around Maryland totaled to about 54,373 gallons.

Emission Factor

MDE staff used an emission factor recommended to the Metropolitan Washington Council of Governments by E.H. PECHAN and Associates, Inc., the contractor used by MWCOG to prepare their 1990 base year inventory. This emission factor was based on a California Air Resources Board (CARB), study of air emissions from large oil spills (over 10 million gallons of oil). Based on this study, a range of evaporation estimates for reactive organic gases was found to be between 5,500 and 13,000 tons. Using this information, an average emission factor was calculated to be 0.0000925 tons VOC per gallon of oil spilled.

Point Source Adjustments

No point source adjustments were made.

Adjustment for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

The equation used to estimate emissions from oil spills:

$$E_{\text{Oil Spills}} = EF_{\text{Oil Spills}} \mathbf{x} \text{ GOSj}$$

Where:

$E_{\text{Oil Spills}}$ = VOC emissions from oil spills in tons $_{\text{VOC}}$ per year
$EF_{\text{Oil Spills}}$ = tons of pollutant per gallon of oil spilled
GOSi = gallons of oil spilled in county I

<u>2011 Sample Calculation for Oil Spill VOC Emissions (Prince George's County)</u>:

Annual Emissions:
Number gallons oil spilled in Prince George's County 2011: **5,958** gallons

$$E_{\text{Oil Spills}} = (0.0000925) \mathbf{x} (5{,}958)$$

$$E_{\text{Oil Spills}} = 0.5511 \text{ tons}_{\text{VOC}} \text{ per year}$$

4.1.4.2 **Leaking Underground Storage Tanks / Soil Remediation**

SCC: 26 60 000 000

Description

Many underground storage tanks (USTs) are over 15 years old and are constructed of steel, which may rust over time. The underground piping connected to these tanks also has the potential to leak. Leaking USTs (leaking underground storage tank sites or LUST sites) are of concern because they may result in the contamination of drinking water, subsurface soils, and ground and surface water, and may emit toxic and/or explosive vapors. The contaminated soil and water may also emit VOC.

Pollutants

VOC

Method and Data Sources

Activity

Emission calculation methods were taken from EIIP, AREA SOURCE CATEGORY METHOD ABSTRACT - REMEDIATION OF LEAKING UNDERGROUND STORAGE TANKS, 2001. The numbers of LUST sites by county were obtained from MDE's Oil Control Program. No seasonal variation was assumed. Each remediation event takes an average of 30 days; during this period emissions are released.

Emission Factor

An emissions factor of 28 lbs of VOC per day per site was used.

Point Source Adjustments

No point source adjustments were made.

Adjustment for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial
Data for spatial allocation is not available for this source.

Temporal
A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

$$E_{LUST} = \frac{LS1_j \textbf{ x } EF \textbf{ x } 30 \text{ day}}{2000 \text{ lb./ton}}$$

Where:

E_{LUST} = VOC emissions in tons per year from leaking underground storage tanks

$LS1_j$ = number of remediation site(s) in county j

EF = emissions factor

<u>2011 Sample Calculation for Leaking Underground Storage Tanks (Anne Arundel County)</u>

No seasonal variation assumed

$$E_{LUST\text{-}AA} = \frac{2 \textbf{ x } 28_{VOC} \text{ lbs./day } \textbf{x } 30 \text{ day}}{2000 \text{ lb./ton}}$$

$E_{LUST\text{-}AA}$ = 0.84 tons $_{VOC}$ per year

4.1.5 SOLID WASTE DISPOSAL, TREATMENT, AND RECOVERY

4.1.5.1 On-site Incineration

SCC: 2601020000

Description

On-site incineration is the confined burning of waste on a small scale by institutions such as hospitals, nursing homes, veterinary offices, funeral homes and laboratories. Large-scale incineration is included in the point source inventory.

Pollutants

VOC, NOx, SOx, CO, PM_{10}, $PM_{2.5}$, and HAPS,

Method and Data Sources

In Maryland incinerators are regulated under COMAR 26.11.08. Maryland began regulating incinerators for control of particulates in the 1970's. In AQCRs III and IV single chamber incinerators, the type that would be used for on-site residential incineration, were banned. All such incinerators were rendered inoperative under the direction of the Maryland Department of the Environment (MDE). Over 1700 small incinerators were eliminated under this requirement.

In the other Maryland counties included in the Washington, D.C. nonattainment area, incineration of trash in on-site incinerators is prohibited except in areas where public trash collection is not provided.

COMAR 26.11.08.09 now requires all incinerators to obtain a permit to operate and any person who owns or operates an incinerator must obtain certification from MDE and renew the certification annually.

MDE/ARMA maintains a registry of all incinerators within the State. Because of the requirements prohibiting single chamber incinerators, the requirement for a permit to operate, and the operator certification requirements, staff used the sum of the incinerators in the registry as representing the total area source emissions from incinerators of all types emitting less than 10 tons/VOC, 100 tons/yr CO and 50 tons per year NO_x. Incinerators from the registry with emissions above these thresholds are included in the point source inventory.

No seasonality is applied. The emission factor is chosen by type of incinerator: waste, pathological, hazardous, industrial, special medical, sewage sludge and municipal waste combustors. The burn rate is determined by stack test or AP-42. Hours of operation and tons of waste per day are supplied by the operator.

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

4.1.5.2 Publicly Owned Treatment Works (POTWs)

SCC: 26 30 020 000

Description

Wastewater is usually collected and treated at a public waterworks facility to be filtered and reused or discharged into surrounding waterways. While the wastewater is held and being treated VOCs are released into the air due to contaminates and byproducts in the water.

Pollutants

VOC

Method and Data Sources

The emissions from these facilities were calculated based on the method described in EPA EIIP II Chapter 5 Section 5.1.

Activity

The amount of actual flow for each POTW in Maryland was supplied by the MDE's Wastewater Management Administration (see Appendices). MDE staff multiplied this amount by the emission factor listed to get VOC emissions from each POTW. The individual POTW emissions were then totaled by county.

Emission Factor

EPA and ERTAC supplied MDE with a new emission factor of 0.44 pounds $_{VOC}$ per million gallons of actual flow of wastewater discharged.

Point Source Adjustments

VOC stack emissions in the Air Management registration files from the Patapsco, Western Branch, and Back River Wastewater Treatment Plants were subtracted from the totals below.

Adjustment for Controls

A seasonal adjustment factor of 1.4 was used when calculating ozone season or daily emissions not yearly.

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

The equation used to estimate yearly emissions from POTWs is:

$$E_{POTWY} = \frac{ADF_{IJ} \textbf{ x } EF_{POTW} \textbf{ x } \textbf{365 days}}{2000}$$

For seasonal emissions:

$$E_{POTWS} = \frac{ADF_{IJ} \textbf{ x } EF_{POTW} \textbf{ x } SAF_{POTW}}{2000}$$

Where:

E_{POTWY}	=	VOC emissions in tons $_{VOC}$ per year from POTWs
ADF_{IJ}	=	Actual daily flow into POTW i in county j
EF_{POTW}	=	VOC emission factor[44] for POTWs
SAF_{POTW}	=	Seasonal adjustment factor[45] for peak ozone season which is 1.4
		Plant operation is 365 days a year

<u>2011 Sample Calculation for POTW VOC Emissions (Howard County)</u>:
Little Patuxent Treatment Plant statistics[46]:
Actual daily flow (MGD)[47]: 15.755

$$E_{POTWY} = \frac{(15.755) \textbf{ x } (0.44 \text{ lbs.}_{VOC} / \text{gal}) \textbf{ x } 365 \text{ days}}{2000}$$

$$E_{POTWY} = 1.27 \text{ tons}_{VOC} / \text{year}$$

[44] Emission factor taken from Procedures, Section 3.5.1
[45] Seasonal adjustment factor taken from Procedures, Table 5.8.1
[46] Supplied by the Maryland Water Management Administration (see Appendices)
[47] MGD : Million Gallons per Day

4.1.5.3 **Open Burning – Land Clearing Debris**

SCC: 26 10 000 500

Description

Open burning of land clearing debris refers to the clearing of land for new construction and the burning of organic material (i.e., trees, shrubs and other vegetation). The clearing of land for the construction of new buildings and highways often results in debris consisting of trees, shrubs, and brush. This debris may be burned in place but it is usually collected in piles for burning. The burning of land clearing wastes may be practiced by private individuals, corporations, and government agencies (e.g., highway construction department). There are no federal laws restricting the open burning of land clearing wastes, although state or local laws may exist.

Residential open burning without a permit is prohibited under Maryland law (COMAR 26.11.07), where trash and leaf collection is available. The basic difference between the regulation as it applies to counties in AQCRs III and IV and the rest of the state is the requirements under which the burn takes place, i.e., minimum setbacks from property lines, etc. In the more rural counties, areas with no available trash collection are more prevalent. MDE adopted a regulation that prohibits open burning during the peak ozone period (June to August). The seasonal prohibition only affects those counties that lie within serious and severe ozone nonattainment areas. Certain exemptions must be in place however so as not to adversely affect agriculture or restrict fire training and recreational activities. Commercial open burning without a permit is prohibited in Maryland.

Pollutants

VOC, NOx, SOx, CO, PM_{10} and $PM_{2.5}$

Method and Data Sources

The method used to calculate emissions, is presented in EIIP[48], Chapter 16, Open Burning (Revised Final 2001).

Activity

The number of acres disturbed by residential, non-residential and roadway construction are estimated and then these values are added together to obtain a county-level estimate of total acres disturbed by land-clearing. County-level emissions from land clearing debris are then calculated by multiplying the total acres disturbed by construction by a weighted loading factor and emission factor.

The BELD database in BEIS was used to determine the number of acres of hardwoods, softwoods, and grasses in each county. Average loading factors were weighted according to the percent contribution of each type of vegetation class to the total land area for each county. The loading factors for slash hardwood and slash softwood were further adjusted

[48] Emission Inventory Improvement Program

by a factor of 1.5 to account for the mass of tree that is below the soil surface that would also be subject to burning once the land is cleared.

Fuel loading factors are as follows:

Fuel Type	Fuel Load Factor (tons/acre)	Adjusted Load Factor (tons/acre)
Hardwood	99	148.5
Softwood	57	85.5
Grass	4.5	4.5

Average fuel loading factors were calculated as follows:

$$LF_{OB-LCD-COi} \frac{(Acres_{HW-COi} \times LF_{Adj-HW}) + (Acres_{SW-COi} \times LF_{Adj-SW}) + (Acres_{GR-COi} \times LF_{Adj-GR})}{Acres_{TOT-COi}}$$

$LF_{OB-LCD-COi}$	=	Average Load Factor in County i
$Acres_{HW-COi}$	=	Acres of hardwood in County i from BELD database
LF_{Adj-HW}	=	Adjusted Load Factor for Hardwood
$Acres_{SW-COi}$	=	Acres of softwood in County i from BELD database
LF_{Adj-SW}	=	Adjusted Load Factor for Softwood
$Acres_{GR-COi}$	=	Acres of grasses in County i from BELD database
LF_{Adj-GR}	=	Adjusted Load Factor for Grasses
$Acres_{TOT-COi}$	=	Total Land Acres in County i

Emission Factors [49]

Emission factors in lbs. /ton were taken from AP-42 Table 2.5-1, Emission Factors for Open Burning of Municipal Refuse and are listed below:

VOC	11.6	Lbs. $_{VOC}$/ ton
SOx	0.0	Lbs. $_{SOx}$/ ton
CO	169	Lbs. $_{CO}$/ ton
PM_{10}	17	Lbs. $_{PM10}$/ ton
$PM_{2.5}$	17	Lbs. $_{PM2.5}$/ ton
NOx	5	Lbs. N_{NOx}/ ton

Ozone Season Daily (OSD) emissions calculated by multiplying annual emissions by 0.25 then dividing by 92.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

[49] Emissions factors for VOC NOx, CO, SO_2, PM_{10} and $PM_{2.5}$ were obtained from AP-42 Table 2.5-1.

Adjustments for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

Annual Emissions

$$E_{OB-LCD-Ann} = \frac{AD_{R\text{-}NR\text{-}Road} \times LF_{OB-LCD-COi} \times EF_{OB\,i}}{2000}$$

$E_{OB-LCD-Ann}$ = Annual emissions from open burning of land clearing debris
$AD_{R\text{-}NR\text{-}Road}$ = Acres disturbed from Residential, Non-residential and Roadway construction in the county
$LF_{OB-LCD-COi}$ = Average Load Factor in County i
$FL_{HW\text{-}SW\text{-}G}$ = Fuel loading factor for hardwoods, softwoods, and grasses
$EF_{OB\,i}$ = Open burning emission factor for pollutant i in lbs. / ton

Ozone Season Daily Emissions

$$E_{OB-LCD-Day} = \frac{E_{OB-LCD-Ann}}{4 \times 92}$$

$E_{OB-LCD-Day}$ = Ozone Season Daily emissions from open burning
$E_{OB-LCD-Ann}$ = Annual emissions from open burning of land clearing debris
4 = Number of seasons in the year
92 = Days in the season

4.1.5.4 **Open Burning – Residential Municipal Solid Waste**

SCC: 26 10 030 000

Description

Open burning is the unconfined burning of wood, leaves, land clearing debris, household waste, and agricultural crop waste. Household waste is often referred to as residential municipal solid waste (MSW); a term for nonhazardous refuse produced by households (e.g., paper, plastics, metals, wood, glass, rubber, leather, textiles, and food wastes).

Open burning without a permit is prohibited in Maryland where trash and leaf collection is available, (COMAR 26.11.07). The basic difference between the regulation as it applies to counties in AQCRs III and IV and the rest of the state is the requirements under which the burn takes place, i.e., minimum setbacks from property lines, etc. In the more rural counties, areas with no available trash collection are more prevalent. MDE adopted a regulation that prohibits open burning during the peak ozone period (June to August). The seasonal prohibition only affects those counties that lie within serious and severe ozone nonattainment areas. Certain exemptions must be in place however so as not to adversely affect agriculture or restrict fire training and recreational activities.

Pollutants

VOC, NOx, SOx, CO, PM_{10}, $PM_{2.5}$, and HAPs

Method and
Data Sources

The method used to calculate emissions is presented in a study/survey conducted by the Mid-Atlantic/Northeast Visibility Union (MANE-VU), titled "Open Burning in Residential Areas Emissions Inventory Development Report."[50]

Activity

The purpose of the survey was to obtain data for developing activity estimates and control information (e.g., bans on burning) that would form the basis of an improved open burning emission inventory for Mid-Atlantic/Northeast Visibility Union (MANE-VU) states and tribes for the year 2002. But for 2011, the percentages used to calculate emissions are the same; the emissions increase or decrease due to the estimated number of households that burn and the amount of material burned.

A rule effectiveness (RE) survey was also taken to estimate controlled emissions for areas under restriction. Household waste burning surveys were completed for 72 respondents or jurisdictions, while yard waste surveys were conducted for 181 respondents. The respondents for this survey were typically local fire wardens or chiefs. Rule effectiveness surveys related to residential MSW rules were conducted for 49 respondents, while RE

[50] Open Burning in Residential Areas Emissions Inventory Development Report, Prepared by E.H. PECHAN & Associates, Inc. for the Mid-Atlantic/Northeast Visibility Union, dated January 31, 2004.

surveys for yard waste burning rules were performed for 51 respondents. In obtaining survey responses, PECHAN collected activity data and control information for areas classified as urban, suburban, and rural, or a combination of these designations (defined using data from the 2000 U.S. Census). PECHAN also developed a control database for each open burning category that describes the recommended control efficiency (CE) and rule penetration (RP) values by state and county, and by sub-county, where applicable.

Open burning activity estimates recorded from the survey were used directly to estimate emissions for the surveyed jurisdictions. For the non-surveyed areas, including tribal lands, the default activity data derived from all survey responses were applied. Households are defined as detached single-family unit dwellings, and were updated by using the 2011 U.S. Census.

Emission Factors

Emission factors in lbs/ton total mass were taken from AP-42 Table 2.5-1 Emission Factors for Open Burning of Municipal Refuse and from a 1997 EPA research paper on open burning[51] are listed below:

SCC	Type of Waste	PM2.5 lb/ton	PM10 lb/ton	VOC lb/ton	NOX lb/ton	SO2 lb/ton	CO lb/ton
2610030000	**HH MSW**	**34.8**	**38**	**8.56**	**6**	**1**	**85**
2610000100	Leaf Waste	22	22	28	6.2	0.76	112
2610000400	Brush Waste	15.21	19.73	19	5	1.66	140

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

If an area has controls or prohibitions on residential burning, controlled emissions were calculated from uncontrolled emissions using the following equation:

$E_c = E_{uc} * [(1-(CE)(RP)(RE)]$

[51] EPA. 1997. Evaluation of Emissions from the Open Burning Of Household Waste in Barrels. EPA-600/R-97-134a. U.S. Environmental Protection Agency, Control Technologies Center./ Research Triangle Park, North Carolina.

Where:

E_c	=	Controlled area source emissions
E_{uc}	=	Uncontrolled area source emissions
CE	=	% Control efficiency varied 0 to 100%
RP	=	% Rule penetration varied 0 to 100%
RE	=	% Rule effectiveness was 96.8%

The following sections describe how values for CE, RP and RE were derived from surveys.

Rule Effectiveness

PECHAN evaluated differences in RE between rural/suburban and urban areas, as well as differences in RE for MSW and yard waste burning. Although one may expect that RE would be higher for urban than for suburban or rural areas, ANOVA of the survey results from these geographic subdivisions, as well as for the different open burning categories, did not show that RE values were drawn from distinct populations. Therefore, the final selection of RE reflects a value for all areas and all burning categories.

There were a total of 26 RE survey responses that included information on the number of violating households. To calculate RE, PECHAN used the number of households violating the rule, and the number of households expected to perform open burning for areas in the region where there is no rule (i.e., # households x fraction of open burning households by region from survey).

The RE values obtained from the survey responses will be used for the specific State or jurisdiction surveyed. Non-surveyed areas could not be assigned a jurisdiction-specific RE because no responses were obtained. PECHAN did not develop state specific RE value. They believed that local jurisdictions in individual states implemented their rules the same as local jurisdictions in the MANE-VU region. To estimate a default RE value for the remaining areas, the survey data were statistically analyzed. After evaluating the data using the Census 2000 data, a mean value of 96.8 percent reflected the best estimator of central tendency. As such, PECHAN applied a rule effectiveness of 96.8 percent to all areas and for both MSW and yard waste burning (PECHAN, 2002b).

Control Efficiency and Rule Penetration

For those areas identified to have a control, CE is assumed to be 100 percent (since the control is typically a ban on burning activity). For MSW burning, with the exception of Pennsylvania, PECHAN assigned 100 percent CE and 100 percent RP to urban and suburban areas in the MANE-VU region (i.e., even if the state did not have a statewide ban on burning). In Pennsylvania, unless a jurisdiction or county (e.g., Allegheny County) was determined via survey to have a ban, it will be assumed that suburban and rural areas allow open burning. For yard waste burning, PECHAN assigned 100 percent CE and RP to all urban areas in the MANE-VU region. Yard waste emissions calculated for suburban and urban areas were assumed to be uncontrolled, unless the survey data or other statewide or local control information indicated otherwise. For municipal yard waste burning areas were assumed to either perform this activity

and have associated emissions, or did not conduct burns and therefore were assigned zero emissions.

In determining annual emissions for those areas with a seasonal ban, PECHAN adjusted the RP by the length of the seasonal ban relative to the entire year. The RP value also depends on how the time period of the ban overlaps with the activity profile for the specific category of burning. For example, for brush waste burning, the survey data revealed an average activity profile as follows: Winter–20%; Spring–46%; Summer–6%; and Fall–28%. So, for an area that has a brush burning ban in the summer, although some percentage of burning is likely to be prevented during this season, we assume that 2 percent of the summer season brush burning in August is delayed until September when burning is permitted, resulting in an RP of 4 percent to apply to annual brush waste burning emissions. As mentioned in the discussion of temporal allocation profiles, this also has an affect on the monthly activity profile. A summer RP value of 4 percent would result in a revised temporal allocation profile to be: Winter–20%; Spring–46%; Summer–4%; and Fall–30%.

Control Percentages used for each county:

STATE CO	SCC	RE	RP	CE
24001	2610030000	96.80%	82.61%	82.61%
24003	2610030000	96.80%	93.62%	100%
24005	2610030000	96.80%	94.80%	100%
24009	2610030000	96.80%	60.29%	100%
24011	2610030000	96.80%	28.57%	28.57%
24013	2610030000	96.80%	100%	100%
24015	2610030000	96.80%	62.50%	100%
24017	2610030000	96.80%	68.75%	100%
24019	2610030000	96.80%	33.33%	33.33%
24021	2610030000	96.80%	71.88%	100%
24023	2610030000	96.80%	14.29%	14.29%
24025	2610030000	96.80%	80%	100%
24027	2610030000	96.80%	92.68%	100%
24029	2610030000	96.80%	40%	40%
24031	2610030000	96.80%	98.31%	100%
24033	2610030000	96.80%	100%	100%
24035	2610030000	96.80%	25%	100%
24037	2610030000	96.80%	40%	40%
24039	2610030000	96.80%	50%	50%
24041	2610030000	96.80%	33.33%	33.33%
24043	2610030000	96.80%	0%	0%
24045	2610030000	96.80%	94.12%	94.12%
24047	2610030000	96.80%	75%	75%
24510	2610030000	96.80%	0%	0%

Spatial and Temporal Allocations

Spatial

PECHAN collected activity data and control information for areas classified as urban, suburban, and rural, or a combination of these designations (defined using data from the 2000 U.S. Census).

Temporal

Activity estimates and associated emissions are calculated on an annual basis. PECHAN proposes the following temporal allocation profiles to represent monthly, weekly, and daily activity profiles by SCC (see Tables II-2 through II-5). The monthly activity profiles were developed based on data obtained from the survey. The weekly and weekday/weekend profiles were developed based on engineering judgment. These profiles will be applied to annual activity for all areas of MANE-VU (i.e., variations in regional, State, or tribal areas are not accounted for). Also, a SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Temporal Allocation Profile Formats (monthly)

	Month											
SCC	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2610030000	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083
2610000400	0.067	0.067	0.153	0.153	0.153	0.020	0.020	0.020	0.093	0.093	0.093	0.067
2610040400	0.067	0.067	0.153	0.153	0.153	0.020	0.020	0.020	0.093	0.093	0.093	0.067
2610000100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.333	0.333	0.333	0.000

Temporal Allocation Profile Formats (weekly)

SCC	Day of Week						
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
2610030000	0.111	0.111	0.111	0.111	0.111	0.222	0.222
2610000400	0.111	0.111	0.111	0.111	0.111	0.222	0.222
2610040400	0.200	0.200	0.200	0.200	0.200	0.000	0.000
2610000100	0.111	0.111	0.111	0.111	0.111	0.222	0.222

Temporal Allocation Profile Formats (daily; weekday)

	Weekday Hour											
SCC	**0100**	**0200**	**0300**	**0400**	**0500**	**0600**	**0700**	**0800**	**0900**	**1000**	**1100**	**1200**
2610030000	0	0	0	0	0	0	0.071	0.071	0.071	0.071	0.071	0.071
2610000400	0	0	0	0	0	0	0.071	0.071	0.071	0.071	0.071	0.071
2610040400	0	0	0	0	0	0	0.071	0.071	0.071	0.071	0.071	0.071
2610000100	0	0	0	0	0	0	0.071	0.071	0.071	0.071	0.071	0.071

	Weekday Hour											
SCC	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**	**2300**	**0000**
2610030000	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0
2610000400	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0
2610040400	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0
2610000100	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0

Temporal Allocation Profile Formats (daily; weekend day)

	Weekend Day Hour											
SCC	**0100**	**0200**	**0300**	**0400**	**0500**	**0600**	**0700**	**0800**	**0900**	**1000**	**1100**	**1200**
2610030000	0	0	0	0	0	0	0.071	0.071	0.071	0.071	0.071	0.071
2610000400	0	0	0	0	0	0	0.071	0.071	0.071	0.071	0.071	0.071
2610040400	0	0	0	0	0	0	0.071	0.071	0.071	0.071	0.071	0.071
2610000100	0	0	0	0	0	0	0.071	0.071	0.071	0.071	0.071	0.071

	Weekend Day Hour											
SCC	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**	**2300**	**0000**
2610030000	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0
2610000400	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0
2610040400	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0
2610000100	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0

Emissions
Calculation

Emissions were calculated at a census tract level and summed over a county for county level emissions. A county level sample emission calculation will not be presented here, however the equations for a particular census tract are presented below. All of the census tracts in a county would then be summed for county level emission estimates.

The equation for estimating the mass of waste burned is:

$$Wtm_{SW} = HH * Bt * M$$

Where:
Wt_{MSW} = Mass of waste burned per time period
HH = Number of households that burn (Question 1, Part 2 of survey)
Bt = Number of burns per time period (Question 3, Part 2)
M = Mass of waste per burn (Question 5, Part 3)

Uncontrolled emissions were then calculated using the following equation:

$$E_{UNC} = Wt_{MSW} * EF$$

Where:
E_{UNC} = Uncontrolled area source emissions
Wt_{MSW} = Mass of waste burned per time period
EF = Emission factor per pollutant

Controlled emissions were then calculated using the following equation:

$$E_C = E_{UNC} * [(1-(CE)(RP)(RE)]$$

where: E_C = Controlled area source emissions
E_{UNC} = Uncontrolled area source emissions

4.1.5.5 **Open Burning – Residential Yard Waste**

SCC: 26 10 000 100 (Leaf Debris)
SCC: 26 10 000 400 (Brush Debris)

Description

Open burning is the unconfined burning of wood, leaves, land clearing debris, household waste, and agricultural crop waste. Household waste often referred to as residential municipal solid waste (MSW), is a term for nonhazardous refuse produced by households (e.g., paper, plastics, metals, wood, glass, rubber, leather, textiles, and food wastes).

Open burning without a permit is prohibited in Maryland where trash and leaf collection is available, COMAR 26.11.07. The basic difference between the regulation as it applies to counties in AQCRs III and IV and the rest of the state is the requirements under which the burn takes place, i.e., minimum setbacks from property lines, etc. In the more rural counties, areas with no available trash collection are more prevalent. MDE adopted a regulation that prohibits open burning during the peak ozone period (June to August). The seasonal prohibition only affects those counties that lie within serious and severe ozone nonattainment areas. Certain exemptions must be in place however so as not to adversely affect agriculture or restrict fire training and recreational activities.

Pollutants

VOC, NOx, SOx, CO, PM_{10}, $PM_{2.5}$, and HAPs

Method and Data Sources

The method used to calculate emissions is presented in a study/survey conducted by the Mid-Atlantic/Northeast Visibility Union (MANE-VU), titled "Open Burning in Residential Areas Emissions Inventory Development Report."[52]

Activity

The purpose of the survey was to obtain data for developing activity estimates and control information (e.g., bans on burning) that would form the basis of an improved open burning emission inventory for Mid-Atlantic/Northeast Visibility Union (MANE-VU) states and tribes for the year 2002. But for 2011, the percentages used to calculate emissions are the same; the emissions increase or decrease due to the estimated number of households that burn and the amount of material burned.

A rule effectiveness (RE) survey was also taken to estimate controlled emissions for areas under restriction. Household waste burning surveys were completed for 72 respondents or jurisdictions, while yard waste surveys were conducted for 181 respondents. The respondents for this survey were typically local fire wardens or chiefs. Rule effectiveness surveys related to residential MSW rules were conducted for 49 respondents, while RE

[52] Open Burning in Residential Areas Emissions Inventory Development Report, Prepared by E.H. PECHAN & Associates, Inc. for the Mid-Atlantic/Northeast Visibility Union, dated January 31, 2004.

surveys for yard waste burning rules were performed for 51 respondents. In obtaining survey responses, PECHAN collected activity data and control information for areas classified as urban, suburban, and rural, or a combination of these designations (defined using data from the 2000 U.S. Census). PECHAN also developed a control database for each open burning category that describes the recommended control efficiency (CE), rule penetration (RP) values by state per county, and by sub-county, where applicable.

Open burning activity estimates recorded from the survey were used directly to estimate emissions for the surveyed jurisdictions. For the non-surveyed areas, including tribal lands, the default activity data derived from all survey responses were applied. Households are defined as detached single-family unit dwellings, and were updated by using the 2011 U.S. Census.

Emission Factors

Emission factors in lbs/ton total mass were taken from AP-42 Table 2.5-1 Emission Factors for Open Burning of Municipal Refuse and from a 1997 EPA research paper on open burning[53] are listed below:

SCC	Type of Waste	PM2.5 lb/ton	PM10 lb/ton	VOC lb/ton	NOX lb/ton	SO2 lb/ton	CO lb/ton
2610030000	HH MSW	34.8	38	8.56	6	1	85
2610000100	Leaf Waste	22	22	28	6.2	0.76	112
2610000400	Brush Waste	15.21	19.73	19	5	1.66	140

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

If an area has controls or prohibitions on residential burning, controlled emissions were calculated from uncontrolled emissions using the following equation:

$E_c = E_{uc} * [(1-(CE)(RP)(RE)]$

[53] EPA. 1997. Evaluation of Emissions from the Open Burning Of Household Waste in Barrels. EPA-600/R-97-134a. U.S. Environmental Protection Agency, Control Technologies Center / Research Triangle Park, North Carolina

Where:

E_c	=	Controlled area source emissions
E_{uc}	=	Uncontrolled area source emissions
CE	=	% Control efficiency varied 0% to 100%
RP	=	% Rule penetration varied 0% to 100%
RE	=	% Rule effectiveness 96.8%

The following sections describe how values for CE, RP, and RE were derived from surveys.

Rule Effectiveness

PECHAN evaluated differences in RE between rural/suburban and urban areas, as well as differences in RE for MSW and yard waste burning. Although one may expect that RE would be higher for urban than for suburban or rural areas, ANOVA of the survey results from these geographic subdivisions, as well as for the different open burning categories, did not show that RE values were drawn from distinct populations. Therefore, the final selection of RE reflects a value for all areas and all burning categories.

There were a total of 26 RE survey responses that included information on the number of violating households. To calculate RE, PECHAN used the number of households violating the rule, and the number of households expected to perform open burning for areas in the region where there is no rule (i.e., # households x fraction of open burning households by region from survey).

The RE values obtained from the survey responses will be used for the specific State or jurisdiction surveyed. Non-surveyed areas could not be assigned a jurisdiction-specific RE because no responses were obtained. PECHAN did not develop state specific RE value. They believed that local jurisdictions in individual states implemented their rules the same as local jurisdictions in the MANE-VU region. To estimate a default RE value for the remaining areas, the survey data were statistically analyzed. After evaluating the data using the Census 2000 data, a mean value of 96.8 percent reflected the best estimator of central tendency. As such, PECHAN applied a rule effectiveness of 96.8 percent to all areas and for both MSW and yard waste burning (PECHAN, 2002b).

Control Efficiency and Rule Penetration

For those areas identified to have a control, CE is assumed to be 100 percent (since the control is typically a ban on burning activity). For MSW burning, with the exception of Pennsylvania, PECHAN assigned 100 percent CE and 100 percent RP to urban and suburban areas in the MANE-VU region (i.e., even if the state did not have a statewide ban on burning). In Pennsylvania, unless a jurisdiction or county (e.g., Allegheny County) was determined via survey to have a ban, it will be assumed that suburban and rural areas allow open burning. For yard waste burning, PECHAN assigned 100 percent CE and RP to all urban areas in the MANE-VU region. Yard waste emissions calculated for suburban and urban areas were assumed to be uncontrolled, unless the survey data or other statewide or local control information indicated otherwise. For the municipal yard waste burning category, areas that performed this activity had associated emissions, or did not conduct burns and therefore were assigned zero emissions.

In determining annual emissions for those areas with a seasonal ban, PECHAN adjusted the RP by the length of the seasonal ban relative to the entire year. The RP value also depends on how the time period of the ban overlaps with the activity profile for the specific category of burning. For example, for brush waste burning, the survey data revealed an average activity profile as follows: Winter–20%; Spring–46%; Summer–6%; and Fall–28%. So, for an area that has a brush burning ban in the summer, although some percentage of burning is likely to be prevented during this season, we assume that 2 percent of the summer season brush burning in August is delayed until September when burning is permitted, resulting in an RP of 4 percent to apply to annual brush waste burning emissions. As mentioned in the discussion of temporal allocation profiles, this also has an affect on the monthly activity profile. A summer RP value of 4 percent would result in a revised temporal allocation profile to be: Winter–20%; Spring–46%; Summer– 4%; and Fall–30%.

Spatial and Temporal Allocations

Spatial

PECHAN collected activity data and control information for areas classified as urban, suburban, and rural, or a combination of these designations (defined using data from the 2000 U.S. Census).

Temporal

Activity estimates and associated emissions are calculated on an annual basis. PECHAN proposes the following temporal allocation profiles to represent monthly, weekly, and daily activity profiles by SCC (see Tables II-2 through II-5). The monthly activity profiles were developed based on data obtained from the survey. The weekly and weekday/weekend profiles were developed based on engineering judgment. These profiles will be applied to annual activity for all areas of MANE-VU (i.e., variations in regional, State, or tribal areas are not accounted for). Also, a SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Temporal Allocation Profile Formats (monthly)

SCC	Month											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2610030000	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083
2610000400	0.067	0.067	0.153	0.153	0.153	0.020	0.020	0.020	0.093	0.093	0.093	0.067
2610040400	0.067	0.067	0.153	0.153	0.153	0.020	0.020	0.020	0.093	0.093	0.093	0.067
2610000100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.333	0.333	0.333	0.000

Temporal Allocation Profile Formats (weekly)

SCC	Day of Week						
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
2610030000	0.111	0.111	0.111	0.111	0.111	0.222	0.222
2610000400	0.111	0.111	0.111	0.111	0.111	0.222	0.222
2610040400	0.200	0.200	0.200	0.200	0.200	0.000	0.000
2610000100	0.111	0.111	0.111	0.111	0.111	0.222	0.222

Temporal Allocation Profile Formats (daily; weekday)

	Weekday Hour											
SCC	**0100**	**0200**	**0300**	**0400**	**0500**	**0600**	**0700**	**0800**	**0900**	**1000**	**1100**	**1200**
2610030000	0	0	0	0	0	0	0.071	0.071	0.071	0.071	0.071	0.071
2610000400	0	0	0	0	0	0	0.071	0.071	0.071	0.071	0.071	0.071
2610040400	0	0	0	0	0	0	0.071	0.071	0.071	0.071	0.071	0.071
2610000100	0	0	0	0	0	0	0.071	0.071	0.071	0.071	0.071	0.071

	Weekday Hour											
SCC	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**	**2300**	**0000**
2610030000	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0
2610000400	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0
2610040400	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0
2610000100	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0

Temporal Allocation Profile Formats (daily; weekend day)

	Weekend Day Hour											
SCC	**0100**	**0200**	**0300**	**0400**	**0500**	**0600**	**0700**	**0800**	**0900**	**1000**	**1100**	**1200**
2610030000	0	0	0	0	0	0	0.071	0.071	0.071	0.071	0.071	0.071
2610000400	0	0	0	0	0	0	0.071	0.071	0.071	0.071	0.071	0.071
2610040400	0	0	0	0	0	0	0.071	0.071	0.071	0.071	0.071	0.071
2610000100	0	0	0	0	0	0	0.071	0.071	0.071	0.071	0.071	0.071

	Weekend Day Hour											
SCC	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**	**2100**	**2200**	**2300**	**0000**
2610030000	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0
2610000400	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0
2610040400	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0
2610000100	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0	0	0	0

Emissions
Calculation

Emissions were calculated at a census tract level and summed over a county for county level emissions. A county level sample emission calculation will not be presented here, however the equations for a particular census tract are presented below. All of the census tracts in a county would then be summed for county level emission estimates.

The equation for estimating the mass of waste burned is:

$$Wtm_{SW} = HH * Bt * M$$

Where:

Wt_{MSW} = Mass of waste burned per time period

HH = Number of households that burn (Question 1, Part 2 of survey)

Bt = Number of burns per time period (Question 3, Part 2)

M = Mass of waste per burn (Question 5, Part 3)

Uncontrolled emissions were then calculated using the following equation:

$E_{UNC} = Wt_{MSW} * EF$

Where:

E_{UNC}	=	Uncontrolled area source emissions
Wt_{MSW}	=	Mass of waste burned per time period
EF	=	Emission factor per pollutant

Controlled emissions were then calculated using the following equation:

$E_C = E_{UNC} * [(1-(CE)(RP)(RE)]$

Where:

E_C	=	Controlled area source emissions
E_{UNC}	=	Uncontrolled area source emissions
CE	=	% Control efficiency/100
RP	=	% Rule penetration/100
RE	=	% Rule effectiveness/100

4.1.5.6 **Cremation – Animal and Human**

SCC: 28 10 060 100 (Humans)
28 10 060 200 (Animals)

Description

Propane-fired burners (afterburner and ignition) are typically used at cemeteries for human body and animal cremation. Burners are usually rated at 2,115,000 Btu per hour capacity. Newer units installed in the late 1980's are equipped with a modulating ignition burner. When afterburner temperatures reach about 1800 F (980 C), the ignition burner modulates to a low-fire mode that will reduce the Btu per hour usage.

When the crematory reaches an operating temperature of 1,250 F (680 C) the body container is placed on the combustion chamber grate and the ignition burner is fired to attain a target combustion temperature sufficient for the proper reduction of human remains. The chamber preheats by the afterburner reaches 1,250 F (680 C) in about 30 to 45 minutes prior to ash removal. When the body container is introduced into the combustion chamber, and the burner is ignited, cremation begins at about 1600 to 1800 F (870 to 980 C). Flame impingement on the body takes two to three minutes; cremation occurs for about two hours. The remains are then raked towards the ignition burner for about two minutes. Cool-down follows for 45 minutes to 1.5 hours.

Pollutants

HAPs (Criteria Pollutants were not calculated)

Method and
Data Sources

The method used to calculate emissions, is presented in "Documentation for the 1996 Base Year National Toxics Inventory for Area Sources" prepared by Eastern Research Group, Inc. (May 31, 2001) and distributed by U.S. EPA Emissions, Monitoring and Analysis Division, Emission Factor and Inventory Group.

Activity

In Maryland crematories are regulated under COMAR. COMAR now requires all crematories to obtain a permit to operate and any person who owns or operates an crematory must obtain certification from MDE and renew the certification annually.

MDE/ARMA maintains a registry of all crematories within the State. Because of the requirement for a permit to operate, and the operator certification requirements, staff used the sum of the crematories in the registry as representing the total area source emissions from crematories of all types emitting less than 10 tons/VOC, 100 tons/yr CO and 50 tons per year NO_x.

Emission Factors

Emission factors these hazardous air pollutants, except formaldehyde, were taken from the State of California Air Resources Board Test Report No. C-90-004[54]. The emission factor used for formaldehyde was reported in the USEPA FIRE[55] system database.

Emission factors were converted to a pound per ton basis using the procedure provided by the Emission Standards Division[56]. National activity was provided by the Emissions Standards Division based on an assumed body weight of 150 pounds and information reported by the Cremation Association of North America[57] that 21.13 percent of bodies were cremated and that there were 2,322,265 deaths in the United States in 1996[58].

Pollutant	Animal and Human Cremation Emission Factor Lbs. $_{pollutant}$ / ton cremated
arsenic	4.00E-04
beryllium	1.84E-05
cadmium	1.48E-04
chromium	3.99E-04
formaldehyde	2.89E-09
nickel	5.09E-04
POM as 16-PAH	9.63E-04
POM as 7-PAH	1.03E-09
Mercury	4.39E-02

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

No controls are available for this source category.

[54] State of California Air Resources Board, Engineering Evaluation Branch, Monitoring and Laboratory Division. "Evaluation Test on Two Propane Fired Crematories at Camellia Lawn Cemetary." Test Report No. C-90-004. October 29, 1992

[55] U.S. EPA. Factor Information Retrieval (FIRE) System Database, Version 5.1a. Research Triangle Park, NC. September 1995.

[56] Crume, Richard, U.S. EPA, Emission Standards Division. Note to Anne Pope, U.S. EPA/Emissions Monitoring and Analysis Division. Comments on Human and Animal Cremation information in the "Baseline Emission Inventory of HAP Emissions from MACT Sources – Interim Final Report," September 18, 1998. October 30, 1998.

[57] Cremation Association of North America. 1996 Statistics as found on the Internet Cremation Society, Cremation Stats Nationwide webpage: www.cremation.org/stats.htm

[58] Ventura, S. et al. "Births and Deaths: United States, 1996." Monthly Vital Statistics Report, Vol. 64, No. 1, Supplement 2. Setpember 11, 1997. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health and Statistics.

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

The equation for estimating emissions from crematories is:

$$E_{CREM} = \frac{TON_{cty} * EF}{2000}$$

Where:

E_{CREM} = Annual emissions from crematories
TON_{cty} = Tons cremated per year in county
EF = Emission Factor per pollutant (lbs/ton)

<u>2011 Sample Calculation (Harford County)</u>

Arsenic Annual Emissions:

$$E_{CREM} = \frac{TON_{cty} * EF}{2000}$$

TON_{cty} = 226.67
EF = 0.0004 lbs Arsenic/Ton Cremated

$$E_{CREM} = \frac{(226.67) \text{ x } (0.0004)}{(2000 \text{ lbs/ton})}$$

E_{CREM} = 4.53E-05 tons Arsenic per year

4.1.5.7 **Municipal Solid Waste Landfills**

SCC: 26 20 030 000

Description

Municipal solid waste landfills receive household and commercial trash. VOC emissions are produced from volatilization, chemical reaction and biological decomposition of waste. Methane and Carbon dioxide are the primary constituents of landfill gas, and are produced during anaerobic decomposition of cellulose and proteins in the land filled waste. 98.7 percent of landfill emissions are methane and carbon dioxide according to the Volatile Organic Compounds Species Data Manual, an EPA publication. In addition to methane and carbon dioxide, non-methane organic carbons (NMOCs) are produced as a small fraction of the landfill gas emissions (less than 1%). NMOCs include hazardous air pollutants and reactive VOCs.

Pollutants

VOC

Method and Data Sources

The method used to calculate emissions, is presented in AP-42, Chapter 2.4, Municipal Solid Waste Landfills and EIIP[59], Volume III, Chapter 15, Landfills, dated September 1997.

Emission estimation assumptions were also made using supporting documents Standards of Performance for New Stationary Sources (NARA, 1991a) and Emission Guidelines for Control of Existing Sources (NARA, 1997b).

To estimate emissions for the various compounds present in landfill gas, total landfill gas emissions must first be estimated. Emissions of landfill gas were calculated using a computer program known as the Landfill Gas Emissions Model (LandGEM 3.02). The model equation is as follows:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} kL_o \left(\frac{M_i}{10} \right) e^{-kt_{ij}}$$

Where:

Q_{CH4} = annual methane generation in the year of the calculation (m^3/year)
i = 1 year time increment
n = (year of the calculation) - (initial year of waste acceptance)
j = 0.1 year time increment
k = methane generation rate ($year^{-1}$)
L_o = potential methane generation capacity (m^3/Mg)

[59] Emission Inventory Improvement Program

M_i = mass of waste accepted in the i_{th} year (Mg)
t_{ij} = age of the j_{th} section of waste mass M_i accepted in the i_{th} year (decimal years, e.g., 3.2 years)

Site-specific landfill information is generally available for variables M_i, n, and t_{ij}. A more detailed explanation on how to run the model can be found in the LandGEM 3.02 Users Guide at http://www.epa.gov/ttncatc1/dir1/landgem-v302-guide.pdf .

Landgem Model Parameters AP-42 Default Values

Lo : 100.00 m^3 / Mg	Methane Generation Potential
k : 0.0400 1/yr	Decay Rate/Rate of Decomposition
NMOC : 595.00 ppmv	Non-methane Concentration
Methane : 50.00 % volume	
Carbon Dioxide : 50..00 % volume	

Activity
Data was obtained from MDE's Solid Waste Program and from the landfill facilities directly.
Emission Factors
All factors are incorporated into the LandGEM model.

Point Source Adjustments

Thirteen municipal solid waste landfills were considered point sources and LandGEM model runs for these landfills were done, but keep out of the Area source emission estimates. Emission reductions were calculated for landfills that used control technology to reduce emissions.

Adjustments for Controls

Controlled emissions from landfills were calculated in the following manner:
Equation:

$$E_{CON\text{-}LF} = \{E_{UNC\text{-}LF} \times (1 - C_{EFF})\} + \{E_{UNC\text{-}LF} \times C_{EFF} \times [1 - (D_{EFF} \times RE)]\}$$

Where:

$E_{CON\text{-}LF}$ = Controlled emissions from landfills
$E_{UNC\text{-}LF}$ = Uncontrolled emissions from landfills (generated from the LandGEM model)
C_{EFF} = Landfill collection efficiency (EPA default = 75%)
D_{EFF} = Control device destruction efficiency (98%)
RE = Rule effectiveness (EPA default 80%)

Spatial and Temporal Allocations

Spatial
Data for spatial allocation is not available for this source.

Temporal
A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

4.1.6 SMALL STATIONARY SOURCE FOSSIL FUEL USE

4.1.6.1 **Small Electric Utility Boilers**

All small electric utility boilers are inventoried in the point source category. The list of small boilers from Inventory of Power Plants in the United States, DOE/EIA-0095(88) was obtained and indicated that all small electric boilers were included in the point source inventory.

4.1.6.2 **Other Fuel Consumption**

Coke and process gas emissions will be inventoried as point sources.

4.1.6.3 **Fuel Oil Combustion**

SCC: 21 04 011 000 (residential kerosene)
21 03 011 000 (commercial/institutional kerosene)
21 04 004 000 (residential distillate oil)
21 03 004 000 (commercial/institutional distillate oil)
21 03 005 000 (commercial/institutional residual oil)

Description

Data collection for fuel oil consumption covers the use of both distillate and residual oil. Distillate oil includes fuel oil grades 1,2 and 4. Diesel fuel and kerosene also can be considered as distillate oils. Residential and commercial/institutional sources are the largest consumers of distillate oil, nationwide. Residual oil includes fuel oil grades 5 and 6. In most areas residual oil is not used by residential sources, but industrial and commercial/institutional users may consume significant amounts.

Pollutants

PM_{10}, $PM_{2.5}$, SOx, NOx, CO, VOC

Method and Data Sources

Activity

Total sales statistics of kerosene, distillate oil, and residual oil in the State of Maryland were obtained from the Annual Report on Sales of Fuel Oil and Kerosene, 2011, published by Energy Information Administration, U.S. Department of Energy[60].

Emission Factors

Uncontrolled Emission Factors – AP-42 Tables 1.3-1 and 1.3-3 (hand-fed units)

	Residential Distillate lbs/Kgal	**Residential Kerosene** lbs/Kgal	**Commercial Distillate** lbs/Kgal	**Commercial Kerosene** lbs/Kgal	**Commercial Residual** lbs/Kgal	**Commercial Residual 1% S** lbs/Kgal
PM10-FIL	1.080	1.080	1.080	1.080	13.494	7.703
PM2.5-FIL	0.830	0.830	0.830	0.830	5.011	2.861
PM-CON	1.300	1.300	1.300	1.300	1.500	1.500
NH3	1.000	1.000	0.800	0.800	0.800	0.800
SO2	43.200	41.657	43.200	41.657	318.000	159.000
NOx	18.000	18.000	20.000	20.000	55.000	55.000
CO	5.000	5.000	5.000	5.000	5.000	5.000
VOC	0.713	0.713	0.340	0.340	1.130	1.130

[60] Total residential distillate oil use in the State of Maryland in 2011 from U.S Department of Energy, Energy Information Administration, Office of Oil and Gas, Petroleum Marketing Monthly, "Annual Report on Sales of Fuel Oil and Kerosene, 2011".

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial

This information on total sales of kerosene, distillate oil and residual oil was broken down to the county level using a spatial allocation factor documented and recommended by EIIP[61] in an Area Source Method Abstract for Residential and Commercial/Institutional Fuel Oil and Kerosene combustion.

Temporal 1

SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

MDE developed an allocation factor from local and state totals of annual heating-degree days and population with fuel oil to spatially allocate fuel oil consumption. The method is

A "heating-degree day" is a unit of measure used to indicate how cold it has been over a 24-hour period. Daily heating-degree days are calculated as the difference between the base value of 65°F and the mean temperature for the day (mean of the high and low temperatures for the day).

Annual heating degree days are the sum of the daily heating degree days. Heating degree data is available from the National Oceanographic and Atmospheric Administration (NOAA).[62]

$$SAF_{InventoryCounty} = \frac{HDD_{InventoryCounty} * POP_{InventoryCounty}}{\sum_{AllCountiesInState} (HDD_{County} * POP_{County})}$$

Where:

$SAF_{InventoryCounty}$ = Spatial apportioning factor for inventory county

[61] Emissions Inventory Improvement Program (EIIP) Area Source Method Abstract – Residential and Commercial/Institutional Fuel Oil and Kerosene Combustion, dated April 2011.

[62] http://www.noaa.gov (home page) or http://www.ncdc.noaa.gov/ol/climate/climateproducts.html#PUBS (for a list of available data)

$HDD_{InventoryCounty}$ = Annual heating degree days for inventory county
$POP_{InventoryCounty}$ = Population of the inventory county
HDD_{County} = Annual heating degree days for each county in the state
POP_{County} = Population for each county in the state

The spatial apportioning factor is used to allocate the state fuel total to the county level using the following equation:

$$Fuel_{INVENTORY\ COUNTY} = SAF_{INVENTORY\ COUNTY} \times Fuel_{TOTAL\ STATE}$$

Where:
$Fuel_{INVENTORY\ COUNTY}$ = Total Fuel consumed annually in the inventory county
$Fuel_{TOTAL\ STATE}$ = Total Fuel consumed annually in the state

Temporal 2

Kerosene, distillate oil, and residual oil are almost entirely used for space heating. MDE made the assumption that the amount of fuel consumed in a county over the course of a month is proportional to the number of heat degree days in that county for the month.

The total amount of fuel consumed in the county annually is allocated from state totals using the following formula.

$$Fuel_{InventoryCountyAnnual} = SAF_{InventoryCounty} * Fuel_{TotalState}$$

Where:
$Fuel_{InventroyCountyAnnual}$ = Total Fuel consumed annually in the inventory county
$Fuel_{TotalState}$ = Total Fuel consumed annually in the state

The amount of fuel consumed in a month per county is proportional to the number heat degree days for the month in the county divided by the total number heat degree days for the year in the county.

$$Fuel_{InventoryCountyPerMonth} = Fuel_{InventoryCountyAnnual} * \frac{HDD_{InventoryCounty-Month}}{HDD_{InventoryCounty-Annual}}$$

Emissions Calculation

Activity Data Gathered

- Total amount of fuel (kerosene, distillate oil, and residual oil) consumed in the state.
- Number of heat degree days per county per month for the year of the inventory.

Calculate Spatial Apportioning Factor

$$SAF_{InventoryCounty} = \frac{HDD_{InventoryCounty} * POP_{InventoryCounty}}{\sum_{AllCounties\,InState} (HDD_{County} * POP_{County})}$$

Apportion State Fuel Consumption to the County Level

F_{I-CTY} = SAF_{CTY} x F_{ST} (see Appendices)

Where

F_{I-CTY} = Fuel type I consumed in county
SAF_{CTY} = Spatial apportioning factor for inventory county
F_{ST} = Total fuel consumed in the state.

Calculate Annual Emissions

Emissions were calculated in tons/year for residential, commercial and industrial categories from each type of fuel combustion using following equations.

$EM_R = (F_{I-CTY}$ **x** $EF_R) / 2000$

Where

EM_R = Emissions from residential category.
F_{I-CTY} = Total annual residential sales of fuel i in the county.
EF_R = Residential emission factor for fuel i from AP-42

$EM_C = (F_{I-CTY}$ **x** $EF_C) / 2000$

Where

EM_C = Emissions from commercial/institutional category.
F_{I-CTY} = Total annual commercial/institutional sales of fuel i in the county.
EF_C = Commercial emission factor for fuel i from AP-42.

<u>Residential Distillate Oil Combustion Sample Calculation (Baltimore City)</u>

Residential Distillate Oil Consumed State of Maryland = **6,143**[63] kilogallons

Spatial apportioning factor for Baltimore City:

$$SAF_{Baltimore\ City} = \frac{HDD_{Baltimore\ City} \times POP_{Units\ Heating\ Baltimore\ City}}{\sum_{ALL\ COUNTIES\ IN\ STATE} (HDD_{COUNTY} \times POP_{Units\ Heating\ State})}$$ [64]

$SAF_{Baltimore\ City}$ = **0.089899**

[63] From EIA: Adjusted Sales for Residential End Use: Distillate Fuel Oil and Kerosene, 2011 (Thousand Barrels)
[64] Population data from the U.S. Bureau of the Census, The Maryland Department of Planning.

To calculate the total annual kilogallons of distillate oil used in city of Baltimore for residential space heating:

$Fuel_{Baltimore\ City}$ = $SAF_{Baltimore\ City}$ x $Fuel_{TOTAL\ STATE}$
$Fuel_{Baltimore\ City}$ = **0.089899** x **6,143,000**
$Fuel_{Baltimore\ City}$ = **552.25** kilogallons

Annual Emissions Calculation
$E_{Baltimore\ City – Res\ -\ VOC}$ = $Fuel_{Baltimore\ City}$ x EF_{VOC}
$E_{Baltimore\ City – Res\ -\ VOC}$ = **552.25** x 0.713
$E_{Baltimore\ City – Res\ -\ VOC}$ = **393.75** lbs $_{VOC}$ / year
$E_{Baltimore\ City – Res\ -\ VOC}$ = **0.1969** tons $_{VOC}$ / year

All pollutants (PM, SOx, NOx, VOC, and CO) are calculated in a similar manner.

Commercial and industrial emissions from this source category are calculated in a similar manner with the exception that the number of days in an ozone season changes from 214 for residential to 168 for commercial and industrial. Residential ozone season days are based on 7 days per week activity. Commercial and industrial ozone season days are based on 6 days per week activity.

4.1.6.4 **Coal Combustion**

SCC: 21 04 002 000 (Residential Coal)
SCC: 21 03 002 000 (Commercial/Institutional Coal)

Description Residential Coal

This source category covers air emissions from coal combustion in the residential sector. Bituminous coal, mined here in Maryland, represents the bulk of the coal used residentially for space heating in the State. Although mined nearby in Pennsylvania, readily available, and cleaner burning, anthracite coal is not used much in Maryland because of its expense.

Pollutants

PM_{10}, $PM_{2.5}$, SOx, NOx, CO, VOC

Method and Data Sources

Activity

The following assumptions were made in the computation of emissions from coal combustion from the residential sources.

(i) Number of Dwelling Units using Coal

The number of dwelling units using coal for space heating for 2011 was obtained from 1990 Census Profile Series, Social and Economic Characteristics of Population and Housing; the number of new housing units authorized for construction between 1990 and 2011 was obtained from the Maryland Office of Planning – New Residential Units Authorized for Construction by Building Permits (http://www.op.state.md.us). MDE estimated that no new housing units would be equipped to burn coal as a home heating fuel.

COMAR 26.11.09.04 prohibits the use of solid fuel-burning equipment that has a rated heat input of less than 35 million BTU per hour.

(ii) Residential Coal Activity Consumption Data

The State Energy Data Report, Consumption Estimates, by the Energy Information Administration, provided information on estimated coal consumption. The report indicates that in Maryland mostly bituminous coal was used in 2011. It was assumed, therefore, that bituminous coal was consumed by most of the hand-fired residential coal sources in the State of Maryland.

Emission Factors

Emission factors were obtained from AP-42, Tables 1.1-3 and 1.1-4 (Residential-hand-fed units) and PM2.5 from ERTAC.

Coal Emission Factors						
	NOx (lbs./ton)	**CO (lbs./ton)**	**VOC (lbs./ton)**	**PM10-PRI (lbs./ton)**	**PM2.5-PRI (lbs./ton)**	**SO2 (lbs./ton)**
Residential	9.1	275	10	6.2	3.84	37.2

Maryland's 2008 average sulfur content in coal = 1.2% Sulfur DOE/EIA State Electricity Profiles 2008, March 2010 **Table 6. page 124**
AP42 Table 1.1-19 (hand fed units) Emission factor SO2 = 31S
In formula S = 1.2, such that SO2 EF =31*1.2 = 37.2 lb/ton

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial

MDE developed an allocation factor from local and state totals of annual heating-degree days and housing units heating with coal to spatially allocated coal consumption. The method is documented and recommended by EIIP[65] in an Area Source Method Abstract for natural gas and LPG combustion. Because the emission factor was specifically adjusted to reflect seasonal emissions through heating degree days, no further seasonal adjustment factor is necessary.

A "heating-degree day" is a unit of measure used to indicate how cold it has been over a 24-hour period. Daily heating-degree days are calculated as the difference between the base value of 65°F and the mean temperature for the day (mean of the high and low temperatures for the day).

Annual heating-degree days are the sum of the daily heating-degree days. Heating degree data is available from the National Oceanographic and Atmospheric Administration (NOAA).[66]

$$SAF_{InventoryCounty} = \frac{HDD_{InventoryCounty} * CHU_{InventoryCounty}}{\sum_{AllCountiesInState} (HDD_{County} * CHU_{County})}$$

Where:

$SAF_{INVENTORY\ COUNTY}$	=	Spatial apportioning factor for inventory county
$HDD_{INVENTORY\ COUNTY}$	=	Annual heating degree days for inventory county
$CHU_{INVENTORY\ COUNTY}$	=	Housing units using coal in inventory county
HDD_{COUNTY}	=	Annual heating degree days for each county in the state
CHU_{COUNTY}	=	Housing units using coal for each county in the state

The spatial apportioning factor is used to allocate the state fuel total to the county level using the following equation:

$$Coal_{INVENTORY\ COUNTY} = SAF_{INVENTORY\ COUNTY} \times Coal_{TOTAL\ STATE}$$

Where:

$Coal_{INVENTORY\ COUNTY}$	=	Total Coal fuel consumed in the inventory county
$Coal_{TOTAL\ STATE}$	=	Total Coal fuel consumed in the state.

Temporal

MDE assumed that all residential coal combustion is used for space heating purposes. The total coal consumed in the county can be allocated by month or period using proportions of annual and monthly (or period) heating-degree days. Also, a SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

$$Residential\ Fuel_{MONTH} = Residential\ Fuel_{ANNUAL} \times \frac{HDD_{MONTH}}{HDD_{ANNUAL}}$$

Where:

$Residential\ Fuel_{MONTH}$	=	Space heating fuel use for inventory month
$Residential\ Fuel_{ANNUAL}$	=	Space heating fuel use for inventory year
HDD_{MONTH}	=	Heating degree days for inventory month
HDD_{ANNUAL}	=	Heating degree days for inventory year

[66] http://www.noaa.gov (home page) or http://www.ncdc.noaa.gov/ol/climate/climateproducts.html#PUBS (for a list of available data)

Emissions Calculation

Equation:

$$E_{COALR} = \frac{(EF_{COAL\ i} \times Coal_{INVENTORY\ COUNTY})}{2000}$$

E_{COALR} = Yearly emissions from residential coal combustion
$EF_{COAL\ i}$ = Emission factor for coal combustion for pollutant i

Residential Coal Combustion Sample Calculation (Allegany County) (tons / year)

Total Residential Coal Consumption – State of Maryland 2,000 tons

To calculate spatial apportioning factor for Allegany County:

$$SAF_{ALLEGANY\ COUNTY} = \frac{HDD_{INVENTORY\ COUNTY} \times CHU_{INVENTORY\ COUNTY}}{\sum_{ALL\ COUNTIES\ IN\ STATE} (HDD_{COUNTY} \times CHU_{COUNTY})}$$

$SAF_{ALLEGANY\ COUNTY}$ = **0.2013417**

To calculate tons of coal used in Allegany County:

$Residential\ Coal_{ALLEGANY\ COUNTY}$ = $SAF_{ALLEGANY\ COUNTY} \times Coal_{TOTAL\ STATE}$
$Residential\ Coal_{ALLEGANY\ COUNTY}$ = **0.2013417**x 2,000
$Residential\ Coal_{ALLEGANY\ COUNTY}$ = 402.68 tons

Equation:

Residential Coal SO2 Emission Calculation for Allegany County

$$E_{COALR} = \frac{(EF_{COAL\ SO2} \times Coal_{ALLEGANY\ COUNTY})}{2000}$$

$$E_{COALR} = \frac{(37.2 \times 402.68)}{2000}$$

E_{COALR} = 7.490 tons $_{SO2}$ year

Description -
Commercial and
Institutional Coal

Commercial and Institutional sources of coal combustion above the point source threshold are included in the point source portion of the inventory. The following table lists area source emissions from commercial and institutional sources smaller than the threshold values.

Methods and
Data Sources

The following assumptions were made in the computation of emissions from coal combustion from the commercial and institutional sources not included in the point source inventory.

Activity
(i) Coal Consumption Data

The State Energy Data Report (SEDR) estimated that approximately 31,000 tons/year of total coal was used commercially by Maryland in 2011.

(ii) Number of Dwelling Units using Coal

The number of dwelling units using coal for space heating for 2011 was developed from 1990 Census Profile Series, Social and Economic Characteristics of Population and Housing. The number of new housing units authorized for construction between 1990 and 2011 was obtained from the Maryland Office of Planning – New Residential Units Authorized for Construction by Building Permits (http://www.op.state.md.us). MDE estimated that no new housing units would be equipped to burn coal as a home heating fuel.

COMAR 26.11.09.04 prohibits the use of solid fuel-burning equipment that has a rated heat input of less than 35 million BTU per hour.
Emission Factors

EMISSION FACTORS WERE OBTAINED FROM AP-42, TABLES 1.1-3 AND VOCS (TNMOC) TABLE 1.1-19 (AVERAGE OF OVERFEED AND UNDERFEED STOKER). PM10 AND PM2.5 EF ON TABLES 1.1-10 AND 1.1-11

Coal Emission Factors						
	NOx (lbs./ton)	**CO (lbs./ton)**	**VOC (lbs./ton)**	**PM10-PRI (lbs./ton)**	**PM2.5-PRI (lbs./ton)**	**SO2 (lbs./ton)**
Commercial / Institutional	8.5	8.5	0.675	6.1	3	41.4

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial

Spatial temporal allocations to this source category were calculated in the same manner as the residential coal combustion category.

Temporal

Spatial and temporal allocations to this source category were calculated in the same manner as the residential coal combustion category.

Emissions Calculation

<u>Commercial Coal Combustion Sample Calculation (Allegany County) (tons / year)</u>

Total Commercial Coal Consumption – State of Maryland 16,000 tons

To calculate spatial apportioning factor for Allegany County:

$$SAF_{\text{ALLEGANY COUNTY}} = \frac{HDD_{\text{INVENTORY COUNTY}} \times CHU_{\text{INVENTORY COUNTY}}}{\sum_{\text{ALL COUNTIES IN STATE}} (HDD_{\text{COUNTY}} \times CHU_{\text{COUNTY}})}$$

$$SAF_{\text{ALLEGANY COUNTY}} = \mathbf{0.351336}$$

To calculate tons of coal used in Allegany County:

$$\text{Commercial Coal}_{\text{ALLEGANY COUNTY}} = SAF_{\text{ALLEGANY COUNTY}} \times \text{Coal}_{\text{TOTAL STATE}}$$
$$\text{Commercial Coal}_{\text{ALLEGANY COUNTY}} = 0.351336 \times 16{,}000$$
$$\text{Commercial Coal}_{\text{ALLEGANY COUNTY}} = 5{,}621.38 \text{ tons}$$

Equation:

Commercial Coal VOC Emission Calculation for Allegany County

$$E_{COALC} = \frac{(EF_{COAL\ VOC} \times Coal_{ALLEGANY\ COUNTY})}{2000}$$

$$E_{COALC} = \frac{(0.675 \times 5{,}621.38)}{2000}$$

$$E_{COALC} = 1.897 \text{ tons}_{VOC} \text{ year}$$

4.1.6.5 **Natural Gas Combustion**

SCC: 21 04 060 000 (Residential Natural Gas)
SCC: 21 03 060 000 (Commercial/Institutional Natural Gas)

Description

This source category covers air emissions from natural gas combustion in the residential and commercial/institutional sectors for space heating, water heating, and cooking. This category includes small boilers, furnaces, heaters and other heating units that are not inventoried as point sources. Residential and commercial sectors comprise housing units; wholesale and retail businesses; health institutions; social and educational institutions; and Federal, state and local government institutions (e.g., military installations, prisons, office buildings). Natural gas is one of the major fuels used throughout the country. It is used mainly for power generation, for industrial process steam and heat production, and for domestic and commercial space heating. It is also used for domestic cooking and hot water heating.

Pollutants

PM_{10}, $PM_{2.5}$, SOx, NOx, CO, NH3, VOC

Method and Data Sources

The following assumptions were made in the computation of the emissions from natural gas combustion.

Activity

(i) Number of Dwelling Units using Natural Gas

The number of dwelling units using natural gas for space heating for 2011 was developed from 1990 Census Profile Series, Social and Economic Characteristics of Population and Housing. The number of new housing units authorized for construction between 1990 and 2011 was obtained from the Maryland Office of Planning – New Residential Units Authorized for Construction by Building Permits (http://www.op.state.md.us). The total number of additional housing units constructed in the county was apportioned to type of home heating fuel by the same ratio as the 1990 Census figures.

(ii) Residential and Commercial/Institutional Natural Gas Consumption Data

Total residential and commercial/institutional natural gas consumption data in the State of Maryland for 2011 was obtained from surveying the following companies: Baltimore Gas and Electric (*Constellation Energy Group*), Washington Gas Energy Services (Maryland Division), Chesapeake Utilities Corporation, Columbia Gas of Maryland, Easton Utility

Commission, and Elkton Gas Company. The companies provided natural gas sales statistics for the year 2011 in therms or cubic feet for all counties in their service area for the residential, commercial, and industrial categories. These statistics were then converted into million cubic feet using a conversion factor of 1 therm equals 100 cubic feet.

Emission Factors
(iii)Emission Factors – Natural Gas

Emission factors for residential natural gas came from 2008 Emission Inventory Data & Documentation (http://www.epa.gov/ttn/chief/net/2008inventory.html) Nonpoint section for Residential Heating: Natural Gas factors for combustion of natural gas in commercial boilers are presented in Table 1.4-1 and 1.4-2 of Section 1.4 of *AP-42*. Commercial factors came from the ICI Workbook on the same website created by EPA and ERTAC committee through a joint study.

Natural Gas Emission Factors							
	Nox (lbs./10^6 scf)	**CO (lbs./10^6 scf)**	**VOC (lbs./10^6 scf)**	**PM 10 (lbs./10^6 scf)**	**PM 2.5 (lbs./10^6 scf)**	**NH3 (lbs./10^6 scf)**	**Sox (lbs./10^6 scf)**
Residential	94	40	5.5	0.2	0.11	20	0.6
Commercial	100	84	5.5	0.2	0.11	0.49	0.6

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial
The natural gas survey of suppliers provided MDE with county totals for natural gas consumption. Therefore MDE did not have to use an allocation factor derived from local and state totals of annual heating degree days and housing units heating with natural gas to spatially allocated natural gas consumption to the county level for most of the counties.

Temporal

In addition to space heating, natural gas is often used for cooking and water heating. For ozone and other seasonal inventories, consumption for cooking and water heating may be assumed to be constant through the year, but fuel used for space heating must be apportioned according to heating needs. A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

To separate residential space heating natural gas usage from cooking and water heating, MDE used data from the State Energy Data Report, Consumption Estimates, Energy Information Administration, Office of Energy Markets and End Use, U.S. Department of Energy. Specifically data was collected from Table 15 – Natural Gas Deliveries to Residential Customers, by State, 1998-2011. The residential deliveries for the month with the lowest deliveries can be assumed to be only for cooking and water heating. The percentage of residential natural gas consumption for cooking and water heating may then be calculated:

$$\text{Annual Non-Space Heating Percent} = \frac{12 * \text{Lowest Monthly Fuel Use}}{\text{Annual Fuel Use}} * 100$$

$$\text{Annual Non-Space Heating Percent} = \frac{12 * 1635}{80{,}447} * 100$$

$$\text{Annual Non-Space Heating Percent} = 24.389\ \%$$

The annual non-space heating percent can be calculated in a similar manner for commercial/institutional natural gas usage. The percentage of commercial/institutional natural gas consumption for non-space heating may then be calculated:

$$\text{Annual Non-Space Heating Percent} = \frac{12 * \text{Lowest Monthly Fuel Use}}{\text{Annual Fuel Use}} * 100$$

$$\text{Annual Non-Space Heating Percent} = \frac{12 * 2440}{65323} * 100$$

$$\text{Annual Non-Space Heating Percent} = 44.823\ \%$$

This percentage may be applied to the inventory area's total residential and/or commercial/institutional natural gas consumption to calculate the non-space heating portion of usage. This portion can be subtracted from the annual total, and the remaining consumption, which is being used for space heating, can be allocated by month or period using proportions of annual and monthly or period heating degree days. Also, emissions were averaged according to period of operation to a daily estimate. See section 2.2.1.1

$$\text{Space Heat Fuel}_{\text{MONTH}} = \text{Space Heat Fuel}_{\text{ANNUAL}} \times \frac{\text{HDD}_{\text{MONTH}}}{\text{HDD}_{\text{ANNUAL}}}$$

Where:

Space Heat Fuel $_{MONTH}$ = Space heating fuel use for inventory month
Space Heat Fuel $_{ANNUAL}$ = Space heating fuel use for inventory year
HDD $_{MONTH}$ = Heating degree days for inventory month
HDD $_{ANNUAL}$ = Heating degree days for inventory year

Emissions Calculation

Emission Calculation – Residential Emissions

Equation:

$$E_{NatGas} = \frac{(EF_{NatGas\text{-}P} \times NG_i)}{2000}$$

E_{NatGas} = Yearly emissions from natural gas combustion
$EF_{NatGas\text{-}P}$ = Emission factor for natural gas combustion for pollutant i
NG_i = Natural gas consumed for county i

Total Residential Natural Gas Consumption – Baltimore City[67] 13,700.31 M ft^3

	Total Natural Gas Delivered (M ft^3)	
	Residential	**Commercial**
State of Maryland	**77,411.73**	**61,737.32**

$$E_{NatGas} = \frac{(EF_{NatGas\text{-}voc} \times NG_{Bato.City})}{2000}$$

$$E_{NatGas} = \frac{(5.5 \times 13{,}700.31)}{2000}$$

E_{NatGas} 37.68 tons $_{VOC}$ year

The same equation and methodology can be used to estimate emission of various pollutants.

[3] Natural gas consumption data gathered from MDE survey – Baltimore County data from BGE

4.1.6.6 **Liquefied Petroleum Gas Combustion**

SCC: 21 04 007 000 (Residential LPG)
SCC: 21 03 007 000 (Commercial/Institutional LPG)

Description

This source category covers air emissions from liquefied petroleum gas (LPG) combustion in the residential and commercial sectors for space heating, water heating, or cooking. LPG includes propane, propylene, butane, and butylenes. The product used for domestic heating is composed primarily of propane. This category includes small boilers, furnaces, heaters and other heating units that are not inventoried as point sources. Residential and commercial sectors comprise housing units; wholesale and retail businesses; health institutions; social and educational institutions; and Federal, state and local government institutions (e.g., military installations, prisons, office buildings).

Pollutants

PM_{10}, $PM_{2.5}$, SOx, NOx, CO, NH3, VOC

Method and Data Sources

The following assumptions were made in the computation of the emissions from liquefied petroleum gas (LPG) combustion.

Activity

1. Number of Dwelling Units using LPG

The number of dwelling units using LPG for space heating for 2011 was developed from 1990 Census Profile Series, Social and Economic Characteristics of Population and Housing. The number of new housing units authorized for construction between 1990 and 2011 was obtained from the Maryland Office of Planning – New Residential Units Authorized for Construction by Building Permits (http://www.op.state.md.us). The total number of additional housing units constructed in the county was apportioned to type of home heating fuel by the same ratio as the 1990 Census figures.

2. Residential and Commercial LPG Activity Consumption Data

Total residential and commercial LPG consumption data for space heating in the State of Maryland (LPG_{ST}) for 2011 were obtained from State Energy Data Report, Consumption Estimates, Energy Information Administration, Office of Energy Markets, and End Use, U.S. Department of Energy.

Emission Factors

Emission factors for LPG came from 2008 Emission Inventory Data & Documentation (http://www.epa.gov/ttn/chief/net/2008inventory.html) Nonpoint section for Residential Heating: LPG Combustion Table 1. Commercial factors came from the ICI Workbook on the same website created by EPA and ERTAC committee through a joint study. Factors have been rounded to one and two decimal places.

LPG Emission Factors							
	NOx (lbs./kbbl)	**CO (lbs./kbbl)**	**VOC (lbs./kbbl)**	**PM10-FIL (lbs./kbbl)**	**PM2.5-FIL (lbs./kbbl)**	**NH3 (lbs./kbbl)**	**SO2 (lbs./kbbl)**
Residential	562.8	159.6	21.91	0.8	0.44	1.95	2.39
Commercial	597.66	334.74	21.84	0.84	0.42	2.1	2.52

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial

MDE developed factors from local and state totals of annual heating degree days and housing units that heat with liquid propane gas; to spatially allocate liquid propane gas consumption. The method is documented and recommended by EIIP[68] in an Area Source Method Abstract for natural gas and LPG combustion.

A "heating degree day" is a unit of measure used to indicate how cold it has been over a 24-hour period. Daily heating degree days are calculated as the difference between the base value of 65°F and the mean temperature for the day (mean of the high and low temperatures for the day).

[68] Emissions Inventory Improvement Program (EIIP) Area Source Method Abstract – Natural Gas and LPG Combustion, dated 2011

Annual heating degree days are the sum of the daily heating degree days. Heating degree data is available from the National Oceanographic and Atmospheric Administration (NOAA).[69]

$$SAF_{\text{INVENTORY COUNTY}} = \frac{HDD_{\text{INVENTORY COUNTY}} \times LP\text{-}HU_{\text{INVENTORY COUNTY}}}{\sum_{\text{ALL COUNTIES IN STATE}} (HDD_{\text{COUNTY}} \times LP\text{-}HU_{\text{COUNTY}})}$$

Where:

$SAF_{\text{INVENTORY COUNTY}}$	=	Spatial apportioning factor for inventory county
$HDD_{\text{INVENTORY COUNTY}}$	=	Annual heating degree days for inventory county
$LP\text{-}HU_{\text{INVENTORY COUNTY}}$	=	Housing units using LP gas for inventory county
HDD_{COUNTY}	=	Annual heating degree days for each county in the state
$LP\text{-}HU_{\text{COUNTY}}$	=	Housing units using LP gas for each county in the state

The spatial apportioning factor is used to allocate the state fuel total to the county level using the following equation:

$$LPG_{\text{INVENTORY COUNTY}} = SAF_{\text{INVENTORY COUNTY}} \times LPG_{\text{TOTAL STATE}}$$

Where:

$LPG_{\text{INVENTORY COUNTY}}$	=	Total LPG fuel consumed in the inventory county
$LPG_{\text{TOTAL STATE}}$	=	Total LPG fuel consumed in the inventory county

Temporal

In addition to space heating, liquid propane gas is often used for cooking and water heating. For ozone and other seasonal inventories, consumption for cooking and water heating may be assumed to be constant through the year, but fuel used for space heating must be apportioned according to heating needs. SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

Emission Calculation

$$E_{LPGi} = \frac{(EF_{LPG\,p} \times LPG_{\text{County } i})}{2000}$$

E_{LPGi}	=	Yearly emissions from liquid propane gas combustion in county i
$EF_{LPG\,p}$	=	Emission factor for LPG combustion for pollutant p

[69] http://www.noaa.gov (home page) or http://www.ncdc.noaa.gov/ol/climate/climateproducts.html#PUBS (for a list of available data)

$LPG_{County\ i}$ = LPG consumed for space heating in county i

2011 Residential LPG Combustion Sample Calculation (Baltimore City) (tons/year)

Total Residential LPG Consumption – State of Maryland 2,023 thousand barrels (kbbl)
To calculate spatial apportioning factor for Baltimore City:

$$SAF_{BALTIMORE\ CITY} = \frac{HDD_{INVENTORY\ COUNTY} \times LP\text{-}HU_{INVENTORY\ COUNTY}}{\sum_{ALL\ COUNTIES\ IN\ STATE} (HDD_{COUNTY} \times LP\text{-}HU_{COUNTY})}$$

$$SAF_{BALTIMORE\ CITY} = \frac{4{,}705 \times 2{,}080}{300{,}519{,}851}$$

$$SAF_{BALTIMORE\ CITY} = 0.032565$$

To calculate thousand barrels of liquefied petroleum gas (LPG) used in Baltimore City:

$$\text{Residential } LPG_{BALTIMORE\ CITY} = SAF_{BALTIMORE\ CITY} \times LPG_{TOTAL\ STATE}$$
$$\text{Residential } LPG_{BALTIMORE\ CITY} = 0.032565 \times 2{,}023$$
$$\text{Residential } LPG_{BALTIMORE\ CITY} = \mathbf{65.88} \text{ kbbl}$$

Equation:

$$E_{LPGi} = \frac{(EF_{LPG\ voc} \times LPG_{County\ i})}{2000}$$

$$E_{LPGi} = \frac{(21.91 \times \mathbf{65.88})}{2000}$$

E_{LPGi} = 0.7217 tons $_{VOC}$ per year

4.1.6.7 **Wood Combustion**

SCC:

2104008100	**Fireplace: general**
2104008210	**Fireplaces: Insert; non-EPA certified**
2104008220	**Fireplaces: Insert; EPA certified; non-catalytic**
2104008230	**Woodstove: fireplace inserts; EPA certified; catalytic**
2104008310	**Woodstove: freestanding, non-EPA certified**
2104008320	**Woodstove: freestanding, EPA certified, non-catalytic**
2104008330	**Woodstove: freestanding, EPA certified, catalytic**
2104008400	**Woodstove: pellet-fired, general (freestanding or FP insert)**
2104008510	**Furnace: Indoor, cordwood-fired, non-EPA certified**
2104008610	**Hydronic heater: outdoor**
2104008700	**Outdoor wood burning (fire-pits, chimeas, etc)**
2104009000	**Residential Firelog Total: All Combustor Types**

Description

This source category covers air emissions from wood combustion in the residential sectors primarily for space heating and aesthetics. The inventory includes emission estimates for indoor wood-burning equipment (e.g. fireplaces, woodstoves, pellet stoves, furnaces/boilers) and outdoor wood burning equipment (e.g. outdoor fireplaces, fire pits, wood-fired barbecues, chimneys).

Pollutants

NOx, CO, VOC, PM_{10}, $PM_{2.5,}$ NH3, SO2, and HAPs

Method and Data Sources

Maryland's Residential Wood Combustion Emission Inventory was calculated using a new EPA emissions estimation tool called the, RWC TOOL. A detailed explanation of how activity data and emission factors were developed in order to predict emissions for several states can be read in Appendix X. A collection of surveyed, census, housing tract, equipment use, and wood burned data was used in the tool along with EPA's estimation methodologies and statistics to create an emissions profile for Maryland that can be used repeatedly with a few periodic updates.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial

To produce county-level temporal profiles, the same process used to go from response level profiles to group-level profiles was used to go from group profiles to county profiles. Activity or emissions for each census tract were assigned to each temporal unit based on the tract level temporal profiles. These values were then summed across all tracts in the county and normalized to give activity fractions.

Temporal

Temporal allocation profiles were also developed for this project using the residential wood survey data. Profiles were first developed for each sample group. Activity (for outdoor equipment) or emissions (for indoor equipment) for each respondent was divided. A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

The following RWC methodology comes directly from E.H. PECHAN memo on how emission calculations were made for the category.

CALCULATION METHODOLOGY AND UPDATES

The emissions from RWC are calculated using the Equation 1 below.

$$E_y = u \times EF_y \times (1-CF_y) \qquad \textbf{(Eq. 1)}$$

Where $_y$ is a specific pollutant and:

E_y = annual emissions (ton/year) for a specific appliance (or SCC);
u = annual activity (tons of fuel burned);
EF_y = emission factor (tons of pollutant emitted/mass of fuel used); and
CF_y = control factor.

Each of the terms in Equation 1 and their sources are explained further below.

Activity (u): Methodologies for determining the activity varied by the type of RWC appliance. Activity for the majority of appliance types was derived from census data.

Fireplaces, Inserts, and Woodstoves

For the first method, which applies to fireplaces, fireplace inserts, and woodstoves, activity in terms of tons of fuel burned was calculated based on several factors as shown in Equation 2 below.

$$u = P \times AP \times WBP \times CP \times UR \times BR \times D \qquad \textbf{(Eq. 2)}$$

Where:

P = Number of occupied housing units in a county in 2011;

AP = Percentage of occupied housing units for a specific appliance category (e.g., woodstoves used as main heating equipment, fireplaces without inserts used for other heating, etc.);

WBP = Wood-burning percentage – percentage of wood burned for each purpose from AHS;

CP = Certification Profile - percentage of a specific appliance category per SCC (e.g., for woodstoves: uncertified, certified catalytic, certified non-catalytic);

UR = Urban or Rural adjustment – Profile adjustment based on county population density;

BR = Burn rate (cords/year); and

D = average density of the wood fuel burned.

4.1.6.8 **Commercial Cooking**

SCC: 2302002100 (Conveyorized Charbroiling)
2302002200 (Under-fired Charbroiling)
2302003000 (Deep Fat Frying)
2302003100 (Flat Griddle Frying)
2302003200 (Clamshell Griddle Frying)

Description

This source category covers air emissions from commercial cooking in the Maryland area(s). These emissions (i.e. emissions from commercial cooking of meats) represent the "greatest sources of commercial cooking emissions. In particular, emissions of particulate matter (PM) and volatile organic compounds (VOCs) are the most significant. Of the cooking processes that have been identified, charbroiling is the most important air pollutant emissions contributor" [70]. It follows that this category includes the following meat sources: hamburger, steak, fish, pork, and chicken. And the five equipment types: chain-driven (conveyorized) charbroilers, under-fired charbroilers, deep fat fryers, griddles, and clam shell griddles.

Pollutants

PM, PM_{10}, $PM_{2.5}$, CO, VOC, HAPs

Method and Data Sources

The recommended methods for calculating emissions and emission factors to commercial cooking possessing sources was obtain from PECHAN Technical Memorandum (December 2003) and EIIP Web site Volume III, Area Sources document series methods and web link: http://www.epa.gov/ttnchie1/eiip/techreport/volume03/charbroilingtechmemo_122303.pdf. http://www.epa.gov/ttnchie1/conference/ei13/pointarea/roe.pdf.

Activity

Total number of restaurants came from County Business Patterns 2010 - Maryland, NAICS: 7221, Full-Service Restaurants and 72213, Limited Service Restaurants. Base year 2010 Restaurants statistics for Maryland's counties were collected from the U.S. Census Bureau Internet Website address (http://www.census.gov/epcd/cbp/view/cbpview.html). Table 3.7.1.8-a shows CBP total number of Maryland county restaurants. MDE staff calculated the percent of county restaurant types (i.e. Ethnic Food, Fast Food, Family Food, and Seafood) reported in the PECHAN Technical Memorandum. Table 3.7.1.8-b shows the percent of each restaurant type per county calculated from the PECHAN Technical Memorandum. This percentage was applied to the total number of restaurants collected from the County Business Patterns to determine the number of each type of restaurant facility in each county[1, 71]. Table

[70] Source: Adapted from PECHAN December 2003 Commercial Cooking Processes Technical Memorandum.
[71] Source: Adapted from County Business Patterns (CBP) and U.S. Census Bureau 2010 reports.

3.7.1.8-c gives average number of equipment pieces by restaurant type. Table 3.7.1.8-d shows average pounds of meat cooked on each type of equipment per week (lbs/week). And Table 3.7.1.8-e gives emission factors (lb/ton meat).

Table 3.7.1.8-a 2010 CBPs' Total Number of County Rest.

County Name	NAICS Code 7221 & 72213
Allegany	57
Anne Arundel	423
Baltimore CO	500
Calvert	66
Caroline	13
Carroll	116
Cecil	66
Charles	90
Dorchester	20
Frederick	166
Garrett	30
Harford	150
Howard	210
Kent	34
Montgomery	733
Prince George's	324
Queen Anne's	45
St Mary's	69
Somerset	14
Talbot	59
Washington	111
Wicomico	80
Worcester	189
Baltimore City	415

[3] Total may not be multiplier and divisional because of rounding.

Table 3.7.1.8-b Percent of Each County Restaurant Type[3]

County Name	Ethnic	Fast Food	Family	Seafood	Steak & Barbeque
Allegany	17	27	8	0	5
Anne Arundel	115	202	49	42	14
Baltimore CO	148	240	58	39	14
Calvert	15	27	10	10	3
Caroline	2	9	1	1	13
Carroll	23	69	17	4	3
Cecil	15	34	8	5	3
Charles	25	45	14	9	5
Dorchester	3	13	4	8	1
Frederick	44	79	29	11	3
Garrett	3	16	10	0	1
Harford	35	80	13	15	7
Howard	71	110	16	8	5
Kent	3	14	10	7	0
Montgomery	332	314	50	16	22
Prince George's	97	168	24	20	16
Queen Anne's	3	21	1	17	2
St Mary's	12	28	11	11	7
Somerset	0	6	3	5	0
Talbot	11	27	6	13	2
Washington	27	56	16	10	1
Wicomico	22	34	8	12	3
Worcester	46	80	19	35	9
Baltimore City	109	238	29	32	9

Note: Divide decimal numbers in Table 3.7.1.8-b by 100 to change % into fraction values.

Table 3.7.1.8-c Percent of Restaurants with each type of cooking equipment [1, 2]

Restaurant Category	Chain-Driven Charbroilers (ufc) Rest	Underfired Charbroilers (ufc) Rest.	Deep-Fat Fryers (dff) Rest.	Flat Griddles (fg) Rest.	Clamshell Griddles (cg) Rest.
Ethnic	3.5	47.5	81.9	62.7	4
Fast Food	18.6	30.8	96.8	51.9	14.7
Family	10.1	60.9	91.4	82.9	1.4
Seafood	0	52.6	100	36.8	10.5
Steak & Barbeque	6.9	55.2	82.8	89.7	0

Table 3.7.1.8-d Average Number of Equipment Pieces by Restaurant Type[1, 2]

Restaurant Category	Chain-Driven Charbroilers (ufc) Rest	Underfired Charbroilers (ufc) Rest.	Deep-Fat Fryers (dff) Rest.	Flat Griddles (fg) Rest.	Clamshell Griddles (cg) Rest.
Ethnic	1.62	1.54	1.63	1.88	1.8
Fast Food	1.07	1.58	3.1	1.43	2.09
Family	1.71	1.29	2.34	2.03	0
Seafood	0	1.1	2.47	1.11	1.5
Steak & Barbecue	0	1.63	2.42	1.35	0

Table 3.7.1.8-e Average Pounds of Meat Cooked on Each Type of Equipment Per Week [1, 2]
(lbs/week)

Type of Meat	Chain-Driven Charbroilers (ufc) Rest	Underfired Charbroilers (ufc) Rest.	Deep-Fat Fryers (dff) Rest.	Flat Griddles (fg) Rest.	Clamshell Griddles (cg) Rest.
Steak	236	180	181	166	94
Hamburger	798	270	274	362	1314
Poultry, with Skin	147	144	365	88	113
Poultry, Skinless	266	179	208	111	108
Pork	57.6	148	58.6	112	118
Seafood	119	143	159	92.1	632
Other	0	41.5	274	57.5	0

Emission Factors

Table 3.7.1.8-f Emission Factor (lb/ton meat) [1, 2]

Equipment Type (fuel)	SCC	Meat/Food	PM	PM10	PM2.5	CO	NOX	VOC
Under fired-charbroiler (charcoal) (ufc) Rest.	2302002200	Beef	16.2	15	14.2	327	4.8	9.4
		Beef (marinated)	19	18.4	17.4	335.2	7.2	11.6
		Chicken (marinated)	19.6	18.8	18.2	315.8	8.4	9
		Hamburger (25%fat)	65.4	65.4	63.8	27.44	0	7.88
Under fired-charbroiler (natural gas) (ufc) Rest.	2302002200	Steak	34.4	34.4	33.6	9.94	0	1.72
		Chicken (whole)	21.0	21.0	19.8	9.68	0	3.64
		Seafood	6.6	6.6	6.4	0	0	0.76
Conveyorized Charbroiler (natural gas) (cdc) Rest.	2302002100	Hamburger (21%fat)	14.8	14.8	14.6	16.58	0	4.54

		Shoestring potatoes	0	0	0	0	0	0.42
Deep fat fryer (natural gas) (dff) Rest.	2302003000	Breaded chicken	0	0	0	0	0	0.24
		Breaded fish	0	0	0	0	0	0.28
		Hamburger (24% fat)	10	10	7.6	0.76	0	0.14
Griddle (electric) (fg) Rest.	2302003100	Chicken (boneless breast)	0	0	0	0.9	0	0.8
		Seafood	0	0	0	0	0	0.22
Double-sided (clamshell) Griddle (electric) (cg) Rest.	2302003200	Hamburger (24% fat)	1.7	1.7	1.44	0	0	0.02
		Chicken	0	0	0	0	0	0.114285714
		Seafood	0	0	0	0	0	0.031428571

Point Source Adjustments

No point source subtraction of emissions.

Adjustments for Controls

No adjustments for controls in Maryland for this source.

Spatial

Spatial and Temporal Allocations

Data for spatial allocation is the number of restaurant per county from CBPs'.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

The following steps were used to calculate commercial cooking emissions for Maryland:

i. Multiply total restaurants in a county (i.e. from CBPs' data source) by percent (%) type of restaurant (i.e. from PECHAN document) Table 3.2.6.8-a, and Table 3.2.6.8-b.
ii. Multiply county-level facility counts by the fraction (i.e. percent) of restaurants with each type of cooking equipment (Table 3.2.6.8-c).
iii. Multiply number of restaurants with each type of cooking equipment by number of pieces of equipment (Table 3.2.6.8-d).
iv. Sum number of pieces of cooking equipment across restaurant types.
v. Multiply total summed number of pieces of cooking equipment per restaurant types by average pounds of meat cooked on each type of equipment per week (Table 3.2.6.8-e).

vi. Finally, multiply results from v by emission factor (lb/ton meat) (Table 3.2.6.8-f) and divided emission values by 2000 by 365 for daily lbs/ton unit.

$$B_{poe}$$

$$E_{CC} = (N*(Frac_n/100))* D_{tn} * Sum_{all} * Meat_{type} * EF_{meat\ type}/2000$$

Where:

E_{CC} = Commercial Cooking Emissions in pound (lbs) per tons (i.e. Activity data times $EF_{meat\ type)}$ for county per restaurant food type and equipment type SCC.
N = Total number of food restaurants in county (see CBP report 2004).
$Frac_n$ = Fraction of restaurant type for that type of cooking equipment.
B_{poe} = Number of food restaurants for SCC with restaurants type of equipment.
Dtn = Total number of restaurants type of equipment at food restaurant.
$Sum_{all,}$ = Total number of summed of pieces of cooking equipment across restaurant type.
$Meat_{type}$ = Total pounds per week of meat type cooked on restaurants equipment in county.
$EF_{meat\ type}$ = Meat type emission factor (lb/ton meat).

Example 2011 Commercial Cooking Emission Calculation for Baltimore County, Fast Food Restaurant Type, SCC 2302002100, Chain-Driven Charbroiler (Conveyorzed**). Note:** Emissions are calculated for only a particular county, restaurant, food equipment, and food type. In order to determine emission for a particular county, all emission for meat types must be summed at the equipment level and multiply by the appropriate meat type emission factor.

Step i.

$$E^3_{BC,cdc,FFood,PM} = 500 * (48/100) = 240.00$$

Step ii.

$$E^3_{BC,cdc,FFood,PM} = 240.00*(18.6/100) = 44.64$$

Step iii.

$$E^3_{BC,cdc,Fast\ food,\ PM} = 44.64 * 1.07 = 47.7648$$

Step iv.

$$Sum_{all,} E^3_{BC,cdc,Fast\ food,\ PM} = 47.7648$$

Step v.

$E^3_{BC,cdc,\ Fast\ food,\ PM}$ = 47.76 * 240.00 = 11,262.40

Step vi.

$E^3_{BC,cdc,\ Fast\ food,\ PM}$ =(11,462.40 * 3.891)/2000 = 22.30

$E^3_{BC,cdc,\ Fast\ Food,\ PM10\text{-}PRI}$ = 22.30 tons per year

4.1.7 FUGITIVE SOURCES

Other area sources include forest fires, slash and prescribed burning, agricultural burning, structure fires, orchard heaters, leaking underground storage tanks and natural organic sources. Although often intermittent in nature, many of these sources can produce large quantities of air pollutant emissions.

4.1.7.1 Residential Construction Activity

SCC: 23 11 010 000

Description

This source category covers fugitive dust emissions from residential construction activities.

Pollutants

PM_{10}, $PM_{2.5}$, and HAPs

Method and Data Sources

Activity

For residential construction, housing permit data for single-family units, two-family units, and apartments were obtained at the county level from the U.S. Department of Commerce's (DOC) Bureau of the Census.

Estimated the number of buildings in each category, and then estimated the total acres disturbed by construction by applying conversion factors to the housing start data for each category as follows:

- Single-family ¼ acre/building
- Two-family ⅓ acre/building
- Apartment ½ acre/building

Housing construction PM10 emissions are calculated using an emission factor of 0.032 tons PM10/acre/month, the number of housing units created a units-to-acres conversion factor, and the duration of construction activity. The duration of construction activity for houses is assumed to be 6 months.

Apartment construction emissions are calculated separately using an emission factor of 0.11 tons PM10/acre/month; with a 12 months period assumed for apartment construction.

For areas in which basements are constructed to estimate the cubic yards of dirt moved per house, an average value of 2000 square feet is assumed for both single family and two-family homes. Multiplying the average total square feet by an average basement depth of 8 feet and adding in 10 percent of the cubic feet calculated for peripheral dirt removed produces an estimate of the cubic yards of earth moved during residential construction. The percentage of one-family houses with basements was obtained from the DOC. The percentage of houses per Census region (Northeast, Midwest, South, and West) that contain full or partial basements is applied to the housing start estimates for each of these respective regions. The best available control measures (BACM) Level 2 equation (emission factor of 0.011 tons PM10/acre/month plus 0.059 tons PM10/1000 cubic yards of on-site cut/fill) is applied once the number of acres disturbed due to the estimated number of houses built with basements is determined.

Emission Factors

	Single-family Construction ton PM_{10}/acre/month	**Two-family Construction** ton PM_{10}/acre/month	**Multi-family Construction** ton PM_{10}/acre/month
PM_{10} Emission Factor	0.032	0.032	0.11
Duration of Activity	6 months	6 months	12 months

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

$$E_{RC\ I} = E_{RC-SFH} + E_{RC-2FAM} + E_{RC-MF}$$

Where:

$E_{RC\ i}$ = Emissions of pollutant i in tons per year from residential construction activity

E_{RC-SFH} = Emissions of pollutant i in tons per year from residential single-family home construction activity

$E_{RC-2FAM}$ = Emissions of pollutant i in tons per year from residential two-family home construction activity

E_{RC-MF} = Emissions of pollutant i in tons per year from residential multi-family construction activity

and:

$$E_{RC-SFH} = E_{RC-SFH,\ w\ BM} + E_{RC-SFH\ ,\ w/o\ BM}$$

Where:

$E_{RC-SFH,\ w\ BM}$ = Emissions of pollutant i in tons per year from residential single-family home construction activity of homes with basements

$E_{RC-SFH,\ w/o\ BM}$ = Emissions of pollutant i in tons per year from residential single-family home construction activity of homes without basements

$$E_{RC-SFH,\ w/o\ BM} = \frac{HS_{SFH} \times (1 - HS_{SFH,w\ BM}) \times (AD_{RC-SFH}) \times (PD_{RC-SFH}) \times EF_{RC-SFH}}{2000}$$

Where:

$E_{RC-SFH,\ w/o\ BM}$ = Emissions of pollutant i in tons per year from residential single-family home construction activity

HS_{SFH} = Residential single-family housing starts

$HS_{SFH,\ w\ BM}$ = Percent of residential single-family housing starts with basements

AD_{RC-SFH} = Acres disturbed per housing type (residential single-family)

PD_{RC-SFH} = Average project duration in months

$EF_{RC-SFH\ i}$ = Emissions factor in tons PM10/acre/month for pollutant i

$E_{RC-SFH,\ w\ BM}$ = Emissions from residential construction + Emissions from basement excavation

$$E_{RC-SFH,\ w\ BM} = \frac{[HS_{SFH} \times HS_{SFH,w\ BM} \times (AD_{RC-SFH}) \times (PD_{RC-SFH}) \times EF_{RC-SFH}] + [HS_{SFH} \times HS_{SFH,w\ BM} \times AHS_{RC-SFH} \times ABD_{RC-SFH} \times PDE_{RC-SFH} \times EF_{Acres\text{-}Disturb}]}{2000}$$

Where:

$E_{RC-SFH,\ w\ BM}$ = Emissions of pollutant i in tons per year from residential single-family home construction activity

HS_{SFH} = Residential single-family housing starts

$HS_{SFH,\ w\ BM}$ = Percent of residential single-family housing starts with basements

AD_{RC-SFH} = Acres disturbed per housing type (residential single-family)

PD_{RC-SFH} = Average project duration in months

$EF_{RC-SFH\ i}$ = Emissions factor in tons PM10/acre/month for pollutant i

AHS_{RC-SFH} = Average residential single-family house size (national default = 2000 ft^2)

ABD_{RC-SFH} = Average basement depth for residential single-family homes (national default = 8 ft)

PDE_{RC-SFH} = Peripheral dirt excavated for residential single-family homes (national default = 10 percent)

$EF_{Acres\text{-}Disturb}$ = Emissions factor for the acres disturbed during basement excavation activities during residential single-family home construction in tons PM_{10}/1000 cubic yards

4.1.7.2 **Heavy Construction Activity**

SCC: 23 11 020 000

Description

Emissions produced from the construction of nonresidential buildings are estimated using the value of construction put in place. The national value of construction put in place is obtained from the Bureau of the Census[72]. The national value of construction put in place is allocated to the state level using non-residential building construction employment data within NAIC Code 2362 obtained from 2010 County Business Patterns[73]. The state value of construction put in place is allocated to the county level using non-residential building construction employment data within NAIC Code 2362 obtained from the 2010 County Business Patterns for the State of Maryland.

Pollutants

PM_{10} and $PM_{2.5}$

Method and Data Sources

Activity

ARMA used data from the U.S. Census Bureau on the national value of construction put in place- Not Seasonally Adjusted. The national value of construction put in place is allocated to the state level and then to the county level using non-residential building construction employment data within NAIC 2362 obtained from 2010 County Business Patterns.

A conversion factor of 1.301 acres/10^6 dollars ($) is applied to the construction valuation data. This conversion factor is developed by adjusting the1999 value of 2 acres/$\$10^6$ to 1999 - 2010 constant dollars using The Bureau of Labor Statistics *Producer Price Index*[74] for Construction. The duration of construction activity for nonresidential construction is estimated to be 11 months.

Employee numbers were taken from County Business Patterns 2010 - Maryland, NAIC 2362, Non-residential Building Construction (see Appendices). Some county employment data is represented by a letter code indicating a range for the number of employees for that

[72] Bureau of Census, Annual Value of Construction Put in Place - Not Seasonally Adjusted in the United States: 2010; http://www.census.gov/const/C30/priv2008.pdf

[73] U.S. Census Bureau, County Business Patterns, NAIC Code 2362, Industry Nonresidential Building Construction 2010 http://censtats.census.gov/cgi-bin/cbpnaic/cbpsect.pl

[74] U.S. Census Bureau, County Business Patterns, 2010 http://quickfacts.census.gov/qfd/states/24000.html Select county then "Browse more data sets" then County Business Patterns Economic Profile for 2007 – Repeat for each county.

SIC. In this case the arithmetic average number of employees per letter code per county was adjusted so that the state total employment in a NAIC matched the sum of the number of employees reported per county.

Emission Factors

	PM_{10} (tons/acre/month)	$PM_{2.5}$ (tons/acre/month)
Emissions	0.11	20% of PM_{10}
Duration of Project	11 months	

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

Value of Construction Work in the U.S. - HC_J	$**261,776,000,000**
Number of Employees within NAIC 2362 in the U.S. - EMPus	766,961

Number of Employees within NAIC 2362 in Maryland 13936

$E_{HC\,i}$ = HC_j **x** (EMPj / EMPus) x CF_{HC} **x** $AEF_{HC\,i}$ **x** DC_{HC}

Where:

$E_{HC,i}$ = Emissions of pollutant i in tons per year from heavy construction
HC_J = Value of Heavy construction in US j in 2010
EMPus = Employment NAICS 2362 US in 2010
EMPj = Employment NAICS 2362 County j in 2010
CF_{HC} = Conversion factor (acres/million dollars) for heavy construction (1.262)
$AEF_{HC\,i}$ = Adjusted Emissions factor in tons per acre per month for pollutant i
DC_{HC} = Duration of construction activity (11 months)

<u>2011 Sample Calculation Heavy Construction (Anne Arundel County)</u>

Number of Employees within NAIC 2362 in Anne Arundel County 904

PE = precipitation-evaporation value for each State,
S = % dry silt content in soil for area being inventoried

$AEF_{HC\,i}$ = Initial $EF_{HC\,I}$ x (24/PE) x (S/9%)

$AEF_{HC\,i}$ = 0.19(PM_{10}) x (24/114.1) x (33/9%)

$AEF_{HC\,i}$ = 0.771253287

$E_{HC\,i}$ = HC_j **x** (EMPj / EMPus) x CF_{HC} **x** $EF_{HC\,i}$ **x** DC_{HC}

$E_{HC\,i}$ = **261,776,000,000 x** (904 / 766,961) x 1.264 **x** 0.19(PM_{10}) **x** 11

$E_{HC\,i}$ = 628.614 tons/year PM_{10}

4.1.7.3 **Road Construction Activity**

SCC: 23 11 030 000

Description

This source category covers fugitive dust emissions from road construction activity. PM_{10} emissions produced by road construction are estimated using an emission factor for heavy construction and the State capital outlay for new road construction.

Pollutants

PM_{10} and PM_{25}

Method and Data Sources

Activity

To estimate the acres disturbed by road construction, the Federal Highway Administration (FHWA) has *Highway Statistics, Section IV - Highway Finance, Table SF-12A, State Highway Agency Capital Outlay*[1] for 2011 which outlines spending by state in several different categories. For this SCC, the following columns are used: New Construction, Relocation, Added Capacity, Major Widening, and Minor Widening. These columns are also differentiated according to the following six classifications:

- Interstate, urban
- Interstate, rural
- Other arterial, urban
- Other arterial, rural
- Collectors, urban
- Collectors, rural

Dollar expenditures are converted to miles constructed using data obtained from the North Carolina Department of Transportation (NCDOT) in 2000. A conversion of $4 million/mile is applied to the interstate expenditures. For expenditures on other arterial and collectors, a conversion factor of $1.9 million/mile is applied, which corresponds to all other projects.

.

Miles are converted to acres for each of the 6 road type areas using the following estimate of acres disturbed per mile:

- Interstates: Urban, Rural, and Urban Other Arterial - 15.2 Acres Disturbed/mile
- Rural, Other Arterials - 12.7 Acres Disturbed/mile
- Urban, Collectors - 9.8 Acres Disturbed/mile
- Rural, Collectors - 7.9 Acres Disturbed/mile

Emission Factors

A PM_{10} emission factor of 0.42 tons/acre/month is used to account for the large amount of dirt moved during the construction of roadways. The duration of construction activity for road construction is estimated to be 12 months.

PM_{25} emissions are estimated by applying a particle size multiplier of 0.10 to PM_{10} emissions.

Soil Moisture Level
To account for the soil moisture level, base emissions were multiplied by 24 divided by the precipitation-evaporation (PE) value. Precipitation-Evaporation (PE) values were obtained from Thornthwaite's PE Index. Average PE values for each State were estimated based on PE values for specific climatic divisions within a State. These values range from 7 to 41.

Silt Content
To account for the silt content, base emissions were multiplied by percent dry silt content in soil divided by 9 percent. A data base containing county-level dry silt values were applied to PM_{10} emissions for each county. These values were derived by applying a correction factor developed by the California Air Resources Board to convert wet silt values to dry silt values.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

For construction emissions, a control efficiency of 50 percent is used for both PM_{10} and $PM_{2.5}$ for PM nonattainment areas.

Spatial and Temporal Allocations

Spatial
State-level estimates of acres disturbed are distributed to counties according to the housing starts per county, estimated for the residential construction category.

Temporal
A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

$$E_{RC,\,i} = \frac{Exp \times MC_i \times ADi \times EF_{RC\,i} \times DUR}{2000}$$

Where:

$E_{RC,i}$	=	Emissions of pollutant i in tons per year from road construction
$Exp_{RC,i}$	=	Expenditures per road type i
$MC_{RC,i}$	=	Miles constructed per road type i
AD_i	=	Acres disturbed per road type i
$EF_{RC\,i}$	=	Emissions factor (tons per acre per month for pollutant i)
DUR	=	Duration of project (months)

This calculation would have to be made for each road classification in a county and then summed to get total for that pollutant for that county.

4.1.7.4 **Agricultural Land Preparation**

SCC: 28 01 000 003

Description

The land preparation source category includes estimates of the airborne soil particulate emissions produced during the preparation of agricultural lands for planting and after harvest activities. Operations included in this methodology are dicing, tilling, leveling, chiseling, plowing, and other mechanical operations used to prepare the soil. Dust emissions are produced by the mechanical disturbance of the soil by the implement used and the tractor pulling it. Soil preparation activities tend to be performed in the early spring and fall months.

Particulate emissions from land preparation operations are computed by multiplying an emission factor (EF) by an activity factor. The agricultural tilling emission factor provided in the 4th edition of U.S. EPA's AP-42 document is used to estimate soil preparation emissions. The activity factor is based on the number of acres of each crop in production for each county in the State. Because different crops need different operations to prepare the soil, each crop also has its own acre-pass value. Acre-passes are the number of passes, per acre, that are typically needed to prepare a field for planting a particular crop. By combining the crop acreage, crop specific acre-pass data, and the agricultural tilling emission factor, we estimate the particulate matter produced by agricultural land preparation operations.

Agricultural soil preparation particulate dust emissions are estimated *for each crop* in each county in Maryland using the following equation:

$$\text{Emissions}_{\text{CROP}} = \text{Emission Factor} \times \text{Acres}_{\text{CROP}} \times \text{Acre-passes/acre}_{\text{CROP}}$$

The crop emissions for each county are summed to produce the county and statewide particulate matter (PM) and PM emission estimates.

Pollutants

PM_{10} and $PM_{2.5}$

Method and Data Sources

Activity

The acreages used for estimating soil preparation emissions were collected from the Maryland Cooperative Extension Service and the Maryland Agricultural Statistics Service. A summary of crop acreage harvested in 2010 thru 2011 from individual county agricultural commissioner reports was used to calculate emissions.

In computing land preparation PM emissions, acre-passes are the number of passes typically performed to prepare a crop for planting. These operations may occur following harvest or closer to planting, and can include dicing, tilling, land leveling, and other operations. Each crop is different in the type of soil operations performed and when they occur. MDE used acre-pass estimates compiled by the California Air Resources Board (CARB). For the crops that were not explicitly updated, we either applied an updated crop profile from a similar crop, or used one of the existing CARB profiles.

Emission Factors

The emission factor used to estimate the dust emissions from agricultural land preparations is from U.S. EPA's AP-42[1]. This emission factor was developed in 1981 based on test data measured in California and Kansas by Midwest Research Institute. Because of a lack of more detailed estimates, this single emission factor is used for all land preparation operations, all locations, and all seasons. The form of the emission factor is:

Emission Factor (lbs PM/acre-pass) = $k\ (4.8)\ (s)^{0.6}$

Where:

k = particle size fraction of interest (EPA default = 0.042 for $PM_{2.5}$ or 0.21 for PM_{10})
s = average percent soil silt content (EPA default = 18%)

For PM the value of 'k' used in California is 0.148. This is based on the EPA estimate that 33% of the total particulate entrained to the air during agricultural operations is 30 microns or less. Of this, analysis of California soil samples indicates that about 45% of the 30 micron or less sized particles are 10 microns or less in aerodynamic size (i.e., PM). So, the California PM particle size multiplier is 0.148 (i.e., 0.33 x 0.45 = 0.148). Maryland decided to use the EPA default values listed above for the particle size fraction. For the percent soil silt value, the EPA default value of 18% soil silt is used for most counties.

	$PM_{2.5}$ (Lbs. $PM_{2.5}$ /acre-pass)	PM_{10} (Lbs. PM_{10} /acre-pass)
Emission Factor	1.141968254	5.709841268

The EPA emission factor does not include an association between soil moisture and emissions. Because it is known that dust emissions are reduced when soil moisture is higher, California ARB staff has incorporated an emission correction during the wettest months of the year. The correction was based on some limited agricultural dust source test

[1] U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, AP-42, Section 11.2.2, Fourth Edition. September 1985.

data, as well as the control factor used for watering at construction sites and their best judgment. During December and March, California ARB reduced the emission factor by 25% from the standard uncorrected value. In January and February, often the wettest months, the emission factor is reduced by 50%. This produces a seasonal emissions profile that is more consistent with California's actual ambient air dust levels, and also better reflects that soil preparation operations typically do not occur while the soil is excessively wet or muddy.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial

Crop acreages are collected on a county basis.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

In collecting updated acre-pass data, California also collected detailed information on when agricultural operations occur. Using these data, it was possible to create detailed temporal profiles that help to indicate when PM emissions from land preparations may be highest. The more detailed background document includes detailed crop calendars for each crop with updated information. For all of the acre-pass and crop calendar information, the farmers and other agricultural experts of the San Joaquin Valley were instrumental in helping us to update our crop information.

Emissions Calculation

$$E_{ALP\,i} = \frac{EF_{ALP\,i} \times A_I \times AP_I}{2000}$$

Where:

E_{ALP} = Annual PM emissions of pollutant i in tons per day from agricultural land preparations.

$EF_{ALP\ i}$ = Emissions factor in pounds per acre-pass for pollutant i

A_i = Acres of crop I harvested in county j in 2011

AP_i = Acre-passes per acres for crop i

<u>2011 Sample Calculation Agricultural Land Preparation (Alleghany County):</u>

$$E_{ALP\ PM2.5} = \frac{EF_{ALP\ PM2.5} \mathbf{x} [(A_{wheat} \mathbf{x} AP_{wheat}) + (A_{corn\text{-}gr} \mathbf{x} AP_{corn\text{-}gr}) + (A_{hay} \mathbf{x} AP_{hay}) + (A_{soy} \mathbf{x} AP_{soy}) + (A_{barley} \mathbf{x} AP_{barley})}{2000}$$

$$E_{ALP\ PM2.5} = (1.141968254 \text{ x } [(0 \text{ x } 1) + (500 \text{ x } 4) + (7{,}500 \text{ x } 1) + (0 \text{ x } 6) + (0 \text{ x } 1)) / 2000$$

$$E_{ALP\ PM2.5} = (1.141968254 \text{ x } 9{,}500)/2000$$

$E_{ALP\ PM2.5}$ = 5.42 tons per year of PM2.5

4.1.7.5 **Paved Roads**

SCC: 22 94 000 000

Description

This source category covers fugitive dust emissions from activity on paved roads.
ONLY A GENERAL OUTLINE OF HOW THIS SOURCE WAS CALCULAED WILL BE GIVEN DUE TO THE LARGE NUMBER OF CALCULATIONS NEEDED TO SHOW A SAMPLE CALCULATION FOR ANY ONE COUNTY.

Pollutants

PM_{10} and $PM_{2.5}$

Method and Data Sources

Activity

The basis for the activity data for fugitive dust emissions from paved roads is the state-level vehicle miles traveled per paved road type and the state-level vehicle miles traveled per unpaved road per road type.

Emission Factors

To calculate emissions for Paved Roads we used the The Predictive Emission Factor Equation 13.2.1.3 from AP-42, Fifth Edition, Vol. I Chapter 13: Miscellaneous Sources and the particle size multipliers, k from Table 13.2.1-1.
Several factors used for Paved Road emissions calculations came from 2008 Emission Inventory Data & Documentation http://www.epa.gov/ttn/chief/net/2008inventory.html) Nonpoint section for Paved Roads. Such as, Silt Loading factors for Maryland from Table 2, factors below:

Roadway Class	sL (g/m^2)
Rural Interstate	0.015
Rural Other Principal Arterial	0.03
Rural Minor Arterial	0.06
Rural Major Collector	0.2
Rural Minor Collector	0.2
Rural Local	0.6
Urban Interstate	0.015
Urban Other Freeways and Expressways	0.015
Urban Other Principal Arterial	0.03
Urban Minor Arterial	0.03
Urban Collector	0.06
Urban Local	0.2

The old calculation equation is

$$EF_{CF} = k\,(sL/2)^{0.98} \times (W/3)^{0.53} \times (S/30)^{0.16} \times (CF)$$

The new calculation equation is

$$EF_{PAV} = [(k) \times (sL)^{0.91} \times (W)^{1.02}] \times (1\text{-}P/4N)$$

EF_{CF} = A calculated emission factor for a given road type in a month having *CF* precipitation

EF_{PAV} = A calculated emission factor for a given road type in a month

k = particle size multiplier; particle size range and units used were 0.015 (lb/VMT) for PM10, and 0.0037 (lb/VMT) for PM2.5 from Table 13.2.1-1. PARTICLE SIZE MULTIPLIERS FOR PAVED ROAD EQUATION

sL = road surface silt loading (grams per square meter) (g/m^2),

W = average weight (tons) of the vehicles traveling the road (Maryland estimates the average wt. to be 6,360 pounds or 3.18 tons)

P = number of "wet" days with at least 0.254 mm (0.01 in) of precipitation during the averaging period

N = number of days in the averaging period (e.g., 365 for annual, 91 for seasonal, 30 for monthly

S = average speed (mph) of the vehicles traveling the road.

CF = Correction factor for monthly rain/precipitation

2008 average with 2011 bold monthly rain/precipitation

MONTH	P No. of Days of Rain > 0.01 inches	No. of Days of Snow > 1.0 inches	No. of Days of Rain & Snow > 0.01 inches	N Days in Averaging Period	CF_{RAIN}
Jan	7	**0**	**9**	**31**	0.9274
Feb	9	**1**	**9**	**28**	0.9196
Mar	12	**0**	**11**	**31**	0.9113
Apr	20	**0**	**12**	**30**	0.9000
May	14	**0**	**9**	**31**	0.9274
Jun	12	**0**	**9**	**30**	0.9250
Jul	9	**0**	**11**	**31**	0.9113
Aug	15	**0**	**4**	**31**	0.9677
Sep	15	**0**	**9**	**30**	0.9250
Oct	14	**0**	**4**	**31**	0.9677
Nov	10	**0**	**7**	**30**	0.9417
Dec	9	**1**	**14**	**31**	0.8871

(Maryland estimates the average speed (S) to be:

Road Type	Speed (mph)
Rural Interstate	65.5
Rural Other Principal Arterial	51.7
Rural Minor Arterial	46.2
Rural Major Collector	41.7
Rural Minor Collector	40
Rural Local	30.9
Urban Interstate	58.1
Urban Other Freeways and Expressways	55.5
Urban Other Principal Arterial	28.7
Urban Minor Arterial	27.8
Urban Collector	24.6
Urban Local	21.1

A temporal VMT fraction factor was supplied by which was used to breakdown yearly VMT into seasonal and then monthly VMT (millions of miles by road type).

LookUp	RUR_URB	SEASON	VMTFRAC
RURALWINTER	RURAL	WINTER	0.2199
RURALSPRING	RURAL	SPRING	0.2403
RURALSUMMER	RURAL	SUMMER	0.2845
RURALFALL	RURAL	FALL	0.2553
URBANWINTER	URBAN	WINTER	0.236
URBANSPRING	URBAN	SPRING	0.2547
URBANSUMMER	URBAN	SUMMER	0.264
URBANFALL	URBAN	FALL	0.2453

A Transport factor (***TF***) also of 1, was used in estimation. The transport factor relates to the Modelers, and it is the fraction of Paved Road Dust PM that is transported more than a few yards. An emission factor was created for each month, for each road type, and each county, almost 14,000 emission factors.

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Annual Rural Traffic VMT (millions of miles)

FUNCTIONAL CLASS	State County FIPs	Rural Rural Inter-State	Rural Rural Other Principal Arterial	Rural Rural Minor Arterial	Rural Rural Major Collector	Rural Rural Minor Collector	Rural Rural Local	TOTAL RURAL
ALLEGANY	24001	179	30	51	28	50	43	**381**
ANNE ARUNDEL	24003	324	79	174	58	32	94	**761**
BALTIMORE	24005	434	68	104	204	44	120	**974**
CALVERT	24009	0	331	19	48	38	59	**495**
CAROLINE	24011	0	101	111	73	53	42	**380**
CARROLL	24013	0	54	247	127	62	63	**553**
CECIL	24015	455	52	220	57	53	116	**953**
CHARLES	24017	0	288	82	108	55	71	**604**
DORCHESTER	24019	0	122	81	33	59	35	**330**
FREDERICK	24021	513	337	129	210	127	176	**1492**
GARRETT	24023	179	70	68	70	91	57	**535**
HARFORD	24025	466	80	174	128	68	125	**1041**
HOWARD	24027	269	83	87	100	28	80	**647**
KENT	24029	0	30	51	56	26	20	**183**
MONTGOMERY	24031	142	0	106	93	40	51	**432**
PRINCE GEORGE'S	24033	39	159	32	88	39	47	**404**
QUEEN ANNE'S	24035	0	540	79	90	56	105	**870**
ST. MARY'S	24037	0	153	175	96	63	63	**550**
SOMERSET	24039	0	99	36	29	31	24	**219**
TALBOT	24041	0	245	100	33	33	56	**467**
WASHINGTON	24043	512	24	134	122	96	117	**1005**
WICOMICO	24045	0	231	19	51	50	44	**395**
WORCESTER	24047	0	227	37	58	33	48	**403**
BALTIMORE CITY	24510	0	0	0	1	1	0	**2**
GRAND TOTALS		**3512**	**3403**	**2316**	**1961**	**1228**	**1656**	**14076**

Annual Urban Traffic VMT (millions of miles)

FUNCTIONAL CLASS	State County FIPs	Urban Urban Inter-state	Urban Urban Freeways & Express-ways	Urban Urban Other Principal Arterial	Urban Urban Minor Arterial	Urban Urban Collector	Urban Urban Local	TOTAL URBAN
ALLEGANY	24001	162	0	168	65	28	33	**456**
ANNE ARUNDEL	24003	907	1532	903	762	453	351	**4908**
BALTIMORE	24005	3449	470	1140	1173	477	517	**7226**
CALVERT	24009	0	31	114	34	49	18	**246**
CAROLINE	24011	0	0	0	0	0	0	**0**
CARROLL	24013	39	0	479	77	67	51	**713**
CECIL	24015	127	13	171	37	26	29	**403**
CHARLES	24017	0	0	378	141	75	46	**640**
DORCHESTER	24019	0	0	38	11	9	4	**62**
FREDERICK	24021	549	306	167	163	177	105	**1467**
GARRETT	24023	0	0	1	0	0	0	**1**
HARFORD	24025	283	135	434	252	131	95	**1330**
HOWARD	24027	1084	1069	224	448	260	238	**3323**
KENT	24029	0	0	12	6	2	2	**22**
MONTGOMERY	24031	2473	227	2134	1047	598	499	**6978**
PRINCE GEORGE'S	24033	2879	1502	1706	970	632	592	**8281**
QUEEN ANNE'S	24035	0	47	2	5	0	4	**58**
ST. MARY'S	24037	0	8	194	33	33	21	**289**
SOMERSET	24039	0	46	0	7	8	5	**66**
TALBOT	24041	0	0	110	10	11	10	**141**
WASHINGTON	24043	457	0	216	153	62	69	**957**
WICOMICO	24045	0	184	155	109	88	41	**577**
WORCESTER	24047	0	26	204	36	18	22	**306**
BALTIMORE CITY	24510	1044	138	1164	690	237	252	**3525**
GRAND TOTALS		**13453**	**5734**	**10114**	**6229**	**3441**	**3004**	**41975**

VMT should be converted into monthly totals by county by road type using seasonal fraction factors.

$Ert = \boldsymbol{EF}_{CF} \times VMT \times \boldsymbol{TF}$

Where:

Ert = is the emissions for a particular road type

VMT = the vehicle miles traveled in millions of miles on a particular road type

***TF* = 1**

4.1.7.6 **Unpaved Roads**

SCC: 22 96 000 000

Description

This source category covers fugitive dust emissions from activity on unpaved roads.

Pollutants

PM_{10}-PRI, PM_{10}-FIL, PM_{25}-PRI, PM_{25}-FIL

Method and Data Sources

Activity

The basis for the activity data for fugitive dust emissions from unpaved roads is the county-level miles of unpaved roads. The unpaved road mileage is converted to county-level vehicle miles traveled per unpaved road type by the following equation:

$$VMT_{UNPAVED\ (x,\ i)} = \frac{ADTV_{(i)} * MILES_{UNPAVED\ (x,\ i)} * DAYS_{YR}}{1{,}000{,}000}$$

Where:

$VMT_{UNPAVED\ (x,\ i)}$:	Annual vehicle miles traveled for county x and road type i (in millions)
$ADTV_{(i)}$:	Average Daily Traffic Volume for road type i
$MILES_{UNPAVED\ (x,\ i)}$:	Miles of unpaved roads in county x and road type i
$DAYS_{YR}$:	Days per year (365) conversion of daily traffic to annual traffic

Maryland received unpaved road mileage by county from the Maryland State Highway Administration. The unpaved road mileage data was divided into two functional classes, (Rural Local and Urban Local). The Rural Local and Urban Local roads were further divided into Rural Unpaved and Urban Unpaved roads. The VMT for Unpaved and Unimproved urban and local roads was calculated and then summed by county.

Mileage on urban and rural local roads was broken down into two groups of average daily travel volume (ADTV) in the 1996 Highway Statistics publication (the last year that data was published). These groups are shown in Table 3.2.7.6.a. Maryland used a reasonable assumption that no more than 50 vehicles travel its urban and rural local unpaved roads daily. The assumed ADTV is 5 for both urban and rural groups (<50 Rural Local volume group).

Table 3.8.1.6.a **Assumed Values for Average Daily Traffic Volume by Volume Group**

Rural Roads				
Volume Category (vehicles per day per mile)	< 50	50-199	200-499	> 500
Assumed ADTV	5*	125**	350**	550***
Urban Roads				
Volume Category (vehicles per day per mile)	< 200	200-499	500-1999	> 2000
Assumed ADTV	20*	350**	1250**	2200***

Notes: *10% or volume group's maximum range endpoint, ** Average of volume group's range endpoints, *** 110% or volume group's minimum

Table 3.8.1.6.b **Daily VMT by County and Road Class**

County Name	2011 Daily VMT Rural rt210	2011 Daily VMT Urban rt330
ALLEGANY	0.2076	0.5947
ANNE ARUNDEL	0.0032	0.0529
BALTIMORE	0.0024	0.0368
CALVERT	0.1063	0.1260
CAROLINE	0.4473	0.0000
CARROLL	0.1949	0.2587
CECIL	0.0467	0.0424
CHARLES	0.0215	0.0422
DORCHESTER	0.1420	0.0983
FREDERICK	0.1695	0.4235
GARRETT	0.1852	0.0000
HARFORD	0.0896	0.3122
HOWARD	0.0023	0.0162
KENT	0.0031	0.0011
MONTGOMERY	0.0076	0.2619
PRINCE GEORGE'S	0.0041	0.1557
QUEEN ANNE'S	0.0553	0.0365
ST. MARY'S	0.0246	0.0150
SOMERSET	0.0456	0.0427
TALBOT	0.0086	0.0051
WASHINGTON	0.0544	0.1170
WICOMICO	0.0762	0.1659
WORCESTER	0.0437	0.0759
BALTIMORE CITY	0.0000	0.0542

Unpaved road VMT was calculated first by State and roadway class using temporally allocated NAPAP Inventory factors (seasonal temporal allocations factors or VMT fractions – VMTFRAC values). These factors are provided in the EPA publication, "Paved and Unpaved Road VMT temp factors.xls". The seasonal VMT fractions were then multiplied by the ratio of the number of days in a month to the number of days in a season to adjust to monthly VMTFRAC. The emission factors were then applied to estimate emissions by month.

Below is Table 3.8.1.6.c and d

Seasonal VMT Fractional Values by Road Class

Rural rt210 EPA SEASON	VMTFRAC
WINTER	0.2199
SPRING	0.2403
SUMMER	0.2845
FALL	0.2553

Urban rt330 EPA SEASON	VMTFRAC
WINTER	0.2360
SPRING	0.2547
SUMMER	0.2640
FALL	0.2453

Emission Factors:

Re-entrained road dust emissions for unpaved roads were estimated using unpaved road VMT and the emission factor equation from AP-42 [76]:

$$EF = \frac{\left[k * \left(s/12\right)^a * \left(SPD/30\right)^b\right]}{\left(M/0.5\right)^c} - C$$

where k, a, b, and c are empirical constants given in Table 1 and

EF = size specific emission factor (lb/VMT)
s = surface material silt content (%)
SPD = mean vehicle speed (mph)
M = surface material moisture content (%)
C = emission factor for 1980's vehicle fleet exhaust, brake wear, and tire wear (lb/VMT)

Table 3.8.1.6.e Constants for Unpaved Roads Re-entrained Dust Emission Factor Equation

Constant	PM_{25}	PM_{10}
K (lb/VMT)	0.18	1.8
a	1	1
b	0.5	0.5
c	0.2	0.2

[76] United States Environmental Protection Agency, Office of Air Quality Planning and Standards. "Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources, Section 13.2.2 Unpaved Roads." Research Triangle Park, NC. 2003.

C	0.00036	0.00047

Source: AP-42

Average State-level unpaved silt content values, developed as part of the 1985 National Acid Precipitation Assessment Program (NAPAP) Inventory, were obtained from the Illinois State Water Survey[77]. Silt contents of over 200 unpaved roads from over 30 States were obtained. Average silt contents of unpaved roads were calculated for each State that had three or more samples for that State. For States that did not have three or more samples, the average for all samples from all States was used. Samples and default values were provided by state. Silt content (%) from (AP-42 Table 13.2.2-1) of **3.9** was used for the Unpaved/Unimproved roads.

Table 3.8.1.6.f **State-Level Unpaved Road Surface Material Silt Content Values used in MANE-VU Fugitive Dust Calculations**

State	Unpaved Road Surface Material Silt Content (%)	Data Source
Connecticut	3.9	DEFAULT
Delaware	0	No Unpaved Roads
DC	0	No Unpaved Roads
Maine	3.9	DEFAULT
Maryland	3.9	DEFAULT
Massachusetts	3.9	DEFAULT
New Hampshire	3.9	DEFAULT
New Jersey	3.9	DEFAULT
New York	4.7	SAMPLES
Pennsylvania	3.3	SAMPLES
Rhode Island	3.9	DEFAULT
Vermont	3.9	DEFAULT

Table 3.8.1.6.g lists the speeds modeled on the unpaved roads by roadway type. These speeds were determined based on national average speeds modeled for onroad emission calculations and weighted to determine a single average speed for each of the roadway types. The value of 0.5 percent for M was chosen as the national default as sufficient resources were not available to determine more locally-specific values for this variable.

[77] G. Stensland, Illinois State Water Survey, personal communication with W. Barnard of E.H. PECHAN & Associates, Inc., Durham, NC. 1989.

Table 3.8.1.6.g Speeds Modeled by Roadway Type on Unpaved Roads

Unpaved Roadway Type	Speed (mph)
Rural Minor Arterial	39
Rural Major Collector	34
Rural Minor Collector	30
Rural Local	30
Urban Other Principal Arterial	20
Urban Minor Arterial	20
Urban Collector	20
Urban Local	20

The emission factor for paved roads is calculated from the empirical AP-42 formula and then is adjusted for precipitation. Correction factors were applied to the emission factors to account for the number of days with a sufficient amount of precipitation to prevent road dust resuspension. Monthly-corrected emission factors by State and roadway classification were calculated using the following equation:

$$EF_{CORR} = EF * \left[\frac{(D - p)}{D} \right]$$

Where:
EF_{CORR} = unpaved road dust emission factor corrected for precipitation effects
EF = uncorrected emission factor
D = number of days in the month
p = number of days in the month with at least 0.01 inches of precipitation

The number of days in each county with at least 0.01 inches of precipitation in each month was obtained from the National Climatic Data Center[78]. For counties with more than one precipitation collection station with valid data from the NCDC data set, an average number of precipitation days were calculated for each month from all valid stations in the county. Counties with no precipitation collection station or no valid data were assigned the data from an adjacent county. The 2011 monthly precipitation data for MANE-VU counties were updated and are shown in Table 4. This method of assigning monthly precipitation days by county improves on the NEI approach of assigning monthly precipitation data by State. These are the same precipitation data used to calculate paved road emissions for the MANE-VU States.

Table 3.8.1.6.h **2011 Number of Days with at Least 0.01 Inches of Precipitation**

State	County	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
MD	ALLEGANY	7	9	12	20	14	12	9	15	15	14	10	9
MD	ANNE ARUNDEL	9	9	12	14	12	10	8	16	16	11	9	7
MD	BALTIMORE	4	5	7	8	8	3	3	2	13	10	8	6
MD	CALVERT	9	4	14	12	11	12	9	10	12	9	11	9
MD	CAROLINE	11	10	11	12	11	11	8	14	12	15	11	6
MD	CARROLL	12	9	11	16	15	10	7	17	22	14	8	11
MD	CECIL	8	12	11	15	10	9	9	14	19	14	10	5
MD	CHARLES	9	4	14	12	11	12	9	10	12	9	11	9
MD	DORCHESTER	9	4	14	12	11	12	9	10	12	9	11	9
MD	FREDERICK	10	9	12	16	16	10	6	14	22	11	9	7
MD	GARRETT	20	16	18	20	17	12	11	13	14	18	11	15
MD	HARFORD	8	12	11	15	10	9	9	14	19	14	10	5
MD	HOWARD	7	6	14	14	10	2	7	8	10	11	8	8
MD	KENT	11	8	9	15	8	8	7	16	13	11	7	6
MD	MONTGOMERY	10	9	12	17	12	7	7	13	18	12	8	11
MD	PRINCE GEORGE'S	9	10	12	15	13	8	6	11	14	16	9	9
MD	QUEEN ANNE'S	11	10	11	12	11	11	8	14	12	15	11	6
MD	ST. MARY'S	8	6	12	10	11	7	9	11	13	10	9	6
MD	SOMERSET	10	7	12	10	7	8	9	12	12	9	12	9
MD	TALBOT	9	7	11	12	11	11	9	14	12	13	9	10
MD	WASHINGTON	11	10	14	15	16	5	10	16	16	12	8	7
MD	WICOMICO	12	9	12	9	9	14	9	13	13	11	10	8
MD	WORCESTER	10	7	12	10	7	8	9	12	12	9	12	9
MD	BALTIMORE CITY	9	10	10	13	11	8	7	16	13	11	7	6

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

[78] U.S. Department of Commerce, National Oceanic and Atmospheric Administration. Summary of the Day Element TD-3200, 2002 data provided on CD. National Climatic Data Center. 2003.

Adjustment for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial

BMC provided miles of unpaved roads at the county-level to spatially allocate emission estimates.

Temporal

The unpaved road VMT data were temporally allocated by month using the NAPAP [79] temporal allocation factors. A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

AP-42 Unpaved Roads Emission Factor Formula

$$EF = \frac{\left[k * \left(s/12 \right)^{a} * \left(SPD/30 \right)^{b} \right]}{\left(M/0.5 \right)^{c}} - C$$

Where k, a, b, and c are empirical constants given in Table 1 and

EF = size specific emission factor (lb/VMT)
s = surface material silt content (%)
SPD = mean vehicle speed (mph)
M = surface material moisture content (%)
C = emission factor for 1980's vehicle fleet exhaust, brake wear, and tire wear (lb/VMT)

Calculate Local Unpaved Roads Emission Factors
Example: Anne Arundel County - Local Rural Unpaved Roads – PM_{25}

[79] U.S. Environmental Protection Agency. "The 1985 NAPAP Emissions Inventory: Development of Temporal Allocation Factors," EPA-600/7-89-010d. Air & Energy Engineering Research Laboratory. Research Triangle Park, NC. April 1990.

$$EF_{PM\,25} = \frac{\left[k * \left(s/12\right)^{a} * \left(SPD/30\right)^{b}\right]}{\left(M/0.5\right)^{c}} - C$$

$$EF_{PM\,25} = \frac{\left[0.27 * \left(3.9/12\right)^{1} * \left(30/30\right)^{0.5}\right]}{\left(0.5/0.5\right)^{0.2}} - 0.00036$$

$$EF_{PM\,25} = 0.08739$$

Adjust Emission Factor Formula for Precipitation

$$EF_{CORR} = EF * \left[\frac{(D-p)}{D}\right]$$

Where:

EF_{CORR} = unpaved road dust emission factor corrected for precipitation effects
EF = uncorrected emission factor
D = number of days in the month
p = number of days in the month with at least 0.01 inches of precipitation

Calculate Unpaved Roads Emission Factors Adjusted for Precipitation
(Example Calculation: Anne Arundel County – July – PM_{25})

$$EF_{PM\,25-CORR} = EF_{PM\,25} * \left[\frac{(D-p)}{D}\right]$$

$$EF_{PM\,25-CORR} = 0.08739 * \left[\frac{(31-8)}{31}\right]$$

$$EF_{PM\,25-CORR} = 0.064838$$

<u>Emission Equation:</u>

$$EM_{PM\,25} = \frac{EF_{PM\,25-CORR} * VMT * VMTFRAC}{2000} * \left[1 - (CE * RE * RP)\right]$$

Where:

EM_{PM25} = PM_{25} emissions in tons per year for unpaved roads in county i
VMT_i = Annual VMT (million miles of Vehicle Miles Traveled for county i)
VMTFRAC = Temporal Allocation Factor
$EF_{PM25\text{-}CORR\,i}$ = Unpaved road emission factor adjusted for precipitation in county i

CE = Control efficiency of 0% applied to Urban and Rural roads
RE = Rule effectiveness of 100% applied to Urban and Rural roads
RP = Rule penetration of 100% applied to Urban and Rural roads

<u>Sample Calculation Unpaved Roads (Anne Arundel County - July)</u>

$$EM_{PM25} = \frac{EF_{PM25-CORR} * VMT * VMTFRAC}{2000} * [1 - (CE * RE * RP)]$$

$$EM_{PM25} = \frac{0.0648377 * 0.0001533 * 0.09586}{2000} * [1 - (0 * 100 * 100)]$$

$EM_{PM25} = 4.764$ x E-10 Tons

4.1.8 FIRE SOURCES

Other area sources include forest fires, slash and prescribed burning, agricultural burning, structure fires, orchard heaters, leaking underground storage tanks and natural organic sources. Although often intermittent in nature, many of these sources can produce large quantities of air pollutant emissions.

Date: September 10, 2012
This note is intended to support the DRAFT 2011 day-specific emissions estimates that EPA has posted for Wild Land Fires (WLF= prescribed and wild fires) intended for the NEI EVENT data category. These data are posted as .csv files for every state. The state FIPS is used in the title of the file to identify the area in question. The methods used by EPA reflect use of the SMARTFIRE2 (SF2) framework. We have provided background on these methods as part of the training(s) we have offered over the past few months on the 2011 NEI submittal process. For further information on this training, please see our 2011 webpage under "Events Inventory" training at: http://www.epa.gov/ttn/chief/eidocs/training.html#eis.
For the 2011 cycle, EPA is offering three options for SLTs to submit WLF emissions into the EVENTS module.

Note: EPA's methods will be reporting all Wild Fires to SCC 281001000; all Prescribed Fires to 2811015000; all Wild Land Fire Use to 2810001001. MDE calculated and reported emissions for Prescribed Fires.

Option 1: Review the DRAFT 2011 emission estimates and report back to EPA through a Support Request in the Emission Inventory System (EIS) indicating that your agency accepts the EVENT data from EPA.

4.1.8.1 **Vehicle Fires**

SCC: 28 10 001 000

Description

This emission guidance report covers air emissions from accidental vehicle fires. Vehicles included are any commercial or private mode of transportation that is authorized for use on public roads.

Pollutants

PM_{10}, NOx, CO, VOC

Method and Data Sources

Activity

Local data was collected from state or local fire marshals and public safety departments. See the spatial apportioning section for available information sources.

Emission Factors

Emission factors are available for open burning of automobile components including upholstery, belts, hoses, and tires (AP-42, Section 2.5 Open Burning) (EPA, 1996)[80]. The amount of vehicle material burned (the fuel loading) in a vehicle fire must be estimated to use these factors. A conservative assumption is that an average vehicle has 500 pounds of components that can burn in a fire, based on a 3,700 pound average vehicle weight (CARB, 1995)[81]. Maryland used a more conservative assumption based on a 2,000 pound average vehicle weight. EPA and ERTAC committee through a joint study estimated PM2.5-PRI to be 100 lbs per ton of material burned in fire. Also, EIIP, Vehicle Fires – January 1999 and 2000.

Pollutant	Lbs/ton burned
VOC	32
NOx	4
CO	125
PM10-PRI	100
PM2.5-PRI	100

[80] EPA. 1996. *Compilation of Air Pollutant Emission Factors--Volume I: Stationary Point and Area Sources. Fifth Edition, AP-42.* U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. (GPO 055-000-00251-7). Research Triangle Park, North Carolina

[81] CARB. 1995. Emission Inventory Procedural Manual, Vol. III: Methods for Assessing Area Source Emissions. California Environmental Protection Agency: Air Resources Board.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial

The activity data for vehicle fires was collected at a county-level. No other method to spatially profile the vehicle fire source category was used.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

$$E_{VF,i} = \frac{VB_j \times FLF_{VF} \times EF_{VF\,i}}{2000}$$

Where:

$E_{VF,i}$ = Emissions of pollutant i in tons per year from vehicle fires

VB_J = Vehicles burned in county j in 2011

FLF_{VF} = Fuel loading factor (tons/vehicle burned) for vehicle fires (500 lbs/2000 lb auto) which is also equal to 0.25 tons/vehicle burned

$EF_{VF\,i}$ = Emissions factor in pounds per ton burned for pollutant i

<u>2011 Sample Calculation Vehicle Fires (Anne Arundel County)</u>

$$E_{VF,i} = \frac{VB_j \times FLF_{VF} \times EF_{VOC}}{2000}$$

$$E_{VF,i} = \frac{(241 \times (0.25) \times 32)}{2000}$$

$E_{VF,i}$ = 0.96 tons VOC per year emitted from vehicle fires in Anne Arundel County in 2011

4.1.8.2 **Forest Fires**

SCC: 28 10 001 000 (Wildfires)

(MDE accepted EPA's Wild Fire Emissions generated by their SmartFire Tool, but calculated emissions for forest fires in order to compare them with the tool.)

4.1.8.3 **Slash/Prescribed Burning**

SCC: 28 10 015 000 (prescribed burn)
SCC: 28 10 005 000 (slash burn)

Description

Slash burning is a technique used to control waste from logging operations burned under controlled conditions to reduce the potential fire hazard in forests and to remove brush that can serve as a host for destructive insects. Also, to cleared forest to create fields for farming, pastures for livestock, and many other reasons. Prescribed burning is used as a forest management practice to establish favorable seedbeds, remove competing underbrush, accelerate nutrient cycling, control tree pests and contribute other ecological benefits.

Pollutants

PM_{10} and $PM_{2.5\text{-}PRI}$

Method and Data Sources

Activity

Emissions from this source were calculated using data from the Maryland Forest Service for prescribed burning by county and type of material burned (see Appendices).

Emission Factor

	VOC (Lbs./ton)	CO (Lbs./ton)	NOx (Lbs./ton)	PM10-FIL (Lbs./ton)	PM2.5-FIL (Lbs./ton)	SO2 (Lbs./ton)
Prescribed Marsh Grass	13.6	289	6.2	28.1	24.1	1.7
Pine Slash	19	140	4	17	unavailable	unavailable

Fuel loading factors:	tons/acre
Prescribed	2
Slash	30

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial

The activity data for prescribed burning was collected at a county-level. No other method to spatially profile the prescribed burning source category was used.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

$$E_{PB\,i} = \frac{AB_j \times EF_{PB\,i} \times FLF_m}{2000}$$

Where:

$E_{PB,i}$ = Emissions of pollutant i in tons per year from prescribed burning

FLF_m = Fuel loading factor for type of material burned j (for marsh grass the factor is 2 tons per acre and for pine slash it is 30 tons per acre burned)

AB_k = Acres burned in county k in 2011

$EF_{PB,i}$ = Emission factor for pollutant i

<u>2011 Sample Calculation Prescribed Burning (Frederick County)</u>

$$E_{PB\,i} = \frac{AB_j \times EF_{PB\,i} \times FLF_m}{2000}$$

$$E_{PB\,i} = \frac{(55.5 \times 13.6 \times 2)}{2000}$$

$$E_{PB\,i} = 0.75 \text{ tons VOC / year}$$

Slash burning calculations are done in a similar manner.

4.1.8.4 **Agricultural Burning**

SCC: 21 01 500 000

Description

This source category covers agricultural burning practices used to clear and/or prepare land for planting. Operations included under this category are stubble burning, burning of agricultural crop residues, and burning of standing field crops as part of harvesting (e.g., sugar cane).

Pollutants

PM_{10} and $PM_{2.5}$

Method and Data Sources

Emissions from this source were assigned to the open burning category because the county permits issued in 2008 did not require information distinguishing the amount of agricultural waste to be burned versus other materials.

4.1.8.5 **Structure Fires**

SCC: 28 10 030 000

Description

Building fires produce short-term emissions of organic compounds.

Pollutants

PM_{10} and $PM_{2.5}$

Method and Data Sources

MDE staff used emission factors, fuel loading factors and methodology documented in EIIP[82], Structure Fires, dated July 1999.

Activity

The Maryland State Fire Marshal's office provided the number of structure fires by county.

Emission Factors

	VOC (lbs./ton)	NOx (lbs./ton)	CO (lbs./ton)	PM10-PRI (lbs./ton)
Emissions	11.0	1.4	60.0	10.8
Fuel loading factor:	1.15	Tons/fire		

[82] Emission Inventory Improvement Program

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial

The activity data for structure fires was collected at a county-level. No other method to spatially profile the prescribed burning source category was used.

Temporal

A SAF was applied to emissions and were averaged according to period of operation to a daily estimate.

Emissions Calculation

$$E_{SF\,i} = \frac{SF_k \times EF_{SF\,i} \times FLF_{SF}}{2000}$$

where:

$E_{FF,i}$ = Emissions of pollutant i in tons per year from structure fires

FLF_{SF} = Fuel loading factor (tons/acre burned) for structure fires

SF_k = Structure fires in county k in 2011

$EF_{SF,i}$ = Emission factor for pollutant i in pounds per ton

ARMA used an activity level of 7 days a week with no seasonal variation as given in Table 5.8-1 in the EIIP document.

<u>2011 Sample Calculation Structure Fires (Baltimore County)</u>

<u>Equation:</u>

$$E_{SF\,i} = \frac{SF_k \times EF_{SF\,i} \times FLF_{SF}}{2000}$$

$$E_{SF\,i} = \frac{310 \times 11 \times 1.15}{2000}$$

$$E_{SF\,i} = 1.96 \text{ tons}_{VOC} / \text{year}$$

4.1.8.6 **Orchard Heaters**

SCC: 28 01 520 000

Description

In areas of the country where frost threatens orchards, heaters may be used in cold portions of the growing season.

Pollutants

PM_{10} and $PM_{2.5}$

Method and Data Sources

Calls to several orchards in Washington and Frederick Counties (where most of the orchards in Maryland are located), revealed that no heaters were used. One orchard used fans to move air on still nights when there would be danger of frost to fruit tree blossoms. Therefore, orchard heaters are not included in Maryland's baseline inventory.

4.1.9 AMMONIA SOURCES

4.1.9.1 INTRODUCTION

Currently, there is a significant amount of uncertainty concerning the contribution of soil to ammonia emission levels. High quality emission factors for this category do not exist, and even the physics of ammonia-surface exchange is not well understood. Soils emit and uptake ammonia so it is difficult to evaluate the net contribution, emissions may be potentially significant in some regions if the uptake is not substantial. Indeed, the literature shows that a soil-plant canopy system can be a source of ammonia emissions under certain conditions and a sink under other conditions. Because of this uncertainty, the State of Maryland has decided not to include emissions from soils. MDE inventoried the following sources for ammonia emissions.

- Agricultural Livestock Production Operations
- Agricultural Fertilizer Application
- Mobile Sources
- Publicly Owned Treatment Works (POTWs)
- Human activity

4.1.9.2 Emission Calculations Methodology

Normally, the Department use the Carnegie Mellon University Ammonia Model (CMU-Ammonia Model version 3.6) [83] computer program to develop an ammonia emissions inventory. However, for the 2011 NEI emissions inventory cycle, MDE has accepted EPA's 2011 emissions inventory data.

The CMU-Ammonia Model program is an approve methodology by EPA for developing ammonia source categories emissions inventory. Basically, the CMU-Ammonia Model program multiplies emission factors per source category by its particular activity data

4.1.9.3 Agricultural Livestock Production Operations

Livestock waste is one of the most important sources of ammonia when considering the sheer magnitude of the emissions. Existing ammonia inventories indicate that livestock wastes are responsible for 50-70% of national ammonia emissions. The United States Department of Agriculture publishes the Census of Agriculture (USDA, 2007), conducted every five years, which includes accurate inventories for livestock; however, the categories of animals reported at the county level differ from the categories of animals for which current emission factors exist. 2007 activity data were used from the USDA Census of Agriculture data to develop the 2011 ammonia emission inventory.

[83] Copyright 2004, *CMU- NH3 Ammonia Model Inventory Version 3.6 computer program.* Departments of Civil and Environmental Engineering and Engineering and Public Policy Porter Hall Room 119, Carnegie Mellon University, 5000 Forbes Ave, Pittsburgh, PA 15213

4.1.9.4 **Dairy Cattle (cows)**

SCC: 2805001100 (Beef feedlots (drylots) Confinement)
2805001200 (Beef Manure handling & storage)
2805002000 (Beef Not Elsewhere Classified)
2805003100 (Beef pasture Confinement)
2805018000 (Not elsewhere classified Composite)
2805019100 (Flush Confinement)
2805019200 (Flush Manure handling & storage)
2805019300 (Flush Land application of manure)
2805021100 (Scrape Confinement)
2805021200 (Scrape Manure handling & storage)
2805021300 (Scrape Land application of manure)
2805022100 (Deep pit Confinement)
2805022200 (Deep pit Manure handling & storage)
2805022300 (Deep pit Land application of manure)
2805023100 (Drylot pasture Confinement)
2805023200 (Drylot pasture Manure handling & storage)
2805023300 (Drylot pasture Land application of manure)

Description

These animals and livestock are sources of ammonia emissions that are due to the biological decomposition of their waste products.

Pollutants

NH_3

Method and Data Sources

Conceptually, the method for estimating emissions from cattle is to count the number of animals, then multiply this by the average emissions per animal, and the resulting value provides the emissions. The CMU Ammonia Model v.3.6 program utilizes this approach, a methodology approved by EPA for developing the emissions inventory for other categories.

Activity

The U.S. Census Bureau was use to obtain activity level data for this category.

Emission Factors

Emission factors are the defaulted values in the CMU ammonia model (version 3.6).

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

The CMU ammonia model automatically applies controls, when applicable for a given year.

Spatial and Temporal Allocations

Spatial

The CMU ammonia model spatially allocates activity data emissions. Input files specify the state or county then set up county-level allocations factor files for the chosen state.

Temporal

The CMU-NH3 ammonia model temporally allocates activity data to the different months of the year or annually (yearly). Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

Emissions Calculation

Equation:

2011 TPY ammonia emissions for cows in an individual county

$$EM_{COWS\text{-}2011\ Total} = 2011EM_{BC} + 2011\ EM_{MC} + 2011EM_{HF} + 2011\ EM_{ST}$$

Where:

$EM_{COWS\text{-}2011\ Total}$ = Total NH3 emissions from cows, all categories

EM_{BC} = 2011 Uncontrolled emissions from beef cows

EM_{MC} = 2011 Uncontrolled emissions from milk cows

EM_{HF} = 2011 Uncontrolled emissions from heifers

EM_{ST} = 2011 Uncontrolled emissions from steers

Where:

$EM_{BC} = (AC_{BC} * EF_{BC})$

$EM_{MC} = (AC_{BC} * EF_{MC})$

$EM_{HF} = (AC_{BC} * EF_{HF})$

$EM_{ST} = (AC_{BC} * EF_{ST})$

Where:

AC_{BC} = Activity level (number) of beef cows

AC_{MC} = Activity level (number) of milk cows

AC_{HF} = Activity level (number) of heifers

AC_{ST} = Activity level (number) of steers

EF_{BC} = Emission factor for beef cows

EF_{MC} = Emission factor for milk cows

EF_{HF} = Emission factor for heifers

EF_{ST} = Emission factor for steers

4.1.9.5 **Hogs and Pigs**

SCC: 28 05 025 000 (Swine Composite)

Description

These animals and livestock are sources of ammonia emissions that are due to the biological decomposition of their waste products.

Pollutants

NH_3

Method and Data Sources

Conceptually, the method for estimating emissions from hogs and pigs are to count the number of animals, then multiply this by the average emissions per animal, and the resulting value provides the emissions. The CMU Ammonia Model v.3.6 program utilizes this approach, a methodology approved by EPA for developing the emissions inventory for other categories.

Activity

The U.S. Census Bureau, 2007 was used to obtain activity level data for this category.

Emission Factors

Emission factors are the defaulted values in the CMU ammonia model (version 3.6).

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

The CMU ammonia model automatically applies controls, when applicable for a given year.

Spatial and Temporal Allocations

Spatial

The CMU ammonia model spatially allocates activity data emissions. Input files specify the state or county then set up county-level allocations factor files for the chosen state.

Temporal

The CMU-NH3 ammonia model temporally allocates activity data to the different months of the year or annually (yearly). Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

Emissions Calculation

Equation:

2011 TPY ammonia emissions for swine in an individual county

$$EM_{SWINE\text{-}2011\ Total} = 2011\ EM_{HOGS} + 2011\ EM_{PIGS}$$

Where:

$EM_{SWINE\text{-}2011\ Total}$ = Total NH3 emissions from swine, all categories
EM_{HOGS} = 2011Uncontrolled emissions from hogs
EM_{PIGS} = 2011 Uncontrolled emissions from pigs

Where:

$$EM_{HOGS} = (AC_{HOGS} * EF_{HOGS})$$
$$EM_{PIGS} = (AC_{PIGS} * EF_{PIGS})$$

Where:

AC_{HOGS} = Activity level (number) of hogs
AC_{PIGS} = Activity level (number) of pigs
EF_{HOGS}= Emission factor for hogs
EF_{PIGS} = Emission factor for pigs

4.1.9.6 **Chickens (Pullets, Layers, Broilers, and Misc Poultry)**

SCC: 28 05 007 100 (Chickens Composite)
28 05 007 300 (Chickens Composite)
28 05 008 100 (Chickens Composite)
28 05 008 200 (Chickens Composite)
28 05 008 300 (Chickens Composite)
28 05 009 100 (Chickens Composite)
28 05 009 200 (Chickens Composite)
28 05 009 300 (Chickens Composite)
28 05 030 000 (Misc Poultry)

Description

These animals and livestock are sources of ammonia emissions that are due to the biological decomposition of their waste products.

Pollutants

NH_3

Method and Data Sources

Conceptually, the method for estimating emissions from chickens composite is to count the number of animals, then multiply this by the average emissions per animal, and the resulting value provides the emissions. The CMU Ammonia Model v.3.6 program utilizes this approach, a methodology approved by EPA for developing the emissions inventory for other categories.

Activity

The U.S. Census Bureau, 2007 was used to obtain activity level data for this category.

Emission Factors

Emission factors are the defaulted values in the CMU ammonia model (version 3.6).

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

The CMU ammonia model automatically applies controls, when applicable for a given year.

Spatial and Temporal Allocations

Spatial

The CMU ammonia model spatially allocates activity data emissions. Input files specify the state or county then set up county-level allocations factor files for the chosen state.

Temporal

The CMU-NH3 ammonia model temporally allocates activity data to the different months of the year or annually (yearly). Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

Emissions Calculation

Equation:

2011 TPY ammonia emissions for chickens in an individual county

$$EM_{CHICKENS\text{-}2011\ Total} = 2011\ EM_{PULLET} + 2011\ EM_{LAYER} + 2011\ EM_{BROILER}$$

Where:

$EM_{CHICKENS\text{-}2011\ Total}$ = Total NH3 emissions from chickens, all categories

EM_{PULLET} = 2011 Uncontrolled emissions from pullets

EM_{LAYER} = 2011 Uncontrolled emissions from layers

$EM_{BROILER}$ = 2011 Uncontrolled emissions from broilers

Where:

$$EM_{PULLET} = (AC_{PULLET} * EF_{PULLET})$$

$$EM_{LAYER} = (AC_{LAYER} * EF_{LAYER})$$

$$EM_{BROILER} = (AC_{BROILER} * EF_{BROILER})$$

Where:

AC_{PULLET} = Activity level (number) of pullet chickens

AC_{LAYER} = Activity level (number) of layer chickens

$AC_{BROILER}$ = Activity level (number) of broiler chickens

EF_{PULLET} = Emission factor for pullet chickens

EF_{LAYER} = Emission factor for layer chickens

$EF_{BROILER}$ = Emission factor for broiler chickens

4.1.9.7 **Sheep**

SCC: 28 05 040 000 (Sheep Composite)

Description

These animals and livestock are sources of ammonia emissions that are due to the biological decomposition of their waste products.

Pollutants

NH_3

Method and Data Sources

Conceptually, the method for estimating emissions from sheep composite is to count the number of animals, then multiply this by the average emissions per animal, and the resulting value provides the emissions. The CMU Ammonia Model v.3.6 program utilizes this approach, a methodology approved by EPA for developing the emissions inventory for other categories.

Activity

The U.S. Census Bureau, 2007 was used to obtain activity level data for this category.

Emission Factors

Emission factors are the defaulted values in the CMU ammonia model (version 3.6).

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

The CMU ammonia model automatically applies controls, when applicable for a given year.

Spatial and Temporal Allocations

Spatial

The CMU ammonia model spatially allocates activity data emissions. Input files specify the state or county then set up county-level allocations factor files for the chosen state.

Temporal

The CMU-NH3 ammonia model temporally allocates activity data to the different months of the year or annually (yearly). Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

Emissions Calculation

Equation:

2011 TPY ammonia emissions for sheep in an individual county

$$EM_{SHEEP} = AC_{SHEEP} * EF_{SHEEP}$$

Where:

EM_{SHEEP} = Total NH3 emissions from sheep, all categories

AC_{SHEEP} = Activity level (number) of sheep

EF_{SHEEP} = Emission factor for sheep

4.1.9.8 **Goats (Angora and Milk)**

SCC: 28 05 045 001(Goats Composite)

Description

These animals and livestock are sources of ammonia emissions that are due to the biological decomposition of their waste products.

Pollutants

NH_3

Method and Data Sources

Conceptually, the method for estimating emissions from goats are to count the number of animals, then multiply this by the average emissions per animal, and the resulting value provides the emissions. The CMU Ammonia Model v.3.6 program utilizes this approach, a methodology approved by the EPA for developing the emissions inventory for other categories.

Activity

The U.S. Census Bureau, 2007 was used to obtain activity level data for this category.

Emission Factors

Emission factors are the defaulted values in the CMU ammonia model (version 3.6).

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

The CMU ammonia model automatically applies controls, when applicable for a given year.

Spatial and Temporal Allocations

Spatial

The CMU ammonia model spatially allocates activity data emissions. Input files specify the state or county then set up county-level allocations factor files for the chosen state.

Temporal

The CMU-NH3 ammonia model temporally allocates activity data to the different months of the year or annually (yearly). Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

Emissions Calculation

Equation:

2011 TPY ammonia emissions for goats in an individual county

$$EM_{GOATS\text{-}2011\ Total} = 2011\ EM_{AG} + 2011\ EM_{MG}$$

Where:

$EM_{GOATS\text{-}2011\ Total}$ = Total NH3 emissions from goats, all categories

EM_{AG} = 2011 Uncontrolled emissions from angora goats

EM_{MG} = 2011 Uncontrolled emissions from milk goats

Where:

$EM_{AG} = (AC_{AG} * EF_{AG})$

$EM_{MG} = (AC_{AG} * EF_{AG})$

Where:

AC_{AG} = Activity level (number) of angora goats

AC_{MG} = Activity level (number) of milk goats

EF_{AG} = Emission factor for angora goats

EF_{MG} = Emission factor for milk goats

4.1.9.9 **Horses**

SCC: 28 05 035 000 (Horses)

Description

These animals and livestock are sources of ammonia emissions that are due to the biological decomposition of their waste products.

Pollutants

NH_3

Method and Data Sources

Conceptually, the method for estimating emissions from horses are to count the number of animals, then multiply this by the average emissions per animal, and the resulting value provides the emissions. The CMU Ammonia Model v.3.6 program utilizes this approach, a methodology approved by EPA for developing the emissions inventory for other categories.

Activity

The U.S. Census Bureau, 2007 was used to obtain activity level data for this category.

Emission Factors

Emission factors are the defaulted values in the CMU ammonia model (version 3.6).

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

The CMU ammonia model automatically applies controls, when applicable for a given year.

Spatial and Temporal Allocations

Spatial

The CMU ammonia model spatially allocates activity data emissions. Input files specify the state or county then set up county-level allocations factor files for the chosen state.

Temporal

The CMU-NH3 ammonia model temporally allocates activity data to the different months of the year or annually (yearly). Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

Emissions Calculation

Equation:

2011 TPY ammonia emissions for horses in an individual county

$$EM_{HORSE} = AC_{HORSE} * EF_{HORSE}$$

Where:

EM_{HORSE} = Total NH3 emissions from horses, all categories

AC_{HORSE} = Activity level (number) of horses

EF_{HORSE} = Emission factor for horses

4.1.9.10 **Ducks, Geese and Turkeys**

SCC: 28 05 030 007 (Ducks)
SCC: 28 05 010 100 (Turkeys)
28 05 010 200
28 05 010 300
SCC: 28 05 030 008 (Geese)

Description

These animals and livestock are sources of ammonia emissions that are due to the biological decomposition of their waste products.

Pollutants

NH_3

Method and Data Sources

Conceptually, the method for estimating emissions from ducks, geese and turkeys are to count the number of animals, then multiply this by the average emissions per animal, and the resulting value provides the emissions. The CMU Ammonia Model v.3.6 program utilizes this approach, a methodology approved by EPA for developing the emissions inventory for other categories.

Activity
The U.S. Census Bureau, 2007 was used to obtain activity level data for this category.

Emission Factors
Emission factors are the defaulted values in the CMU ammonia model (version 3.6).

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

The CMU ammonia model automatically applies controls, when applicable for a given year.

Spatial and Temporal Allocations

Spatial
The CMU ammonia model spatially allocates activity data emissions. Input files specify the state or county then set up county-level allocations factor files for the chosen state.

Temporal
The CMU-NH3 ammonia model temporally allocates activity data to the different months of the year or annually (yearly). Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

Emissions Calculation

Equation:

2011 TPY ammonia emissions for ducks in an individual county

$$EM_{DUCKS} = AC_{DUCKS} * EF_{DUCKS}$$

Where:
EM_{DUCKS} = Total NH3 emissions from ducks, all categories
AC_{DUCKS} = Activity level (number) of ducks
EF_{DUCKS} = Emission factor for ducks

4.1.9.11 **Agricultural Fertilizer Application**

SCC: 28 01 700 001 (Anhydrous Ammonia)
28 01 700 002 (Aqueous Ammonia)
28 01 700 003 (Nitrogen Solutions)
28 01 700 004 (Urea)
28 01 700 005 (Ammonium Nitrate)
28 01 700 006 (Ammonium Sulfate)
28 01 700 007 (Ammonium Thiosulfate)
28 01 700 010 (Mix-N-P-K MGN Fertilizers)
28 01 700 011 (Calcium Ammonium Nitrate)
28 01 700 012 (Potassium Nitrate)
28 01 700 013 (Diammonium Phosphate)
28 01 700 014 (Monoammonium Phosphate)
28 01 700 015 (Liquid Ammoniu Polyphosphate)
28 01 700 099 (Miscellaneous Fertilizers)

Description:

Fertilizer in this category refers to any nitrogen-based compound, or mixture containing such a compound, that is applied to land to improve plant fitness. The consumption of fertilizer data includes total fertilizer sales or shipments for farm and non-farm usage. Fertilizer application is typically considered to be the second or third most important source on a national level.

Fertilizer emissions were calculated per fertilizer types per SCC listed above. These fertilizer types are the activity input files for the CMU Ammonia Model v.3.6.

Finally, ammonia emissions from fertilizer application have a strong temporal component that has previously been ignored; yearly averages have been used in existing inventories. Significantly more fertilizer is applied in the spring and fall than in the summer and winter, corresponding to crop cycles. To improve temporal allocation, USDA data on crop planting times and fertilizer application times and rates were used to generate a monthly distribution of fertilizer application.

Pollutants

NH_3

Method and Data Sources

The method for estimating emissions from fertilizer sources is simple: collect data on the amount of fertilizer sold to farmers and non-farms in a specific county, and then multiply this by the per cent of ammonia released per fertilizer application (that is **Table: Fertilizer Nitrogen Content**), and the resulting value provides the emissions. The fertilizer activity files provided with the CMU Ammonia Model v.3.6 were use and county-level ammonia emissions were then calculated by running the model. The model corrects for the difference in mass between nitrogen and ammonia.

Activity

Activity level data for fertilizer application was obtained from the Fertilizer Institute's Commercial Fertilizers 2007 reports and the Association of American Plant and Food Control Officials (AAPFCO). These fertilizer reports show sales to farmers and non-farms per county level activities. AAPFCO dataset only contained state-level resolution; the USGS dataset was used to allocate the AAPFCO state-level data to county-level.

Emission Factors

Emission factors (percent of Nitrogen volatilized as Ammonia) were collected from 2004 CMU Ammonia Model v.3.6 run and is presented in the table below:

Emission Factors and Source

Fertilizer Type	Emission Factor % N volatilized as NH3	Source of Emission Factor
Ammonium Nitrate	2.0	CMU NH3 Model v.3.6
Ammonium Sulfate	10.0	CMU NH3 Model v.3.6
Ammonium Thiosulfate	2.5	CMU NH3 Model v.3.6
Anhydrous Ammonia	4.0	CMU NH3 Model v.3.6
Aqueous Ammonia	4.0	CMU NH3 Model v.3.6
Calcium Ammonium Nitrate	2.0	CMU NH3 Model v.3.6
Diammonium Phosphate	5.0	CMU NH3 Model v.3.6
Liquid Ammonium Polyphosphate	5.0	CMU NH3 Model v.3.6
Miscellaneous Fertilizers	6.0	CMU NH3 Model v.3.6
Monoammonium Phosphate	5.0	CMU NH3 Model v.3.6
Nitrogen Solutions	8.0	CMU NH3 Model v.3.6
Mix: N-P-K (multi-grade nutrient)	2.0	CMU NH3 Model v.3.6
Potassium Nitrate	2.0	CMU NH3 Model v.3.6
Urea	15.0	CMU NH3 Model v.3.6

Table: Fertilizer Nitrogen Content

Fertilizer	**Nitrogen Content (percent)**
Ammonium Nitrate	36
Ammonium Sulfate	22
Ammonium Thiosulfate	12
Anhydrous Ammonia	82
Aqueous Ammonia	21
Calcium Ammonium Nitrate	17
Diammonium Phosphate	18
Liquid Ammonium Polyphosphate	10
Miscellaneous	8
Mix	12
Monoammonium Phosphate	11
Nitrogen Solutions	29
Potassium Nitrate	14
Urea	46

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

The CMU ammonia model automatically applies controls, when applicable for a given year.

Spatial and Temporal Allocations

Spatial

The CMU ammonia model spatially allocates activity data emissions. Input files specify the state or county then set up county-level allocations factor files for the chosen state.

Temporal

Finally, ammonia emissions from fertilizer application have a strong temporal component that has previously been ignored; yearly averages have been used in existing inventories. Significantly more fertilizer is applied in the spring and fall than in the summer and winter, corresponding to crop cycles. To improve temporal allocation, USDA data on crop planting times and fertilizer application times and rates were used to generate a monthly distribution of fertilizer application (USDA, 1997; USDA-ERS, 1991; USDA-ERS, 1996; USDA-ERS, 1996-1997; USDA-NASS, 1992-1997a; USDA-NASS, 1992-1997b; USDA-NASS, 1992-1997c; USDA-NASS, 1992-1997d; USDA-NASS, 1992-1997a; USDA-NASS, 1995; USDA-NASS, 1997). Results show that assuming a yearly average for this category results in a substantial error for most months of the year. The CMU-NH3 ammonia model temporally allocates activity data to the different months of the year or annually (yearly). Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

Emissions Calculation

<u>Equation:</u>

<u>2011 TPY ammonia emissions for agricultural fertilizer sources in an individual county</u>

$$EM_{FERT\text{-}2011\ Total} = EM_{AmmNit} + EM_{AmmSul} + EM_{AmmThio} + EM_{AnhyAmm}\ EM_{AqueAmm} + EM_{CalAmmNit} + EM_{NitSol} + EM_{Urea} + EM_{DiAmmPhos} + EM_{MonoAmmPhos} + EM_{LiqAmmPhos} + EM_{PotNit} + EM_{Mix\text{-}N\text{-}P\text{-}K} + EM_{Misc}$$

Where:

$EM_{Fertilizer\text{-}2011\ Total}$ = Total NH3 emissions from agricultural fertilizer application, all categories

EM_{AmmNit} = Emissions from Ammonium Nitrate fertilizer

EM_{AmmSul} = Emissions from Ammonium Sulfate fertilizer

$EM_{AmmThio}$ = Emissions from Ammonium Thiosulfate fertilizer
$EM_{AnhyAmm}$ = Emissions from Ammonium Anhydrous Ammonia
$EM_{AqueAmm}$ = Emissions from Ammonium Aqueous Ammonia
$EM_{CalAmmNit}$ = Emissions from Calcium Ammonium Nitrate fertilizer
EM_{NitSol} = Emissions from Nitrogen Solutions fertilizer
EM_{Urea} = Emissions from Urea fertilizer
$EM_{DiAmmPhos}$ = Emissions from Diammonium Phosphate fertilizer
$EM_{MonAmmPhos}$ = Emissions from Monoammonium Phosphate fertilizer
$EM_{LiqAmmPhos}$ = Emissions from Liquid Ammonium Polyphosphate fertilizer
EM_{PotNit} = Emissions from Potassium Nitrate fertilizer
$EM_{Mix\text{-}N\text{-}P\text{-}K}$ = Emissions from Mix-N-P-K (multi-grade nutrient)
EM_{Misc} = Emissions from Miscellaneous fertilizer

Where:

EM_{AmmNit} = (AC_{AmmNit} * Per Cent Released $_{AmmNit}$)
EM_{AmmSul} = (AC_{AmmSul} * Per Cent Released $_{AmmSul}$)
$EM_{AmmThio}$ = ($AC_{AmmThio}$ * Per Cent Released $_{AmmThio}$)
$EM_{CalAmmNit}$ = ($AC_{CalAmmNit}$ * Per Cent Released $_{CalAmmNit}$)
EM_{NitSol} = (AC_{NitSol} * Per Cent Released $_{NitSol}$)
EM_{Urea} = (AC_{Urea} * Per Cent Released $_{Urea}$)
$EM_{DiAmmPhos}$ = ($AC_{DiAmmPhos}$ * Per Cent Released $_{DiAmmPhos}$)
$EM_{MonAmmPhos}$ = ($AC_{MonAmmPhos}$ * Per Cent Released$_{MonAmPhos}$)
$EM_{LiqAmmPhos}$ = ($AC_{LiqAmmPhos}$ * Per Cent Released $_{LiqAmmPhos}$)
EM_{PotNit} = (AC_{PotNit} * Per Cent Released $_{PotNit}$)
EM_{Misc} = (AC_{Misc} * Per Cent Released $_{Misc}$)
$EM_{Mix\text{-}N\text{-}P\text{-}K}$ = (AC_{Mix} * Per Cent Released $_{Mix\text{-}N\text{-}P\text{-}K}$)
$EM_{AnhyAmm}$ ($AC_{AnhyAmm}$ * Per Cent Released $_{AnhyAmm}$)
$EM_{AqueAmm}$ = ($AC_{AqueAmm}$ * Per Cent Released $_{AqueAmm}$)

Where:

AC_{AmmNit} = Activity level (amount of Ammonium Nitrate fertilizer applied per county) (Appendix 8.**)
Per Cent Released $_{AmmNit}$ = Per Cent of NH3 released during fertilizer application

4.1.9.12 **Human Breath and Perspiration**

SCC: 28 10 010 000 (Human Perspiration)

Description

Ammonia emissions from human breath and perspiration comprise a few percent of the national ammonia emission inventory.

Data Sources

Activity Data Source

The U.S. Census Bureau, 2007 was used to obtain activity level data for this category.

Temporal Allocations

Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

Emission Factor Data Source

Emission factors were obtained from 2007 CMU Ammonia Model v.3.6 run and is presented in the table below:

Emission Factors and Source

Emission Category	Emission Factor Kg NH3/person*month	Source of Emission Factor
Human Breathe & Perspiration	0.0367	CMU NH3 Model v.3.6

Method Sources

Conceptually, the method for estimating emissions from human breathe and perspiration is simple: count the number of people, and then multiply this by the average emissions per person and the resulting value provides the emissions. The CMU Ammonia Model v.3.6 program utilizes this approach, a methodology approved by EPA for developing the emissions inventory for other categories.

Equation:

2011 TPY ammonia emissions from human breathe and perspiration in an individual county

$$EM_{HUMAN\ B\&P} = AC_{HUMAN} * EF_{HUMAN\ B\&P}$$

Where:

$EM_{HUMAN\ B\&P}$ = Total NH3 emissions from human breathe and perspiration

AC_{HUMAN} = Activity level (number) of people per county

$EF_{HUMAN\ B\&P}$ = Emission factor for human breathe and perspiration

5.0 NONROAD SOURCES

5.1 NONROAD VEHICLES/ENGINES

This section contains the nonroad source emission inventory for volatile organic compounds (VOCs), nitrogen oxides (NOx), carbon monoxide (CO), sulfur oxides (SO_x), particulate matter (PM2.5 and PM10), ammonia (NH3), and toxic air pollutants. Nonroad mobile sources include motorized vehicles and equipment that are normally not operated on public roadways to provide transportation. Nonroad mobile sources are broken up into the following categories:

- Lawn and garden equipment
- Airport service equipment
- Recreational land vehicles or equipment
- Recreational Marine Equipment
- Light commercial equipment
- Industrial equipment
- Construction equipment
- Agricultural or farm equipment
- Logging equipment
- Railroads
- Commercial aviation
- Air taxis
- General aviation
- Military aviation
- Commercial marine vessels

The Department used two methodologies approved by the EPA for developing the 2011 emissions inventory for nonroad categories. One of the methodologies used consisted of employing EPA's, National Mobile Inventory Model (NMIM-April 5, 2009), which is similar to its NONROAD Emission Inventory Model. In a memorandum[84], dated June 16, 2003, EPA allowed the use of the draft NONROAD Model and associated default inputs in the development of inventories supporting State Implementation Plans (SIPs). The second methodology entailed the use of EPA emission factors.

5.2 NMIM MODEL

The National Mobile Inventory Model (NMIM) uses the current version of the NONROAD model to calculate nonroad emissions. EPA developed NMIM to produce county-level mobile source emission inventories from a national county database that can be easily updated which includes onroad and nonroad data for each state.

Both NMIM and the NONROAD Model use the same formulas and methods to calculate emissions. The difference between the two is the use of the National County Database (NCD) for inputs by NMIM. NMIM is capable of processing county-level inputs on a monthly basis in a single model run.

5.2.1 NMIM Model Improvements

NMIM's primary improvements over NONROAD Model are:

- The inclusion of all the required county data for the nation in a single database
- A Graphical User Interface (GUI)
- Shortcuts for generating national inventories
- Tools for the aggregation and post-processing, including NIF3 output
- Estimation of 33 hazardous air pollutants (HAPs) and 17 dioxin/furan congeners by ratio to various NONROAD output parameters
- Distributed processing capability to enhance performance
- NMIM allows NCD inputs to be used monthly and across other source sectors (e.g. Onroad Mobile and Nonroad); were as NONROAD Model uses NCD inputs on a annual or seasonal bases.

5.2.2 Emission Calculation Methodologies

NMIM provides consistency across the models and all pollutants by using a single input database for NONROAD criteria pollutants and HAPs. However, NMIM is not a complete GUI front end for NONROAD, nor can it replace these models for all applications, as it was designed primarily to generate national inventories. NMIM has features intended to speed its operation and minimize its output database size that also limit its capability. For example, it will not produce hourly or by

[84] USEPA Memorandum, dated June 16, 2003, from Gene Tierney or the Air Quality and Modeling Center and Leila H. Cook of the Transportation and Regional Programs Division; to Regional Mobile Source Program Manages and Staff.

model year output. NMIM, like NONROAD, does not produce emissions inventories for aircraft, locomotives, and commercial marine vessels" [1].

The NMIM model estimates emissions for each specific type of nonroad equipment by multiplying the following input data estimates:

- Equipment population for base year (or base year population grown to a future year), distributed by age, power, fuel type, and application;
- Average load factor expressed as average fraction of available power;
- Available power in horsepower;
- Activity in hours of use per year; and
- Emission factor with deterioration and/or new standards.

The emissions are then temporally and geographically allocated using appropriate allocation factors. There are several input files that provide necessary information to calculate and allocate emissions estimates. These input files correspond to the basic data needed to provide the calculations: emission factors, base year equipment population, activity, load factor, average lifetime, scrap page function, growth estimates, and geographic and temporal allocation. Default values are provided for all input files.

[1]Details of this model can be found in its user guide named "NMIM User Guide", Assessment and Standards, Division Office of Transportation, and Air Quality, U.S. Environmental Protection Agency" (EPA-420-B-09-015 April 2009) available from the EPA.

5.3 NONROAD Categories

The following is a list of each nonroad category with its description, data sources, methods used, a sample calculation, and a table with results for each county.

5.3.1 Lawn and Garden Equipment

SCC: 22 60 004 000 (2-Stroke)
22 65 004 000 (4-Stroke)
22 67 004 000 (LPG)
22 70 004 000 (Diesel)

Description

Lawn and garden equipment includes a variety of types of machinery used in the maintenance of lawns and gardens. Examples of the types of equipment included in this category are trimmers/edgers/brush cutters, lawn mowers, leaf blowers, rear engine riding mowers, front mowers, chainsaws (<4HP), shredders (<5HP), tillers (<5HP), lawn and garden tractors, wood splitters, snow blowers, chippers/stump grinders, commercial turf equipment, and other lawn and garden equipment. Emissions result from operation of the internal combustion engines that power the equipment.

Pollutants

$PM_{2.5}$, SOx, NOx, CO, VOC and HAPs

Method and Data Sources

Data sources

- The "NMIM User Guide" U.S. Environmental Protection Agency" (EPA-420-B-09-015 April 2009) and the "User's Guide for the EPA Nonroad Emissions Model Draft NONROAD 2002" (EPA420-P-02-013), contains an overview of the model, equipment types, pollutants reported, geographic a temporal coverage, the model components, model inputs, and output options. The guide documents how to install and run the model and the associated reporting utilities.

- NMIM Website: http://www.epa.gov/oms/nmim.htm

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran the NMIM model to determine the emission estimate for 2011. MDE-ARMA opted to choose monthly seasonal (Annual and Summer) period totals as the output files from the model.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

The NMIM model automatically applies controls, when applicable, for a given year.

Spatial and Temporal Allocations

Spatial

The NMIM model spatially allocates equipment populations and emissions. Input files specify the state or county then sets up the population and allocation factor data files for the chosen state.

Temporal

The NMIM model allocates activity and emissions monthly. The month of July was chosen and emissions were divided by 31 to give average daily emissions.

Emissions Calculation

The NMIM model estimates the amount of pollution emitted by a particular type of equipment during a unit of use. Typically, emission factors for nonroad sources are reported in grams per horsepower-hour (g/hp-hr), but they also may be reported in grams per mile, grams per hour, and grams per gallon. These emission factors are stored in NMIM's data input files. NMIM adjusts these emission factors as necessary to account for the effects of fuel sulfur. Emission changes with the age of the engine, often called 'deterioration', are also applied by the model.

5.3.2 Airport Service Equipment

SCC: 22 60 008 000 (2-Stroke)
22 65 008 000 (4-Stroke)
22 65 008 005 (4-Stroke)
22 67 008 005 (LPG)
22 70 008 000 (Diesel)
22 70 008 005 (Diesel)

Description

Airport service equipment includes a variety of types and sizes of machinery used to tow airplanes or for transferring luggage between a terminal and an airplane. Examples of the types of equipment included in this category are aircraft support equipment and terminal tractors. Emissions result from operation of the internal combustion engines that power the equipment.

Pollutants

PM_{10}, $PM_{2.5}$, SOx, NOx, CO, VOC

Method and Data Sources

Data sources

- The "NMIM User Guide" U.S. Environmental Protection Agency" (EPA-420-B-09-015 April 2009) and the "User's Guide for the EPA Nonroad Emissions Model Draft NONROAD 2002" (EPA420-P-02-013), contains an overview of the model, equipment types, pollutants reported, geographic a temporal coverage, the model components, model inputs, and output options. The guide documents how to install and run the model and the associated reporting utilities.

- NMIM Website: http://www.epa.gov/oms/nmim.htm

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the our department ran the NMIM model to determine the amount of emissions for Ground Support

Equipment (GSE) for all airports except where emissions were provided, like Andrews Air Force Base (AAFB). The EDMS[85] model was utilized to estimate 2011 emissions for several large airports and heliports, while emission factors from EPA's Procedures for Emission Inventories, Vol. IV; Mobile Sources, 1988 was used to calculate emissions for over 200 smaller air-scripts and airfields. MDE-ARMA opted to choose annual totals as the output files from the model. Average daily emissions can be assumed based on days of operation.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

The NMIM model automatically applies controls, when applicable, for a given year. The latest version of the EDMS model was used.

Spatial and Temporal Allocations

Spatial

The NMIM model spatially allocates equipment populations and emissions. Input files specify the state or county then sets up the population and allocation factor data files for the chosen state.

Temporal

The NMIM model allocates activity and emissions monthly. The month of July was chosen and emissions were divided by 31 to give average daily emissions.

Emissions Calculation

The NMIM model estimates the amount of pollution emitted by a particular type of equipment during a unit of use. Typically, emission factors for nonroad sources are reported in grams per horsepower-hour (g/hp-hr), but they also may be reported in grams per mile, grams per hour, and grams per gallon. These emission factors are stored in NMIM's data input files. NMIM adjusts these emission factors as necessary to account for the effects of fuel sulfur. Emission changes with the age of the engine, often called 'deterioration', are also applied by the model.

[85] Emissions & Dispersion Modeling System (EDMS) Version 5.1 for Windows from CSSI, Inc

ARMA used FAA's EDMS[86] emissions model and databases. EDMS is designed to assess the air quality impacts of airport emission sources, particularly aviation sources, which consist of aircraft, auxiliary power units, and ground support equipment. EDMS features the latest aircraft engine emission factors from the International Civil Aviation Organization (ICAO) Engine Exhaust Emissions Data Bank, vehicle emission factors from EPA MOVES2010b, and EPA-validated dispersion algorithms. Aircraft activity includes landside and airside operations.

The steps used in creating an airport emission inventory using EDMS are:

1. Open the EDMS model and create a new study for the airport in question. Enter the parameters (name, mixing height, average yearly temperature, and units of measurement) that are specific to each airport into the study. By entering the airports ID Code and years that you want to calculate emissions for the model will apply some of the parameters for you.
2. Provide EDMS with information to compute the emissions inventory. Begin by matching engines with aircraft and assigning them to the study. Select the aircraft to be used in the study (data that is collected from the airport) by picking the aircraft name from the menus. EDMS automatically associates specific aircraft with certain engine types.
3. For each aircraft fill in the yearly LTO cycles provided by surveying the airport.
4. For each aircraft fill in the average annual taxi time and queue time specific to the airport or use the EDMS provide default values.
5. Continue to add each aircraft/engine type, LTO cycle, taxi time and queue time to the study.
6. EDMS has tables built into the model that associate aircraft type with the number of engines, auxiliary power units and ground support equipment. The model also assigns default values for Takeoff Time (typically 0.3 minutes), Climb-out Time (typically 5 minutes), and Approach Time (typically 6 minutes).
7. If emissions from parking lots, roadways, stationary sources, and training fires are also required, complete the dialog boxes associated with each of these subcategories.
8. Run the EDMS emission inventory program and view the results.

[86] Emissions & Dispersion Modeling System (EDMS) Version 5.1 for Windows from CSSI, Inc.

5.3.3 Recreational Land Vehicles

SCC: 22 60 001 000 (2-Stroke)
22 65 001 000 (4-Stroke)
22 67 001 000 (LPG)
22 68 001 000 (CNG)
22 70 001 000 (Diesel)

Description

Recreational vehicles include a variety of types of vehicles used off normal roads for pleasure use. Examples of the types of vehicles included in this category are motorcycles, minibikes, and golf carts. Emissions result from operation of the internal combustion engines that power these vehicles.

Pollutants

$PM_{2.5}$ -PRI, SOx, NOx, CO, VOC and HAPs

Method and Data Sources

Data sources

- The "NMIM User Guide" U.S. Environmental Protection Agency" (EPA-420-B-09-015 April 2009) and the "User's Guide for the EPA Nonroad Emissions Model Draft NONROAD 2002" (EPA420-P-02-013), contains an overview of the model, equipment types, pollutants reported, geographic a temporal coverage, the model components, model inputs, and output options. The guide documents how to install and run the model and the associated reporting utilities.

- NMIM Website: http://www.epa.gov/oms/nmim.htm

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran the NMIM model to determine the emission estimate for 2011. MDE-ARMA opted to choose (Annual, Summer) period totals as the output files from the model.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

The NMIM model automatically applies controls, when applicable, for a given year.

Spatial and Temporal Allocations

Spatial

The NMIM model spatially allocates equipment populations and emissions. Input files specify the state or county then sets up the population and allocation factor data files for the chosen state.

Temporal

The NMIM model allocates activity and emissions monthly. The month of July was chosen and emissions were divided by 31 to give average daily emissions.

Emissions
Calculation

The NMIM model estimates the amount of pollution emitted by a particular type of equipment during a unit of use. Typically, emission factors for nonroad sources are reported in grams per horsepower-hour (g/hp-hr), but they also may be reported in grams per mile, grams per hour, and grams per gallon. These emission factors are stored in NMIM's data input files. NMIM adjusts these emission factors as necessary to account for the effects of fuel sulfur. Emission changes with the age of the engine, often called 'deterioration', are also applied by the model.

5.3.4 Recreational Marine Equipment

SCC: 22 82 005 000 (2-Stroke)
22 82 010 000 (4-Stroke)
22 82 020 000 (Diesel)

Description

Recreational marine equipment includes engines used to power recreational motor boats and sailboat auxiliary engines. Emissions result from operation of these engines.

Pollutants

$PM_{2.5}$ -PRI, SOx, NOx, CO, VOC and HAPs

Method and Data Sources

Data sources

- The "NMIM User Guide" U.S. Environmental Protection Agency" (EPA-420-B-09-015 April 2009) and the "User's Guide for the EPA Nonroad Emissions Model Draft NONROAD 2002" (EPA420-P-02-013), contains an overview of the model, equipment types, pollutants reported, geographic a temporal coverage, the model components, model inputs, and output options. The guide documents how to install and run the model and the associated reporting utilities.

- NMIM Website: http://www.epa.gov/oms/nmim.htm

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran the NMIM model to determine the emission estimate for 2011. MDE-ARMA opted to choose (Annual, Summer) period totals as the output files from the model.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

The NMIM model automatically applies controls, when applicable, for a given year.

Spatial and Temporal Allocations

Spatial

The NMIM model spatially allocates equipment populations and emissions. Input files specify the state or county then sets up the population and allocation factor data files for the chosen state.

Temporal

The NMIM model allocates activity and emissions monthly. The month of July was chosen and emissions were divided by 31 to give average daily emissions.

Emissions
Calculation

The NMIM model estimates the amount of pollution emitted by a particular type of equipment during a unit of use. Typically, emission factors for nonroad sources are reported in grams per horsepower-hour (g/hp-hr), but they also may be reported in grams per mile, grams per hour, and grams per gallon. These emission factors are stored in NMIM's data input files. NMIM adjusts these emission factors as necessary to account for the effects of fuel sulfur. Emission changes with the age of the engine, often called 'deterioration', are also applied by the model.

5.3.5 Light Commercial Equipment

SCC: 22 60 006 000 (2-Stroke)
22 65 006 000 (4-Stroke)
22 67 006 000 (LPG)
22 68 006 000 (CNG)
22 70 006 000 (Diesel)

Description

Light commercial equipment includes a variety of types and sizes of machinery used in small commercial applications. Examples of the types of equipment included in this category are pumps, generators, compressors, and welders. Emissions result from operation of the internal combustion engines that power the equipment.

Pollutants

$PM_{2.5}$ -PRI, SOx, NOx, CO, VOC and HAPs

Method and Data Sources

Data sources

- The "NMIM User Guide" U.S. Environmental Protection Agency" (EPA-420-B-09-015 April 2009) and the "User's Guide for the EPA Nonroad Emissions Model Draft NONROAD 2002" (EPA420-P-02-013), contains an overview of the model, equipment types, pollutants reported, geographic a temporal coverage, the model components, model inputs, and output options. The guide documents how to install and run the model and the associated reporting utilities.

- NMIM Website: http://www.epa.gov/oms/nmim.htm

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran the NMIM model to determine the emission estimate for 2011. MDE-ARMA opted to choose (Annual, Summer) period totals as the output files from the model.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

The NMIM model automatically applies controls, when applicable, for a given year.

Spatial and Temporal Allocations

Spatial

The NMIM model spatially allocates equipment populations and emissions. Input files specify the state or county then sets up the population and allocation factor data files for the chosen state.

Temporal

The NMIM model allocates activity and emissions monthly. The month of July was chosen and emissions were divided by 31 to give average daily emissions.

Emissions Calculation

The NMIM model estimates the amount of pollution emitted by a particular type of equipment during a unit of use. Typically, emission factors for nonroad sources are reported in grams per horsepower-hour (g/hp-hr), but they also may be reported in grams per mile, grams per hour, and grams per gallon. These emission factors are stored in NMIM's data input files. NMIM adjusts these emission factors as necessary to account for the effects of fuel sulfur. Emission changes with the age of the engine, often called 'deterioration', are also applied by the model.

5.3.6 Industrial Equipment

SCC: 22 60 003 000 (2-Stroke)
22 65 003 000 (4-Stroke)
22 67 003 000 (LPG)
22 68 003 000 (CNG)
22 70 003 000 (Diesel)

Description

Industrial equipment includes a variety of types and sizes of machinery. Examples of the types of equipment included in this category are forklifts, mobile refrigeration units, auxiliary engines for hydraulic pump service on garbage trucks and other large vehicles, generator and pump service for utilities, airports, and state maintenance organizations, logging, mining, quarrying, oil field operations, and portable well drilling equipment. The majority of these equipment types are found at companies operating in SIC major groups 10 through 14, 20 through 39, 50 and 51. Emissions result from the operation of the internal combustion engines that power the machines.

Pollutants

$PM_{2.5}$ -PRI, SOx, NOx, CO, VOC and HAPs

Method and Data Sources

Data sources

- The "NMIM User Guide" U.S. Environmental Protection Agency" (EPA-420-B-09-015 April 2009) and the "User's Guide for the EPA Nonroad Emissions Model Draft NONROAD 2002" (EPA420-P-02-013), contains an overview of the model, equipment types, pollutants reported, geographic a temporal coverage, the model components, model inputs, and output options. The guide documents how to install and run the model and the associated reporting utilities.

- NMIM Website: http://www.epa.gov/oms/nmim.htm

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran the NMIM model to determine the emission estimate for 2011. MDE-ARMA opted to choose (Annual, Summer) period totals as the output files from the model.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

The NMIM model automatically applies controls, when applicable, for a given year.

Spatial and Temporal Allocations

Spatial

The NMIM model spatially allocates equipment populations and emissions. Input files specify the state or county then sets up the population and allocation factor data files for the chosen state.

Temporal

The NMIM model allocates activity and emissions monthly. The month of July was chosen and emissions were divided by 31 to give average daily emissions.

Emissions Calculation

The NMIM model estimates the amount of pollution emitted by a particular type of equipment during a unit of use. Typically, emission factors for nonroad sources are reported in grams per horsepower-hour (g/hp-hr), but they also may be reported in grams per mile, grams per hour, and grams per gallon. These emission factors are stored in NMIM's data input files. NMIM adjusts these emission factors as necessary to account for the effects of fuel sulfur. Emission changes with the age of the engine, often called 'deterioration', are also applied by the model.

5.3.7 Construction Equipment

SCC: 22 60 002 000 (2-Stroke)
22 65 002 000 (4-Stroke)
22 67 002 000 (LPG)
22 68 002 000 (CNG)
22 70 002 000 (Diesel)

Description

Construction equipment includes a variety of types and sizes of machinery used in the construction of roadways and buildings. Examples of the types of equipment included in this category are bulldozers, power shovels, scrapers, haulers, and motor graders. Emissions result from the internal combustion engines used to power this equipment.

Pollutants

$PM_{2.5}$ -PRI, SOx, NOx, CO, VOC and HAPs

Method and Data Sources

Data sources

- The "NMIM User Guide" U.S. Environmental Protection Agency" (EPA-420-B-09-015 April 2009) and the "User's Guide for the EPA Nonroad Emissions Model Draft NONROAD 2002" (EPA420-P-02-013), contains an overview of the model, equipment types, pollutants reported, geographic a temporal coverage, the model components, model inputs, and output options. The guide documents how to install and run the model and the associated reporting utilities.

- NMIM Website: http://www.epa.gov/oms/nmim.htm

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran the NMIM model to determine the emission estimate for 2011. MDE-ARMA opted to choose (Annual, Summer) period totals as the output files from the model.
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Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

The NMIM model automatically applies controls, when applicable, for a given year.
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Spatial and Temporal Allocations

Spatial

The NMIM model spatially allocates equipment populations and emissions. Input files specify the state or county then sets up the population and allocation factor data files for the chosen state.

Temporal

The NMIM model allocates activity and emissions monthly. The month of July was chosen and emissions were divided by 31 to give average daily emissions.

Emissions Calculation

The NMIM model estimates the amount of pollution emitted by a particular type of equipment during a unit of use. Typically, emission factors for nonroad sources are reported in grams per horsepower-hour (g/hp-hr), but they also may be reported in grams per mile, grams per hour, and grams per gallon. These emission factors are stored in NMIM's data input files. NMIM adjusts these emission factors as necessary to account for the effects of fuel sulfur. Emission changes with the age of the engine, often called 'deterioration', are also applied by the model.

5.3.8 Agricultural Equipment

SCC: 22 60 005 000 (2-Stroke)
22 65 005 000 (4-Stroke)
22 67 005 000 (LPG)
22 68 005 000 (CNG)
22 70 005 000 (Diesel)

Description

The two types of sources within the agricultural equipment category are tractors and all other motorized equipment. Tractors account for most of the emissions produced from agricultural equipment. The primary types of equipment, other than tractors, are combines, balers, harvesters, and general-purpose machines. Emissions result from operation of the internal combustion engines that power the equipment.

Pollutants

$PM_{2.5}$ -PRI, SOx, NOx, CO, VOC and HAPs

Method and Data Sources

Data sources

- The "NMIM User Guide" U.S. Environmental Protection Agency" (EPA-420-B-09-015 April 2009) and the "User's Guide for the EPA Nonroad Emissions Model Draft NONROAD 2002" (EPA420-P-02-013), contains an overview of the model, equipment types, pollutants reported, geographic a temporal coverage, the model components, model inputs, and output options. The guide documents how to install and run the model and the associated reporting utilities.

- NMIM Website: http://www.epa.gov/oms/nmim.htm

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran the NMIM model to determine the emission estimate for 2011. MDE-ARMA opted to choose (Annual, Summer) period totals as the output files from the model.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

The NMIM model automatically applies controls, when applicable, for a given year.

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Spatial and Temporal Allocations

Spatial

The NMIM model spatially allocates equipment populations and emissions. Input files specify the state or county then sets up the population and allocation factor data files for the chosen state.

Temporal

The NMIM model allocates activity and emissions monthly. The month of July was chosen and emissions were divided by 31 to give average daily emissions.

Emissions Calculation

The NMIM model estimates the amount of pollution emitted by a particular type of equipment during a unit of use. Typically, emission factors for nonroad sources are reported in grams per horsepower-hour (g/hp-hr), but they also may be reported in grams per mile, grams per hour, and grams per gallon. These emission factors are stored in NMIM's data input files. NMIM adjusts these emission factors as necessary to account for the effects of fuel sulfur. Emission changes with the age of the engine, often called 'deterioration', are also applied by the model.

5.3.9 Logging Equipment

SCC: 22 60 004 000 (2-Stroke)
22 65 004 000 (4-Stroke)
22 70 004 000 (Diesel)

Description

Logging equipment includes chainsaws, shredders, and skidders. Emissions result from operation of the internal combustion engines that power the equipment.

Pollutants

$PM_{2.5}$ -PRI, SOx, NOx, CO, VOC and HAPs

Method and Data Sources

Data sources

- The "NMIM User Guide" U.S. Environmental Protection Agency" (EPA-420-B-09-015 April 2009) and the "User's Guide for the EPA Nonroad Emissions Model Draft NONROAD 2002" (EPA420-P-02-013), contains an overview of the model, equipment types, pollutants reported, geographic a temporal coverage, the model components, model inputs, and output options. The guide documents how to install and run the model and the associated reporting utilities.

- NMIM Website: http://www.epa.gov/oms/nmim.htm

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran the NMIM model to determine the emission estimate for 2008. MDE-ARMA opted to choose (Annual, Summer) period totals as the output files from the model.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

The NMIM model automatically applies controls, when applicable, for a given year.

Spatial and Temporal Allocations

Spatial
The NMIM model spatially allocates equipment populations and emissions. Input files specify the state or county then sets up the population and allocation factor data files for the chosen state.

Temporal
The NMIM model allocates activity and emissions monthly. The month of July was chosen and emissions were divided by 31 to give average daily emissions.

Emissions
Calculation

The NMIM model estimates the amount of pollution emitted by a particular type of equipment during a unit of use. Typically, emission factors for nonroad sources are reported in grams per horsepower-hour (g/hp-hr), but they also may be reported in grams per mile, grams per hour, and grams per gallon. These emission factors are stored in NMIM's data input files. NMIM adjusts these emission factors as necessary to account for the effects of fuel sulfur. Emission changes with the age of the engine, often called 'deterioration', are also applied by the model.

5.4 RAILROADS

SCC: 22 85 002 006 (Class I - Line Haul)
SCC: 22 85 002 007 (Class II and III)
SCC: 22 85 002 008 (Passenger)
SCC: 22 85 002 009 (Commuter)
SCC: 22 85 002 010 (Yard Engines)

Description

Railroad locomotives used in the United States are primarily of two types: electric and diesel-electric. Electric locomotives are powered by electricity generated at stationary power plants. Emissions are produced only at the electrical generation plant, which is considered a point source and therefore not included here. Diesel-electric locomotives, on the other hand, use a diesel engine and an alternator or generator to produce the electricity required to power its traction motors. Emissions produced by these diesel engines are of interest in emission inventory development. Other sources of emissions from railroad operations include the small gasoline and diesel engines used on refrigerated and heated rail cars. These engines are thermostatically controlled, working independently of train motive power, and fall in the category of nonroad equipment, addressed elsewhere in this document.

Locomotives can perform two different types of operations: Line Haul and Yard. Line haul locomotives, which perform the line haul operations, generally travel between distant locations, such as from one city to another. Yard locomotives, which perform yard operations, are primarily responsible for moving railcars within a particular railway yard. The use of these engines can be further divided into subcategories such as, Class 1, Class 2, Class3, Passenger, and Commuter.

Rail Classification – Subcategory Description:

1. A Class I railroad is a large freight railroad company, with annual operating revenue in access of $250 million dollars as defined by the Surface Transportation Board (STB) and Bureau of Labor Statistics (BLS).

2. Class II railroads are mid-sized freight-hauling railroads with revenues greater than $20.5 million, but less than $250 million for at least three consecutive years. Switching and terminal railroads are excluded from Class II status.

3. A **Class III railroad**s annual operating revenue is less than $20 million. Class III railroads are typically local short line railroads, serving a few towns or industries; many Class III railroads were once part of larger railroads.

Class II and Class III are also defined by different labor regulations creating the two classes.

4. Passenger Railroad consists of passenger trains or passenger-carrying vehicles. It may be a self powered railcars, or else a combination of one or more engines and one or more unpowered trailers. These trains travel station to station or to a depot where passengers board and get off, usually operate on a fixed schedule.

5. Commuter rail, also called **suburban rail**, transport passengers, but only between a city and outer suburbs or near by towns where people need to travel to on a daily basis, for reasons like working. Commuter trains also operate by schedules.

Pollutants

PM2.5-PRI, SOx, NOx, CO, VOC and HAPs

Method and
Data Sources:

The following thirteen railroad companies operate in Maryland and were asked to provide the amount of fuel used in 2011, and the distribution of the company's track mileage by Maryland County:

Railroad Company	Railroad Classification
1. AMTRAK	Passenger Railroad
2. Canton Railroad Company	Class III - Yard Railroad
3. CSX Transportation, Incorporated	Class I – Yard Railroad
4. Bay Coast Railroad	Class II Railroad
5. Maryland & Delaware Railroad Company	Class I – Yard Railroad
6. Maryland Midland Railway, Incorporated	Class II – Yard Railroad
7. Norfolk and Southern Railway Company	Class I – Yard Railroad
8. R. G. Steel Railroad Holdings LLC	Class III Railroad
9. Western Maryland Scenic Railroad	Class III Railroad
10. Winchester and Western Railroad Company	Class III Railroad
11. MARC	Commuter Railroad

For CSX and Norfolk railroad operating statistics contained in R-1 reports obtained from the Surface Transportation Board under the Office of Economics, Environmental Analysis and Administration were used to add in estimating the amount of fuel used within the state.

MDE received fuel usage and track mileage data from all the railroads. Fuel usage was proportioned to each county by the amount of track miles each company utilized in a county.

Activity

A survey of railroad petroleum consumption and track mileage was conducted.

Emission Factor

Emission factors were obtained from the EPA's *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*, 1992.

TABLE 4.4.1-a Emission Factor for Locomotives

	Line Haul		**Yard**
VOC	0.0179 lbs/gal	**VOC**	0.0325lbs/gal
NOx	0.3285 lbs/gal	**NOx**	0.5181 lbs/gal
CO	0.0587 lbs/gal	**CO**	0.0587 lbs/gal
SO2	0.0001 lbs/gal	**SO2**	0.0001 lbs/gal
PM10	0.0097 lbs/gal	**PM10**	0.0117 lbs/gal
PM25	0.0094 lbs/gal	**PM25**	0.0113 lbs/gal

SO_2 emissions were calculated based on a sulfur content percent weight.

EPA estimates that yard locomotives operate 365 days per year (assuming that when a yard engine is taken in for repairs it is replaced during this period) and consumes an average of 228 gallons per day.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

Controls through Tier regulations were included in the EPA estimated emission factors.

Spatial and Temporal Allocations

Spatial

Emission estimates are based on fuel consumption. Company supplied state total fuel usage was allocated to the county level by the proportion of track miles used in a particular county.

Temporal

Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

Emissions Calculation

When specific county information was not provided, the following equations were used to compute the amount of fuel consumed by each railroad in each Maryland County.

$$G_{CTY} = \frac{M_{CTY}}{M_{ST}} * G_{ST}$$

Where:

M_{CTY} = mileage of company tracks in the county
M_{ST} = mileage of company tracks in the state
G_{ST} = amount of total fuel used in gallons by the company in the state
G_{CTY} = amount of total fuel used in gallons by the company in the county

The following equation was used to calculate the emissions for line haul locomotives from each railroad company operating in a county.

$$E_{LH-i-CTY\,j} = \frac{Fuel_{CTY} \times EF_{LH}}{2000}$$

Where:

$E_{LH-i-CTY\,j}$ = Emissions from line haul railroad locomotives for pollutant i in County j
$Fuel_{CTY\,j}$ = Total amount of fuel consumed by every railroad operating in the calculated county
$Fuel_{CTY\,j}$ = $(G_{cty1} + G_{cty2} + ... + G_{cty12})$
EF_{LH} = line haul locomotive emission factor for a given pollutant

The following equation was used to calculate the yearly emissions for yard locomotives from each railroad company operating in a county.

$$E_{YL-i-CTY\,j} = \frac{N_{YL-i-CTY\,j} \times 228 \times EF_{YL} \times 365}{2000}$$

Where:

$E_{YL-i-CTY\,j}$ = Emissions from yard locomotives for pollutant i in County j
$N_{YL-i-CTY\,j}$ = number of yard locomotives operated by each railroad company in county j
$N_{YL-i-CTY\,j}$ = $(N_{cty1} + N_{cty2} + ... + N_{cty12})$
EF_{YL} = Yard locomotive emission factor for a given pollutant

Example Calculations:

Montgomery County Emissions (not reflected in emissions table)

Line Haul Emission Estimate

AMTRAK, CSX, and MARC operated line haul locomotives in the county. AMTRAK also operated one yard (switcher) locomotive in the county.

Amount of fuel used in gallons by AMTRAK's line haul locomotives in Montgomery County:

G_{cty1} = 25,463.8 gallons used in Montgomery Co. per year by AMTRAK
(Information provided by AMTRAK)

Amount of fuel used in gallons used by CSX Transportation line haul locomotives in Montgomery County:

$$G_{cty4} = \frac{\text{36.37 track miles in Montgomery Co. for CSX}}{\text{514.97 track miles in the state for CSX}} \times \text{10,512,431.53 gallons used in state per year}$$

G_{cty4} = 742,445.45 gallons used in Montgomery Co. per year by CSX

Amount of fuel in gallons used by MARC line haul locomotives in Montgomery County:

$$G_{cty12} = \frac{\text{28 track miles in Montgomery Co. for MARC}}{\text{156 track miles in the state for MARC}} \times \text{1,782,750 gallons used in state per year}$$

G_{cty12} = 319980.77 gallons used in Montgomery Co. per year by MARC

VOC Emissions from line haul locomotives in Montgomery County:

$$EM_{VOC} = \frac{(25{,}463.8 \text{ gal / yr} + 742{,}445.45 \text{ gal / yr} + 319980.77 \text{ gal / yr}) * 0.0213 \text{ lbs.}_{VOC}\text{/gal}}{(2000 \text{ lbs. per ton})}$$

EM_{VOC} = 11.53 tons $_{VOC}$ / year

NOx Emissions from line haul locomotives in Montgomery County:

$$EM_{NOX} = \frac{(25{,}463.8 \text{ gal / yr} + 742{,}445.45 \text{ gal / yr} + 319980.77 \text{ gal / yr}) * 0.4931 \text{ lbs.}_{NOX} \text{/gal}}{(2000 \text{ lbs. per ton})}$$

EM_{NOX} = 268.20 tons $_{NOX}$ / year

CO Emissions from line haul locomotives in Montgomery County:

$$EM_{CO} = \frac{(25{,}463.8 \text{ gal / yr} + 742{,}445.45 \text{ gal / yr} + 319980.77 \text{ gal / yr}) * 0.0626 \text{ lbs.}_{CO} \text{ / gal}}{(2000 \text{ lbs. per ton})}$$

EM_{CO} = 34.05 tons $_{CO}$ / year

Yard Locomotives Emission Estimate

CSX operated 2 yard locomotives in Montgomery County:

VOC Emissions from yard locomotives in Montgomery County:

$$EM_{VOC} = \frac{(2 \text{ engine} * 228 \text{ gallons per engine per day} * 0.0509 \text{ lbs.}_{VOC} \text{ / gallon}) * 365}{(2000 \text{ lbs. per ton})}$$

EM_{VOC} = 4.23 tons $_{VOC}$ / year

NOx Emissions from yard locomotives in Montgomery County:

$$EM_{NOX} = \frac{(2 \text{ engine} * 228 \text{ gallons per engine per day} * 0.5044 \text{ lbs.}_{NOX} \text{ / gallon}) * 365}{(2000 \text{ lbs. per ton})}$$

EM_{NOX} = 41.98 tons $_{NOX}$ / year

CO Emissions from yard locomotives in Montgomery County:

$$EM_{CO} = \frac{(2 \text{ engine} * 228 \text{ gallons per engine per day} * 0.0894 \text{ lbs.}_{CO} \text{ / gallon}) * 365}{(2000 \text{ lbs. per ton})}$$

EM_{CO} = 7.45 tons $_{CO}$ / year

<u>Total Emissions</u>

Emissions from maintenance equipment used in the switching yards were calculated using the EPA's Non-Road Model and then added for the appropriate county.

Total VOC Emissions for Montgomery County:

$Emis_{VOC}$ = 11.53 tons / year from line haul + 4.23 tons / year from yard + 0.4745 tons VOC / year from EPA Non-Road Model.

$Emis_{VOC}$ = **16.23** tons VOC / year

Total NOx Emissions for Montgomery County:

$Emis_{NOx}$ = 268.20 tons / year from line haul + 41.98 tons / year from yard + 0.1825 tons NOx / year from EPA Non-Road Model.

$Emis_{NOx}$ = **310.36** tons NOx / year

Total CO Emissions for Montgomery County:
$Emis_{CO}$ = 34.05 tons / year from line haul + 7.45 tons / year from yard + 18.9.1 tons CO / year from EPA Non-Road Model.
$Emis_{CO}$ = **60.47** tons CO / year

5.5 AIRCRAFT

SCC: 22 75 020 000 (Commercial Aircraft)
SCC: 22 75 050 000 (General Aviation)
SCC: 22 75 060 000 (Air Taxi)
SCC: 22 75 001 000 (Military Aviation)

Description:

This category includes three sub-categories identified as: commercial aircraft, general aviation, and military aircraft. Commercial aircraft are used in regularly scheduled flights transporting passengers, freight, or both. General aviation, which includes air taxis and commuter aviation, is used for recreational flying, business travel, personal transportation, and various other activities. Military aviation is the operation and activities of military aircraft at airports in Maryland. Air Taxi operation can be separated into its own subcategory.

Pollutants

PRI-PM_{10}, PRI-$PM_{2.5}$, SOx, NOx, CO, VOC

Method and Data Sources

ARMA used a variety of sources for data and emission calculation methods as follows:

Data sources

1) Federal Aviation Administration (FAA) website contains airport activity statistics for some Maryland airports and air fields by subcategory description, plane, and engine types.

2) Landing and takeoff cycle information was obtained from the Maryland Aviation Administration for BWI, Martin State, Military Bases, several large, and several small airport and air fields.

3) The MDE's Emission Inventory section also performed a statewide survey to obtain LTO, engine type, location, and usage data from over 200 individual airports and air fields.

Methods sources

1) For general aviation ARMA used emission factors supplied in Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources, EPA's Office of Mobile Sources, 1992. This source provided emission factors for specific commercial engine types, and alternative fleet average factors for general aviation, air taxis, and commuter aircraft.

2) For military aircraft ARMA used a composite factor from section 5.2.5, Table 5-7 of Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources, 1988. This method required ARMA to collect LTO data rather than specific aircraft data. For the 2011 inventory ARMA requested operation data for military aircraft from Maryland Army, Navy, and Air Force base environmental support offices.

3) For commercial aviation ARMA used FAA's EDMS[87] emissions model and databases. EDMS is designed to assess the air quality impacts of airport emission sources, particularly aviation sources, which consist of aircraft, auxiliary power units, and ground support equipment. EDMS features the latest aircraft engine emission factors from the International Civil Aviation Organization (ICAO) Engine Exhaust Emissions Data Bank, vehicle emission factors from EPA MOVES2010b, and EPA-validated dispersion algorithms. Aircraft activity includes landside and airside operations. EDMS defines four distinct modes of aircraft operation based upon EPA and FAA guidance: approach, taxi/idle, takeoff, and climb out. Together, these four modes constitute one Landing and Takeoff (LTO) cycle. EDMS calculates aircraft emissions based on these four modes.

4) For all aircraft types, ARMA used a default mixing height value of 3,000 feet above ground level. The mixing height is the layer of air where airplane emissions affect ground level emission concentrations. Above the mixing level, pollutants are transported away according to sections 5.2.2 of the 1992 Procedures. Because of the mixing height, ARMA assigned all aircraft emissions from a particular airport to the county where that airport was located. We assumed no seasonal variation and a seven day per week activity level.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustment for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial

Data for spatial allocation is not available for this source.

Temporal

Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

[87] Emissions & Dispersion Modeling System (EDMS) Version 5.1 for Windows from CSSI, Inc.

5.5.1 Commercial Aircraft

SCC: 22 75 020 000

Steps in Creating and Airport Emission Inventory in EDMS:

1) Open the EDMS model and create a new study for the airport in question. Choose the airport identification code. Enter the parameters (name, measuring and reporting units, and analysis year you want modeled).
2) Provide EDMS with information to compute the emissions inventory. Begin by matching engines with aircraft and assigning them to the study. Select the aircraft to be used in the study (data that is collected from the airport) by picking the aircraft name from the menus. EDMS automatically associates specific aircraft with certain engine types (Choose from list).
3) For each aircraft fill in the yearly LTO cycles provided by surveying the airport.
4) Each time you fill in LTOs the model will automatically default the taxi time and queue time specific to the specified airport or use the EDMS provide default values.
5) Continue to add each aircraft/engine type, LTO cycle until all are LTOs are entered for that study.
6) EDMS has tables built into the model that associate aircraft type with the number of engines, auxiliary power units and ground support equipment. The model also assigns default values for Takeoff Time (typically 0.3 minutes), Climb-out Time (typically 5 minutes), and Approach Time (typically 6 minutes).
7) If emissions from parking lots, roadways, stationary sources, and training fires are also required, complete the dialog boxes associated with each of these subcategories.
8) Run the EDMS emission inventory program and view the results.

Emissions Calculation

The data for aircraft engines listed below in Table 4.5.1-a, are defaults used to calculate emissions within the EDMS Model. Each mode of operation, such as, annual LTO operations, average taxi time, approach, climb-out, takeoff, and annual queue times are used in the estimation of emissions, but LTO operations was taken from FAA and airport records.

TABLE 4.5.1-a EDMS Aircraft & Engine Estimated Averages and Defaults Data

Aircraft Name	Aircraft Type	Engine Assigned	Approach Time (min)	Climb-out Time (min)	Takeoff Time (min)	Annual LTO	Taxi Time (min)	Queue Time (min)
Falcon 100	GA	TFE731-3	1.60	0.50	0.40	1825	10.50	3.00
P-337P Skymaster	GA	TSIO-360C	4.50	2.50	0.50	9490	10.50	3.00
550 Citation	GA	JT15D-4 (B,C,D)	1.60	0.50	0.40	2190	10.50	3.00
A320	Comm	CFM56-5B4	4.00	2.20	0.70	2555	10.50	3.00
AH-1	Military	T53-L-11D	6.80	6.80	0.00	1825	10.50	3.00
ATR42	Comm	PW120	4.50	2.50	0.50	2190	10.50	3.00
B727-100	Comm	JT8D-7A	4.00	2.20	0.70	8030	10.50	3.00
B737-200	Comm	JT8D-15A	4.00	2.20	0.70	21900	10.50	3.00
B737-300	Comm	CFM56-3B	4.00	2.20	0.70	13140	10.50	3.00
B737-400	Comm	CFM56-3B	4.00	2.20	0.70	3650	10.50	3.00

B737-500	Comm	CFM56-3B	4.00	2.20	0.70	8030	10.50	3.00
B737-700	Comm	CFM56-3C-1	4.00	2.20	0.70	730	10.50	3.00
B747-100	Comm	JT9D-7A	4.00	2.20	0.70	183	10.50	3.00
B757-200	Comm	PW2037	4.00	2.20	0.70	7665	10.50	3.00
B767-200	Comm	CF6-80A (A1)	4.00	2.20	0.70	1095	10.50	3.00
BAE ATP	Comm	PT6A-45	4.00	2.20	0.70	2555	10.50	3.00
BH-1900	Comm	PT6A-65B	1.60	0.50	0.40	3285	10.50	3.00
C-12A/B/C	Military	PT6A-41	3.50	0.80	0.40	730	10.50	3.00
C-130 Hercules	Military	T56-A-16	5.10	1.20	0.40	365	10.50	3.00
C-9A	Military	JT8D-9	5.10	1.20	0.40	365	10.50	3.00
Canadair Reg-100	Comm	CF34-3A1	4.00	2.20	0.70	730	10.50	3.00
Cessna 150	GA	O-200	6.00	5.00	0.30	5110	10.50	3.00
Convair liner	Comm	RDA10	4.50	2.50	0.50	365	10.50	3.00
DC10-10	Comm	CF6-50C	4.00	2.20	0.70	730	10.50	3.00
DC9-10	Comm	JT8D-7A	4.00	2.20	0.70	4380	10.50	3.00
DHC-8	Comm	PW120	4.50	2.50	0.50	3650	10.50	3.00
DHC-8-400	Comm	PW123	4.50	2.50	0.50	18250	10.50	3.00
F-16	Military	F100-PW-100	3.50	0.80	0.40	183	10.50	3.00
F-27 Series	Military	RDa7	4.50	2.50	0.50	365	10.50	3.00
Fokker 100	GA	TAY650	4.00	2.20	0.70	365	10.50	3.00
H-46 Sea Knight	Military	T58-GE-8F	6.80	6.80	0.00	183	10.50	3.00
Kingair B200	GA	PT6A-41	1.60	0.50	0.40	5840	10.50	3.00
Learjet 25B	GA	CJ610-6	1.60	0.50	0.40	1460	10.50	3.00
MD-11	Comm	CF6-80C2D1F	4.00	2.20	0.70	730	10.50	3.00
MD-80	Comm	JT8D-209	4.00	2.20	0.70	4563	10.50	3.00
MD-80-88	Comm	JT8D-217	4.00	2.20	0.70	1825	10.50	3.00
MD-90-10	Comm	V2525-D5	4.00	2.20	0.70	365	10.50	3.00
Porter PC6/B2	Military	PT6A-27	4.50	2.50	0.50	730	10.50	3.00
SF-340-A	Comm	CT7-5	4.50	2.50	0.50	730	10.50	3.00
Swearingen Merlin	Comm	TPE331-3	4.50	2.50	0.50	2920	10.50	3.00
Swearingen Merlin	Comm	TPE331-3	4.50	2.50	0.50	365	10.50	3.00

Once all of the data is entered into the model, the model produces an emission inventory. Annual emission totals inventory are listed in the table below:

The model will also produce an inventory specific to each aircraft type, which allows the data to be separated into types (commercial, general aviation, and military) of operation. For BWI the separation results in the following:

TABLE 4.5.1-b BWI Category Emissions Summary Using EDMS

NAME	CO Tons/year	VOC Tons/year	NOX Tons/year	SOX Tons/year	PM10 Tons/year	PM2.5 Tons/year
Commercial Aircraft	2553.98	322.80	1859.37	220.17	20.72	20.72
General Aviation	237.06	29.96	172.58	20.44	1.92	1.92
Air Taxi	148.16	18.73	107.86	12.77	1.20	1.20
Military Aviation	29.63	3.75	21.57	2.55	0.24	0.24
Total	**2968.83**	**375.24**	**2161.39**	**255.94**	**24.08**	**24.08**

The model was run for all aircraft at BWI, Martin State, Hagerstown Regional, Ocean City Municipal, Frederick County, and Andrews Air Force Base. Aircraft emissions for Aberdeen Phillips Air Field, and Weide Army Air Field were submitted to ARMA by the military.

5.5.2 General Aviation

SCC: 22 75 050 000

Emission Calculation

Estimates of emissions were calculated after information on the LTO operations of aircraft and operation types were obtained from Maryland's airports. This method used the alternative fleet-average procedure of Section 5.2.4.2 of Procedures, 1992. The composite emission factors used are listed in the table below.

TABLE 4.5.2-a EPA Emission Factors for Aircraft

Aviation Category	CO (lbs./LTO)	VOC (lbs./LTO)	NOx (lbs./LTO)	SO2 (lbs./LTO)	PM10-PRI (lbs./LTO)	PM2.5-PRI (lbs./LTO)
General Aviation	12.014	0.382	0.065	0.100	0.020	0.020
Air Taxis	28.130	1.223	0.158	0.015	0.020	0.020
Military	48.800	27.10	9.160	1.430	15.23	15.23

* Requires Hydrocarbon to VOC conversion factor of 0.9708 for General Aviation and 0.9914 for Air Taxis.

1) $Emiss_{VOC} = LTO\ (GA) * EF\ (GA)_{VOC}$

Where:
LTO (GA) = LTOs for General Aviation
$EF\ (GA)_{xx}$ = Emission Factors for General Aviation

2) $Emiss_{VOC} = LTO\ (AT) * EF\ (AT)_{VOC}$

Where:
LTO (AT) = LTOs for Air Taxis
$EF\ (AT)_{xx}$ = Emission factors for Air Taxis

Sample Calculation – General Aviation:

This calculation is for Easton Airport/Newman Field in Talbot County. The airport had 11,513.5 General Aviation LTOs over a twelve month period. Performing step 1 Equations (above) the calculations were:

$Emiss_{VOC}$ = [LTO (GA) * EF $(GA)_{HC}$]* CF (VOC/HC)
$Emiss_{VOC}$ = [(11,513.5 LTOs / Year * 0.394 (lbs. HC / LTO)] * 0.9708 (lbs. VOC / lbs. HC))))
$Emiss_{VOC}$ = 4,403.86 lbs. VOC / Year
$Emiss_{VOC}$ = 2.2 Tons VOC / Year
$Emiss_{CO}$ = [11,513.5 LTOs / Year * 12.014 (lbs. CO / LTO)]
$Emiss_{CO}$ = 138,323.19 lbs. of CO / Year
$Emiss_{CO}$ = 69.16 Tons CO / Year
$Emiss_{NOx}$ = [11,513.5 LTOs / Year * 0.065 (lbs. NOx / LTO)]
$Emiss_{NOx}$ = 748.38 lbs. of NOx / Year
$Emiss_{NOx}$ = 0.374 Tons NOx / Year

$Emiss_{SO2}$ = [11,513.5 LTOs / Year * 0.100 (lbs. SO2 / LTO)]
$Emiss_{SO2}$ = 1,151.35 lbs. of SO2 / Year
$Emiss_{SO2}$ = 0.576 Tons SO2 / Year

$Emiss_{PM2.5\text{-}PRI}$ = [11,513.5 LTOs / Year * 0.020 (lbs. PM10 / LTO)]
$Emiss_{PM2.5\text{-}PRI}$ = 230.27 lbs. of PM $_{PM2.5\text{-}PRI}$ / Year
$Emiss_{PM2.5\text{-}PRI}$ = 0.115 Tons PM $_{PM2.5\text{-}PRI}$ / Year

Sample Calculation – Air Taxi:

This calculation is for Easton Airport/Newman Field in Talbot County. The airport had 1,247.5 Air Taxi Aviation LTOs over a twelve month period. Performing step 1 Equations (above) the calculations were:

$Emiss_{VOC}$ = [L (AT) * EF $(AT)_{HC}$]* CF (VOC/HC)
$Emiss_{VOC}$ = [(1,247.5 LTOs / Year * 1.234 (lbs. HC / LTO)] * 0.9914 (lbs. VOC / lbs. HC))))
$Emiss_{VOC}$ = 1,526.18 lbs. VOC / Year
$Emiss_{VOC}$ = 0.763 Tons VOC / Year

$Emiss_{CO}$ = [1,247.5 LTOs / Year * 28.130 (lbs. CO / LTO)]
$Emiss_{CO}$ = 35,092.18 lbs. of CO / Year
$Emiss_{CO}$ = 17.55 Tons CO / Year

$Emiss_{NOx}$ = [1,247.5 LTOs / Year * 0.158 (lbs. NOx / LTO)]
$Emiss_{NOx}$ = 197.11 lbs. of NOx / Year
$Emiss_{NOx}$ = 0.099 Tons NOx / Year

$Emiss_{SO2}$ = [1,247.5 LTOs / Year * 0.015 (lbs. SO2 / LTO)]
$Emiss_{SO2}$ = 18.71 lbs. of SO2 / Year
$Emiss_{SO2}$ = 0.009 Tons SO2 / Year

$Emiss_{PM2.5\text{-}PRI}$ = [1,247.5 LTOs / Year * 0.020 (lbs. PM / LTO)]
$Emiss_{PM2.5\text{-}PRI}$ = 24.95 lbs. of PM $_{PM2.5\text{-}PRI}$ / Year
$Emiss_{PM2.5\text{-}PRI}$ = 0.012 Tons PM $_{PM2.5\text{-}PRI}$ / Year

5.5.3 Military Aircraft

SCC: 22 75 001 000

There are five military airports in Maryland. They are Andrews Air Force Base, Fort Meade/Tipton, Aberdeen, Patuxent River Naval Air Station, and Martin State Airport. ARMA received LTO and onsite emission information from some military airports and emission totals from others due to national security concerns. Most of the county airports also receive a small number of military operations.

Method and Data Sources

Since ARMA asked for and received LTO information by aircraft operation type, ARMA used composite emission factors from Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources, 1988 and the EDMS model (version 5.1).

TABLE 4.5.3-a EPA Emission Factors for Military Aircraft

	CO (lbs./LTO)	VOC (lbs./LTO)	NOx (lbs./LTO)	SO2 (lbs./LTO)	PM (lbs./LTO)
Military Aircraft	48.80	27.10	9.160	1.43	15.230

1) $Emiss_{VOC} = L(MA) * EF(MA)_{VOC}$

Where:
L(MA) = LTOs for Military Aircraft
$EF(MA)_{xx}$ = Emission factors for Military Aircraft

Emissions Calculation

This calculation is for Patuxent River Naval Air Station in St. Mary's county. The airport had 82,331 LTOs in 2011. Using step 1 from Equations (above) the calculations were:

$Emiss_{VOC}$ = [L (AT) * EF $(MA)_{HC}$]
$Emiss_{VOC}$ = [(82,331 LTOs / Year * 27.10 (lbs. VOC / LTO)]
$Emiss_{VOC}$ = 2,231,170.1 lbs. VOC / Year
$Emiss_{VOC}$ = 1,115.59 Tons VOC / Year

$Emiss_{CO}$ = [82,331 LTOs / Year * 48.80 (lbs. CO / LTO)]
$Emiss_{CO}$ = 4,017,752.8 lbs. of CO / Year
$Emiss_{CO}$ = 2,008.88 Tons CO / Year

$Emiss_{NOx}$ = [82,331 LTOs / Year * 9.160 (lbs. NOx / LTO)]
$Emiss_{NOx}$ = 754,151.96 lbs. of NOx / Year
$Emiss_{NOx}$ = 377.08 Tons NOx / Year

$Emiss_{SO2}$ = [82,331 LTOs / Year * 1.43 (lbs. SO2 / LTO)]
$Emiss_{SO2}$ = 117,733.33 lbs. of SO2 / Year
$Emiss_{SO2}$ = 58.87 Tons SO2 / Year

$Emiss_{PM2.5\text{-}PRI}$ = [82,331 LTOs / Year * 15.23 (lbs. PM / LTO)]
$Emiss_{PM2.5\text{-}PRI}$ = 1,253,901.13 lbs. of PM $_{PM2.5\text{-}PRI}$ / Year
$Emiss_{PM2.5\text{-}PRI}$ = 626.95 Tons PM $_{PM2.5\text{-}PRI}$ / Year

5.6 Marine Vessels

SCC: 2280002100 (Diesel Oil – Port)
2280002200 (Diesel Oil – Underway)
2280003100 (Residual Oil – Port)
2280003200 (Residual Oil – Underway)

Description

Commercial vessels include all boats and ships used either directly or indirectly for commerce or military activity. These include vessels ranging in size from 20-foot charter boats to the largest tankers and military vessels, which can exceed 1,000 feet in length.

Pollutants

PM2.5-FIL, PM10-FIL, SO_2, NOx, CO, HC, CO_2, VOC, NH3, and 22 HAPS

Method and Data Sources

MDE used marine vessels data prepared by the Baltimore Maritime Exchange (BME). BME vessel data was analyzed to major categories associated with ship and port operations and their relationship to air quality issues in the Baltimore non-attainment area.

To calculated emissions from commercial marine vessels, MDE adapted the marine emission inventory guidance method outlined in Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data (EPA-450-R-00-002), February 2000. The methodology is based on a three-step calculation. The first step apportions the time spent by a vessel in a port area to different operating modes. The second calculates fuel consumption in each operating mode. The third step calculates emissions using fuel consumption specific emission factors, which is how marine engine emission factors have been historically specified. All of these calculations are made by vessel type and class, with the type specifying whether the vessel is a tanker, passenger liner, etc, and the class specifying either the weight or horsepower range.

This new methodology considers new information collected on marine vessels. The other factors used in the emission estimate computation are examined, with particular focus on the emission factors, for all pollutants of concern. One reason for a detailed reconsideration of the emission factors is that a number of large marine diesels have been tested for emissions and their tests results have become available in the last few years. In addition, both the EPA and CARB have recently sponsored studies to calculate marine vessel emissions in the South Coast Air Basin and in some areas of Region IX, so that there is a body of new research available to update emission factors. Hence, the use of a larger and newer database on marine vessel emission is expected to substantially improve the quality of the derived emission factors

Activity

The computation of emissions can be performed by ship type for a given port and requires the following inputs:

- The number of calls to the port by vessel class and deadweight tonnage.
- The time spent, by ship type, in each of four operating modes defines as: normal cruise, slow cruise, maneuvering, and hostelling.

Emission Factors

Emission rates were calculated per pollutant (except SO2) per vessel type per mode of operation within the guidance document using the following formula:

$E_{(i)} = a * (\text{Fractional Load})^{-x} + b$

Where:

$E_{(i)}$ = Emission rate of pollutant i in grams per kilowatt-hour
a = Coefficient
x = Exponent
b = Intercept

Emission rates were calculated per pollutant (SO2 only) per vessel type per mode of operation within the guidance document using the following formula:

$E_{(SO2)} = a * (\text{Fuel Sulfur Flow in g/kW-hr}) + b$

The marine engine emission factor and fuel consumption algorithms are presented in the table below:

TABLE 4.6.1-a Marine Engine Emission Factor and Fuel Consumption

Pollutant	Exponent (x)	Intercept (b)	Coefficient (a)
PM	1.5	0.2551	0.0059
NOx	1.5	10.4496	0.1255
SO2	1	0	2.3735
CO	1	0	0.8378
HC	1.5	0	0.0667
CO2	1	648.6	44.1

The marine engine emission rates in grams per kilowatt-hour are presented in the table below:

Vessel Type	Cruise	Slow Cruise	Maneuvering	Hoteling
	PM10-FIL (gr/kw-hr)	**PM10-FIL (gr/kw-hr)**	**PM 10-FIL (gr/kw-hr)**	**PM10-FIL (gr/kw-hr)**
Bulk Carriers & Tankers	0.75	0.2784	0.75	0.75
General Cargo	0.75	0.2836	0.75	0.75
Passenger	1.14	0.3211	1.14	1.14
Container/ RORO/ Reefer/Auto Carrier	0.75	0.291	0.75	0.75
All non-oceangoing	1.14	0.2784	1.14	1.14
	PM2.5-FIL (gr/kw-hr)	**PM2.5-FIL (gr/kw-hr)**	**PM2.5-FIL (gr/kw-hr)**	**PM2.5-FIL (gr/kw-hr)**
Bulk Carriers & Tankers	0.28	0.2784	0.28	0.28
General Cargo	0.28	0.2836	0.28	0.28
Passenger	1.1	0.3211	1.1	1.1
Container/ RORO/ Reefer/Auto Carrier	0.28	0.291	0.28	0.28
All non-oceangoing	1.1	0.2784	1.1	1.1
	SO2 (gr/kw-hr)	**SO2 (gr/kw-hr)**	**SO2 (gr/kw-hr)**	**SO2 (gr/kw-hr)**
Bulk Carriers & Tankers	6.16	28.6027	6.16	11.1
General Cargo	6.16	29.2012	6.16	11.1
Passenger	11.1	32.7919	11.1	57.9273
Container/ RORO/ Reefer/Auto Carrier	6.16	29.9991	6.16	11.1
All non-oceangoing	11.1	28.6027	11.1	11.1
	CO (gr/kw-hr)	**CO (gr/kw-hr)**	**CO (gr/kw-hr)**	**CO (gr/kw-hr)**
Bulk Carriers & Tankers	1.1	2.0945	1.1	1.1
General Cargo	1.1	2.3937	1.1	1.1
Passenger	1.1	4.189	1.1	1.1
Container/ RORO/ Reefer/Auto Carrier	1.1	2.7927	1.1	1.1
All non-oceangoing	1.1	2.0945	1.1	1.1
	HC (gr/kw-hr)	**HC (gr/kw-hr)**	**HC (gr/kw-hr)**	**HC (gr/kw-hr)**
Bulk Carriers & Tankers	0.4	0.2637	0.4	0.4
General Cargo	0.4	0.3221	0.4	0.4
Passenger	0.4	0.7457	0.4	0.4
Container/ RORO/ Reefer/Auto Carrier	0.4	0.4059	0.4	0.4
All non-oceangoing	0.4	0.2637	0.4	0.4
	CO2 (gr/kw-hr)	**CO2 (gr/kw-hr)**	**CO2 (gr/kw-hr)**	**CO2 (gr/kw-hr)**
Bulk Carriers & Tankers	620.62	758.85	620.62	620.62
General Cargo	620.62	774.6	620.62	620.62

Vessel Type	Cruise	Slow Cruise	Maneuvering	Hoteling
Passenger	620.62	869.1	620.62	620.62
Container/ RORO/ Reefer/Auto Carrier	620.62	795.6	620.62	620.62
All non-oceangoing	620.62	758.85	620.62	620.62

Point Source Adjustments

No point source emissions were subtracted from the area source inventory.

Adjustment for Controls

No controls are available for this source category.

Spatial and Temporal Allocations

Spatial

Divided cruise emissions out to counties along travel route.

Temporal

Since this activity is year round annual emissions were divided by 365 to estimate daily emissions.

Emissions Calculation

The equation used to estimate emissions from commercial marine vessels is:

$Emissions_{igh} = Trips_i \times Power_{ih} \times LF_{i\ g} \times Time_{i\ g} \times EF_i$

a. $Trips_i$ = Number of trips or vessel calls by vessel (i) and engine type (h)
b. $Power_i$ = rated power of propulsion engine by vessel (i) and engine type (h)
c. $LF_{i\ g}$ = Load factor (fraction of rated power) in mode g (cruise, slow cruise or maneuvering)
d. $Time_{ig}$ = average time for each mode by vessel (i) and mode (g) (hours)
This information can be obtained from local Port Authorities. If information is not available for certain ports, EPA developed a port matching method that can be used to match an unknown port to a port with detailed characteristics (EPA, 2002).
e. $EF_{i\ h}$ = Emission factor in mode (i) and by engine type (h)
Emission Factors - *Commercial Marine Emission Inventory Development (EPA420-R-02-019, July 2002)*

$$TIME_{VCC,\ DWT,\ MODE} = \frac{CALLS_{VCC,\ DWT} \times LENGTH_{VCC,\ DWT} \times \%TIME_{VCC,\ DWT,\ MODE}}{100}$$

$$EMISSIONS_{VCC,\ DWT,\ MODE} = (EF)(LF_{MODE}) \times (HP)(DWT) \times LF_{MODE} \times TIME_{VCC,\ DWT,\ MODE}$$

Where:

VCC is the vessel class (bulk carrier, tanker, container, general cargo, passenger, reefer, RORO, tug, vehicle carrier, or miscellaneous)

DWT is the deadweight tons

EF is the emissions factor

LF is the mode specific load factor

For the calculation, the TIME equation requires port areas input estimation data from port calls, vessel types and typical times in different operating modes. Three different speeds were considered: cruising, reduced speed zone (RSZ), and maneuvering. For port calculations, diesel and residual fueled ships can use the same calculation methodology.

While the guidance method outlined in Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data (EPA-450-R-00-002), February 2000, provides the EF and HP relationships.

Data on the type of vessels, number of calls per vessel type, deadweight tons per vessel type, and time in each mode per vessel type using Baltimore port facilities came from the Baltimore Maritime Exchange (BME).

In addition, the BME provided data that translated into approximately 85 percent of the vessels arriving from the south (up the Chesapeake Bay) and 15 percent of the vessels arriving from the north (down from the Chesapeake and Delaware Canal). The data allowed MDE to allocate slow cruising emissions to the appropriate counties to the north and south of the Port of Baltimore. Emissions associated with "normal cruising" were assumed by MDE not to have occurred while in the Maryland air shed.

All of the maneuvering and hoteling emissions were assigned to the City of Baltimore.

6.0 ONROAD MOBILE SOURCES

6.1 INTRODUCTION

The purpose of this technical document is to explain how Maryland estimates emissions from highway vehicles for inclusion in its emission inventories and State Implementation Plans (SIP).

In accordance with the standard methodology for the development of highway vehicle emissions inventories, all of the emissions estimates documented herein are based on emission factors developed using the United States Environmental Protection Agency's (U.S. EPA's) latest version of the MOVES emissions factor model and appropriate activity levels i.e., VMT estimates developed from the vehicle count data maintained by the State Highway Administration (SHA) of the Maryland Department of Transportation (MDOT).

The official highway vehicle inventory for the Maryland portion of the Washington, D.C. Ozone Non-attainment Area (comprising the counties of Calvert, Charles, Frederick, Montgomery, and Prince George's) has been developed by the Metropolitan Washington Council of Governments (MWCOG) and has been documented by that Organization under separate cover.

6.1.1 Highway Vehicle Emissions Inventory

The operation of highway vehicles has proven to be a significant contributor to air pollution, particularly to ground-level ozone, as they emit both Volatile Organic Compounds (VOCs), and Oxides of Nitrogen (NOx) during operation. Ground-level ozone is not created directly rather, it is formed through a chemical reaction between VOCs and NOx in the presence of sunlight. Highway vehicles also emit other pollutants such as Carbon Monoxide (CO), Particulate Matter smaller than 2.5 microns (PM2.5), Particulate Matter smaller than 10 microns (PM10), Sulfur Dioxide (SO2), and Ammonia (NH3) in addition to the greenhouse gases such as Carbon Dioxide, Methane, and Nitrous Oxide.

This inventory includes all the pollutants mentioned above, in summer daily and yearly time periods, appropriately.

Estimating the emission rate and activity levels of all vehicles on the road during a typical day is a complicated endeavor. If every vehicle emitted the same amount of pollution all the time, one could simply multiply those emission standards (emission rate in grams of pollution per mile) times the number of miles driven (activity level) to estimate total emissions. The fact is that emission rates from all vehicles vary over the entire range of conditions under which they operate. These variables include ambient air temperature, speed, traffic conditions, road types, road topography, operating mode (whether started cold or started hot, whether accelerating or decelerating) and fuel. The inventory must also account for non-exhaust or evaporative emissions. In addition, the fleet is composed of several generations, types of vehicles and their emission control technologies, each of which performs differently. This requires that the composition of the fleet (vehicle ages and types) must also be included in the estimation algorithm.

In order to estimate both the rate at which emissions are being generated and to calculate vehicle miles traveled (VMT), Maryland examines its road network and fleet to estimate vehicle activity. For ozone-related inventories, this is done for a typical summer weekday in 2011. For the annual inventories, this is done for each of the twelve months in 2011 and aggregated for the entire year. The entire process is extremely complex and involves large amounts of various data sets.

Computer models have been developed to perform these calculations by simulating the travel of vehicles on the State's roadway system. These models then generate emission rates (or emission factors) for different vehicle types for area-specific conditions and then combine them in summary form. The "area-specific conditions" include fleet characteristics such as vehicle population and vehicle age distribution, roadway and travel characteristics, meteorology, control programs in place, mandated fuel requirements, etc.

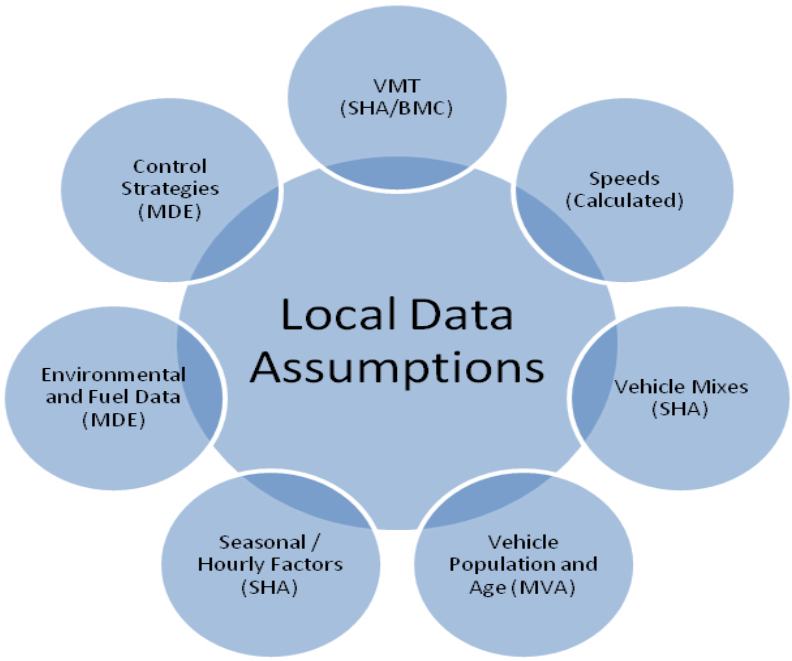
6.1.2 Periodic Inventory Methodology:

Guidance documents from EPA were used to develop the highway emissions inventory. They include:

- *Policy Guidance on the Use of MOVES2010 and Subsequent Minor Revisions for SIP Development, Transportation Conformity, and Other Purposes*, US EPA Office of Air and Radiation, EPA-420-B-12-010, April 2012.
- *Using MOVES to prepare Emission Inventories in State Implementation Plans and Transportation Conformity: Technical Guidance for MOVES2010a and MOVES2010b.* US EPA Office of Air and Radiation, and Office of Transportation and Air Quality, EPA-420-B-12-028, April 2012.
- *Motor Vehicle Emission Simulator, User Guide for MO VES2010a,* EPA-420-B-10-036, August 2010 and *User Guide for MO VES2010b,* EPA-420-B-12-001b June 2012

The methodologies used to produce the emission data conform to the recommendations provided in EPA's technical guidance. A mix of local data and national default (internal to MOVES2010a) data has been used for this submission. As illustrated in Exhibit 1, local data has been used for the primary data items that have a significant impact on emissions. Local data inputs to the analysis process reflect the latest available planning assumptions using data obtained from the Maryland Department of Environment (MDE), Motor Vehicle Administration (MVA), Maryland State Highway Administration (SHA), Baltimore Metropolitan Council (BMC), Metropolitan Washington Council of Governments (MWCOG) and other local/national sources.

Exhibit 1: Local Data Inputs Used for Emissions Inventory



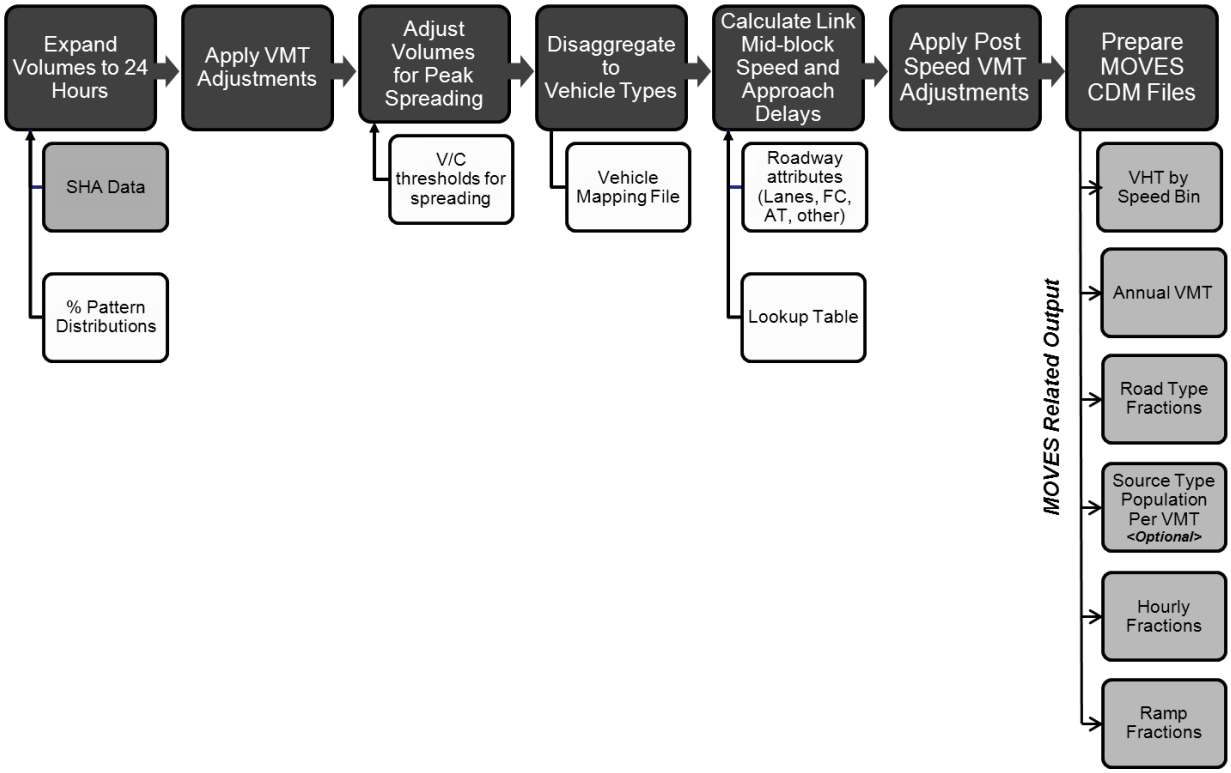
The analysis methodology is consistent with past statewide inventory efforts including the 2011 National Emissions Inventory (NEI) submission. This includes the use of statewide traffic roadway data and custom post-processing software (PPSUITE) to calculate hourly speeds and prepare key traffic input files to the MOVES2010a emission model. PPSUITE consists of a set of programs that perform the following functions:

- Analyzes highway operating conditions.
- Calculates highway speeds.
- Compiles vehicle miles of travel (VMT) and vehicle type mix data.
- Prepares MOVES runs and processes MOVES outputs.

PPSUITE is a widely used and accepted tool for estimating speeds and processing emissions rates. It is has been used for past SIP highway inventories in Maryland, Pennsylvania, and New Jersey. The software is based upon accepted transportation engineering methodologies. For example, PPSUITE utilizes speed and delay estimation procedures based on planning methods provided in the Highway Capacity Manual, a report prepared by the Transportation Research Board (TRB) summarizing current knowledge and analysis techniques for capacity and level-of-service analyses of the transportation system.

The PPSUITE process is integral to producing key input files to the MOVES emission model. Exhibit 2 summarizes the key functions of PPSUITE and the traffic-related input files prepared for MOVES.

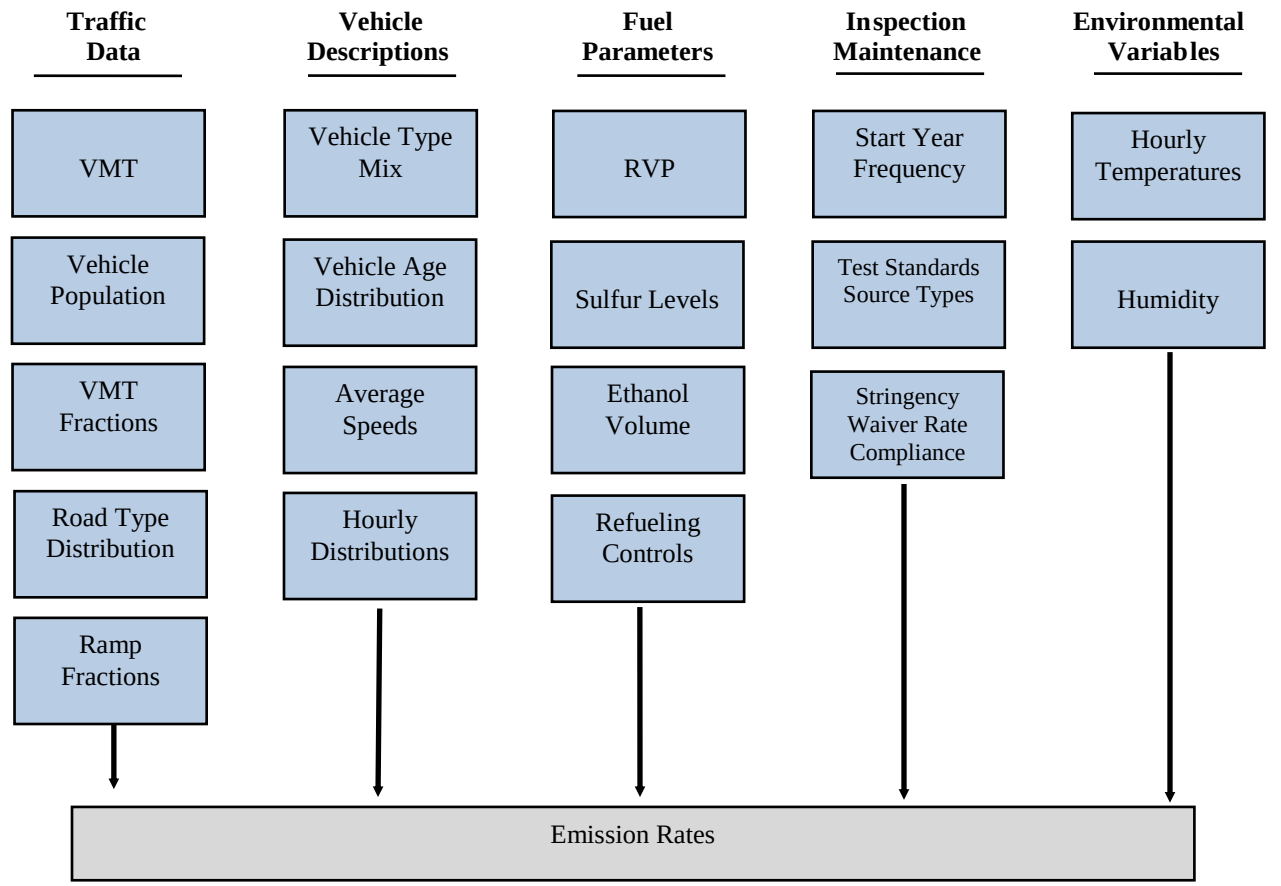
Exhibit 2: Emission Calculation Process



6.2 DESCRIPTION OF INPUT DATA

A large number of inputs to MOVES are needed to fully account for the numerous vehicle and environmental parameters that affect emissions levels. These include traffic flow characteristics, vehicle descriptions, fuel parameters, inspection/maintenance program parameters, and environmental variables as shown in Exhibit 3.

Exhibit 3: Examples of Key MOVES Input Data



MOVES includes a default national database of meteorology, vehicle fleet, vehicle activity, fuel, and emission control program data for every county; but EPA cannot certify that the default data is the most current or best available information for any specific area. As a result, local data is recommended for use for analyses SIPs.

A mix of local and default data is used for this inventory. Local data sources are used for all inputs that have a significant impact on calculated emission rates. These data items are discussed in the following sections.

6.2.1 Roadway Data:

The roadway data input to emissions calculations for this inventory is based on information from the "universal" highway database maintained by the Maryland SHA. SHA obtains this information from periodic visual and electronic traffic counts. The SHA data is dynamic, since it is continually reviewed and updated from new traffic counts. Information on roadways included in the National Highway System is reviewed at least annually, while information on other roadways is reviewed at least biennially.

On a triennial basis, a current "snapshot" of the SHA database is taken and downloaded to provide an up-to-date record of the state's highway system for estimating emissions. This emissions inventory is based on 2011 data which is the most current "snapshot" of the SHA data. The following information is extracted from the database for emission calculations:

- Lanes and distances
- volumes representing Average Annual Daily Traffic (AADT)
- truck percentages and urban/rural classifications
- functional class codes

The volumes and distances are used in calculating highway VMT totals for each county. As discussed in the next section, adjustments are needed to convert the volumes to an average summer weekday . The lane values, area type, and functional class are important inputs for determining the congestion and speeds for individual highway segments. Truck percentages are used in the speed determination process and are used to split volumes to individual vehicle types used by the MOVES software.

Maryland classifies its road segments by function, as well as whether it is located in an urban or rural area, as indicated below in Exhibit 4. The urban/rural (UR) and functional classes (FC) are important indicators of the type and function of each roadway segment. These values are also used to determine the MOVES Road Type classification that has an important impact on the emission factors for each roadway segment. Equivalencies between the SHA and MOVES indices are discussed in later sections.

Exhibit 4: MDOT Urban/Rural and Functional Class Codes

Urban/Rural Code	1=Rural 2=Small Urban 3=Urban	
Functional Class	Rural Functional Classes Used For Rural Areas	Urban Functional Classes Used For Urban Areas
	---	---
	1=Rural Freeway	11=Urban Freeway
	2=Rural Other Principal Arterial	12=Urban Expressway
	6=Rural Minor Arterial	14=Urban Principal Arterial
	7=Rural Major Collector	16=Urban Minor Arterial
	8=Rural Minor Collector	17=Urban Collector
	9=Rural Local	19=Urban Local

The PPSUITE processing software allows for many additional variables other than those available in the SHA database. Using these variables improves the calculation of congested speeds. Such variables include information regarding free-flow speeds and capacities and other physical roadway features (e.g. traffic signals) that can affect a roadway's calculated congested speed. This data can be determined from lookup tables based on a roadway segment's urban/rural code and functional class. Much of the lookup table data was developed from information contained in the Highway Capacity Manual.

6.2.2 Other Supporting Traffic Data:

Other traffic data is used to adjust and disaggregate traffic volumes. Key sources used in these processes include the following:

HPMS VMT: According to EPA guidance, baseline inventory VMT computed from the SHA highway segment volumes must be adjusted to be consistent with HPMS VMT totals. Although it has some limitations, the HPMS system is currently in use in all 50 states and is being improved under FHWA direction. Adjustment factors are calculated which adjust the base year 2011 SHA download VMT to be consistent with the reported 2011 HPMS totals for that year. These factors are applied to all county, urban/rural code, and facility group combinations within the region. These adjustments are important for accounting for missing local roadway VMT that is not contained within or represented by the state-owned roadway system.

Seasonal Factors: The SHA contains AADT volumes that are an average of all days in the year, including weekends and holidays. An ozone emission analysis, however, is based on a typical July or summer weekday. Therefore, the SHA volumes must be seasonally adjusted. The seasonal factors were developed based on the 2011 report *ATR Station Reports in the Traffic Trends System Report Module* from the SHA website. These factors are applied to the existing SHA AADT to produce July weekday volumes. The same factors are also used to develop the MOVES daily and monthly VMT fraction files.

Hourly Patterns: Speeds and emissions vary considerably depending on the time of day. Therefore, it is important to estimate the pattern by which roadway volume varies by hour of the day. Pattern data is in the form of a percentage of the daily volumes for each hour. Distributions are provided for all the counties within the region and by each facility type grouping. This data was developed from 2011 24-hour count data obtained from the SHA website. The same factors are also used to develop the MOVES hourly fraction file.

6.2.3 Vehicle Class Data:

Emission rates within MOVES vary significantly by the type of vehicle. The MOVES model produces emissions and rates by thirteen MOVES vehicle source types. However, VMT is input to MOVES by six HPMS vehicle groups. Exhibit 5 summarizes the distinction between each classification scheme.

Exhibit 5: MOVES Source Types and HPMS Vehicle Groups

SOURCE TYPES		HPMS Class Groups	
11	Motorcycle	10	Motorcycle
21	Passenger Car	20	Passenger Car
31	Passenger Truck	30	Passenger/Light Truck
32	Light Commercial Truck	40	Buses
41	Intercity Bus	50	Single Unit Trucks
42	Transit Bus	60	Combination Trucks
43	School bus		
51	Refuse Truck		
52	Single Unit Short-haul Truck		
53	Single Unit Long-haul Truck		
54	Motor Home		
61	Combination Short-haul Truck		
62	Combination Long-haul Truck		

For this regional inventory, vehicle type pattern data was developed for each county and functional class combination based on SHA classification counts and internal MOVES2010b and MOVES defaults. As the first step, SHA count data was used to develop percentage splits to the following four vehicle groups:

- Autos
- Heavy trucks
- Motorcycles
- Buses

Following procedures used for previous SIP efforts, the vehicle groups were expanded to the 28 MOVES2010b weight-based vehicle types. Using procedures provided in EPA technical guidance, the MOVES2010b vehicle classes were mapped to the MOVES source type and HPMS class groups.

The vehicle type percentages are also provided to the capacity analysis section of PPSUITE to adjust the speeds in response to trucks. That is, a given number of larger trucks take up more roadway space than a given number of cars, and this is accounted for in the speed estimation process by adjusting capacity using information from the Highway Capacity Manual.

6.2.4 Vehicle Ages:

Vehicle age distributions are input to MOVES for each county by the thirteen source types. The distributions reflect the percentage of vehicles in the fleet up to 31 years old. The vehicle age distributions were prepared by MDE based on information obtained from MVA registration data.

The vehicle age distributions are based on 2011 MVA registration data that included cleaning of duplicate, expired, and non-eligible vehicles such as trailers and the farm tractors accounted for in the Area Source category of emissions. The data was transformed into two sets of MOVES2010b

vehicle types; one conforming to MOBILE6-28 vehicle type and the other to MOVES2010b composite vehicle type system using a SAS-based computer program.

The MOVES model input age distributions were produced utilizing the available EPA MS-Excel-based vehicle registration converter tool. This tool assisted in converting the MOBILE6.2-based data into the MOVES source type categories.

6.2.5 Vehicle Population Data:

The information on the vehicle fleet including the number and age of vehicles impacts forecasted start and evaporative emissions within MOVES. MOVES model requires the population of vehicles by the thirteen source type categories. This data was prepared in-house by MDE for the analysis year 2011 utilizing another SAS-based computer program similar to the one discussed in the previous vehicle age section. Maryland county vehicle registration data was used to estimate vehicle population for light-duty and medium duty vehicles for all counties in the region. MOVES default values were adopted for the heavy duty MOVES vehicle types 52, 53, 61 and 62.

6.2.6 Environmental and Fuel Data:

Information on environmental, fuel, vehicle technology and other control strategy assumptions were determined based on a review of MOVES2010a default information by MDE.

Evaporative emissions are influenced significantly by the temperatures of the surrounding air. Ozone analysis temperature and humidity values were determined by MDE as follows using the procedures documented in EPA's technical guidance.

Meteorological Data*:* Along the lines of MD fuel data, 2011 meteorological data for hourly average MOVES inputs of temperature and relative humidity was also compiled on a triennial basis for every county in MD. The month by month raw hourly-data sets came from the National Climate Data Center of NOAA based on weather data collected at the airport situated closest to the county modeled. Hourly average temperature and humidity computations were developed from the 24 hourly values for every hour in a given month. For the Baltimore Area, since the data source is one for the entire area (BWI Airport situated in Anne Arundel County of MD), the same set of data was used for all the constituent city/counties of the Baltimore Area.

Fuel Data: MDE obtains monthly fuel data reports regularly from the MD Fuel Laboratory which is under the jurisdiction of MD Fuel Tax Division of the Office of the Comptroller of MD. These fuel reports are generated by testing samples collected in the field (gas stations) for the purpose of fuel regulation enforcement. It covers all counties in MD. Since the data entry of these samples is a huge task, compilation of fuel data to yield input parameters for MOBILE or MOVES modeling is confined only to the years for which emission inventories are due for submission to EPA on a triennial basis beginning with the baseline year of 1990. 2011 happens to be a year of such periodic emission inventories. As such 2011 fuel data was compiled and fuel data parameters were developed separately for the 14 MD counties with EPA mandates to dispense only reformulated gasoline requirements and the 10 remaining counties dispensing conventional gasoline.

Two sets of fuel data inputs (Fuel Formulation and Fuel Supply tables) required by MOVES model were developed in-house for every county in MD. The fuel parameters changed from the MOVES defaults are as follows:

fuelFormulationID	Unique ID used for easy recognition
fuelSubtypeID	Selected per guidance based on ethanol content of gasoline
sulfurLevel	Computed from the local fuel data
ETOHVolume	Computed from the local fuel data
aromaticContent	Computed from the local fuel data
olefinContent	Computed from the local fuel data
benzineContent	Computed from the local fuel data
E200	Computed from the local fuel data
E300	Computed from the local fuel data

6.2.7 Other Vehicle Technology and Control Strategy Data:

The MOVES2010a default I/M data was reviewed and updated by MDE for all the counties in the region. The current I/M program known as Vehicle Emission Inspection Program (VEIP) assumed for the analysis year 2011 is described below.

MD Vehicle Emission Inspection Program: This program tests model year 1977 and newer gasoline powered vehicles weighing up to 26,000 lb. The test is done biennially, and on change of ownership. There is a two year grace period for new vehicles. Light duty vehicles model year 1996 and newer, and model year 2011 and newer vehicles weighing up to 14,000 lb get the OBD test. All other vehicles get an idle test with a gas cap pressure test and a visual check for the presence of a catalytic converter. The compliance factors reflect the observed fail and waiver rates observed in the program, combined with an assumed 96% compliance rate for vehicles showing up for testing. Heavy duty vehicles have an additional factor, reflecting the fraction of vehicles in the weight range covered by the program. This was derived from documentation comparing the MOVES and MOBILE vehicle classes. The significantly higher compliance rate for the gas cap check reflects the much higher retest pass rate for this check.

Federal Programs: Current federal vehicle emissions control and fuel programs are incorporated into the MOVES2010a software. These include the National Program standards covering model year vehicles through 2016. Modifications of default emission rates are required to reflect the early implementation of the National Low Emission Vehicle Program (NLEV) program in Maryland. To reflect these impacts, EPA has released instructions and input files that can be used to model these impacts. This inventory utilized the August 2010 version of the files (http://www.epa.gov/oms/models/moves/tools.htm).

6.2.8 State Vehicle Technology Programs:

MD Clean Car Program: Under the Maryland Clean Cars Act of 2007 Maryland adopted the California Low Emission Vehicle (LEV II) program. This program began implementation in 2011. This program requires all 2011 model year and newer vehicles (GVWR up to 14,000 lbs.) registered in Maryland to meet California emission standards for both criteria and greenhouse gas pollutants. This program also contains a zero emission vehicles component that requires the manufactures to produce a certain percentage of zero emission vehicles (electric, fuel cell, etc.) for

purchase in the state. California has just adopted new amendments to the Low-Emission Vehicle regulation entitled LEV III (third generation low emission vehicle standards). These amendments create more stringent emission standards for new motor vehicles. These new standards will be phased-in over the 2015-2025 model years.

The impacts of this program were modeled for all analysis years using EPA's guidance document, *Instructions for Using LEV and NLEV Inputs for MOVES, EPA-420-B-10-003, January 2010*. EPA provided input files to reflect the CAL LEVII program with the standard phase-in schedules for new emission standards. Modifications to those schedules were done as per EPA's instructions, to reflect a later start for the State of Maryland beginning with vehicle model year 2011.

6.3 ANALYSIS METHODOLOGY

The previous sections have summarized the input data used for computing speeds and emission rates for this highway emissions inventory. This section explains how PPSUITE and MOVES uses that input data to produce emission estimates. Exhibit 6 provides a more detailed overview of the PPSUITE analysis procedure using the available traffic data information described in the previous section.

6.3.1 VMT Preparation:

Producing an emissions inventory with PPSUITE requires a complex process of disaggregation and aggregation of vehicle activities. Data is available and used on a very small scale -- individual ½ mile roadway segments for each of the 24 hours of the day. This data needs to be processed individually to determine the distribution of vehicle hours of travel (VHT) by speed and then aggregated by vehicle class to determine the input VMT to the MOVES emission model. As an example key steps in the preparation of VMT for a summer daily run include:

- *Apply Seasonal Adjustments* - PPSUITE takes the input daily volumes from SHA (which represents AADT traffic) and seasonally adjusts the volumes to an average weekday in July. This adjustment utilizes factors developed for each functional class and urban/rural code. VMT can then be calculated for each link using the adjusted weekday volumes.

- *Disaggregate to Hours* - After seasonally adjusting the link volume, the volume is split to each hour of the day. This allows for more accurate speed calculations (effects of congested hours) and allows PPSUITE to prepare the hourly VMT and speeds for input to the MOVES model.

- *Peak Spreading* - After dividing the daily volumes to each hour of the day, PPSUITE identifies hours that are unreasonably congested. For those hours, PPSUITE then spreads a portion of the volume to other hours within the same peak period, thereby approximating the "peak spreading" that normally occurs in such over-capacity conditions.

- *Disaggregation to Vehicle Types* - EPA requires VMT estimates to be prepared by source type, reflecting specific local characteristics. As a result, for Maryland's emission inventory runs, the hourly volumes are disaggregated to the six HPMS MOVES vehicle

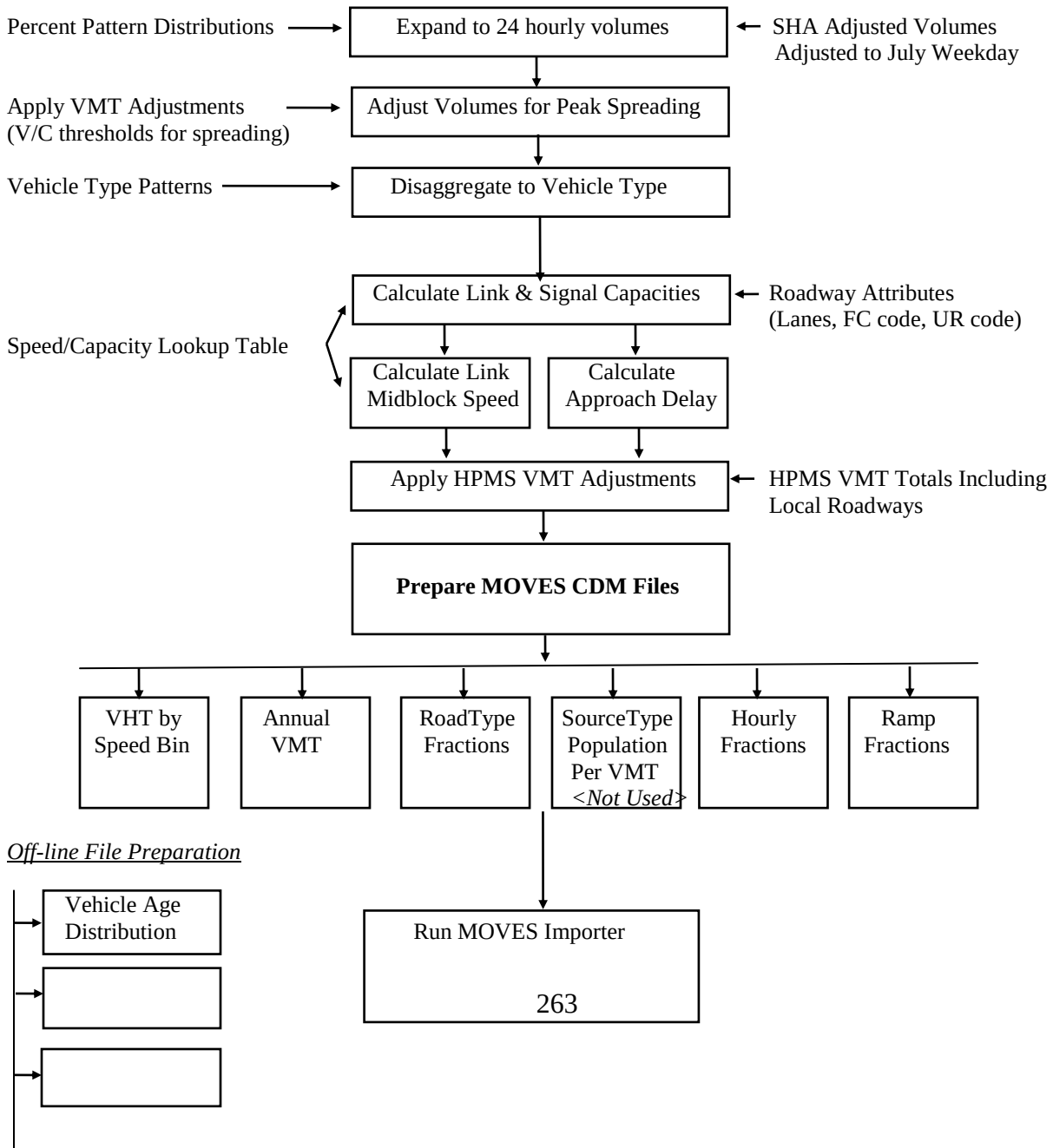
grouping based on count data assembled by SHA in combination with MOVES defaults as described in the previous section.

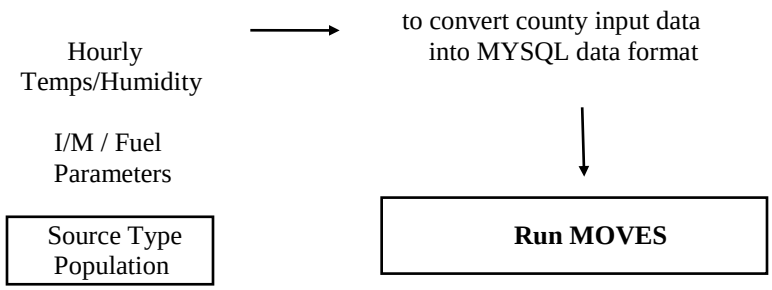
- *Apply HPMS VMT Adjustments* - Volumes must also be adjusted to account for differences with the HPMS VMT totals, as described previously. VMT adjustment factors are provided as input to PPSUITE, and are applied to each of the roadway segment volumes. These factors were developed from the latest HPMS download (conducted triennially); however, they are also applied to any future year runs. The VMT added or subtracted to the SHA database assumes the speeds calculated using the original volumes for each roadway segment for each hour of the day.

Exhibit 6: PPSUITE Speed/Emission Estimation Procedure

PPSUITE Analysis Process

(The Following steps are Performed For Each SHA Roadway Segment)

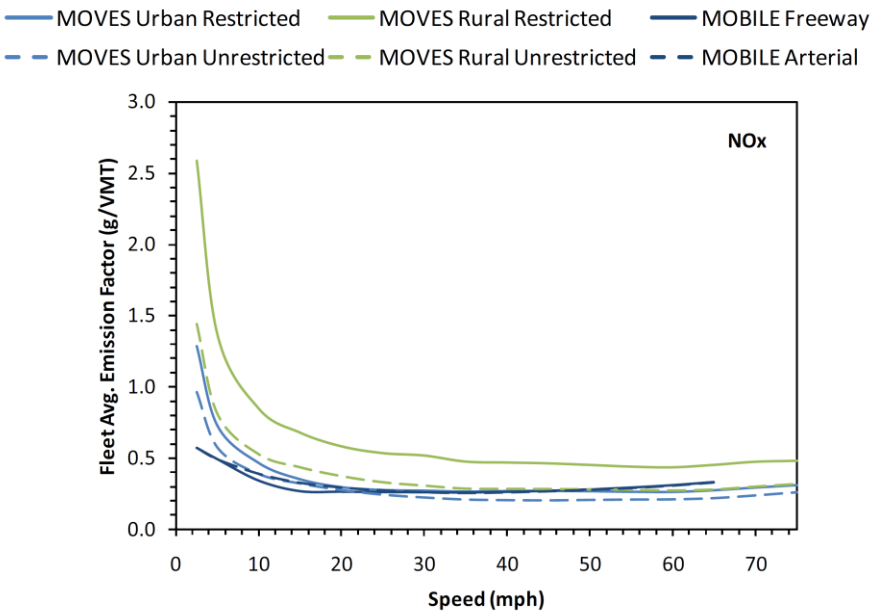




6.3.2 Speed Estimation:

Emissions for many pollutants (including both VOC and NOx) vary significantly with travel speed. While VOCs generally decrease as speed increases, NOx decreases at the low speed range and increases at higher speeds, as illustrated in Exhibit 7.

Exhibit 7: Emission Factor vs. Speed Variances (NOx)



Source: Figure 3 from Implications of the MOVES2010 Model on Mobile Source Emission Estimates, Air & Waste Management Association, July 2010.

EPA recognizes that the estimation of vehicle speeds is a difficult and complex process. Because emissions are so sensitive to speeds, it recommends special attention be given to developing reasonable and consistent speed estimates; it also recommends that VMT be disaggregated into subsets that have roughly equal speed, with separate emission factors for each subset. At a minimum, speeds should be estimated separately by road type.

The computational framework used for this analysis meets and exceeds that recommendation. Speeds are individually calculated for each roadway segment and hour and include the estimated delays encountered at signals. Rather than accumulating the roadway segments into a particular road type and calculating an average speed, each individual link hourly speed is represented in the

MOVES vehicle hours of travel (VHT) by speed bin file. This MOVES input file allows the specification of a distribution of hourly speeds. For example, if 5% of a county's arterial VHT operates at 5 mph during the AM peak hour and the remaining 95% operates at 65 mph, this can be represented in the MOVES speed input file. For the highway emissions inventory, distributions of speeds are input to MOVES by road type and source type by each hour of the day.

To calculate speeds, PPSUITE first obtains initial capacities (how much volume the roadway can serve before heavy congestion) and free-flow speeds (speeds assuming no congestion) from the speed/capacity lookup data. As described in previous sections, this data contains default roadway information indexed by the urban/rural code and functional class. For areas with known characteristics, values can be directly coded to the SHA database and the speed/capacity data can be overridden. However, for most areas where known information is not available, the speed/capacity lookups provide valuable default information regarding speeds, capacities, signal characteristics, and other capacity adjustment information used for calculating congested delays and speeds. The result of this process is an estimated average travel time for each hour of the day for each highway segment. The average time multiplied by the volume produces vehicle hours of travel (VHT).

6.3.3 Developing the MOVES Traffic Input Files:

The PPSUITE software is responsible for producing the following MOVES input files during any analysis run:

- VMT by HPMS vehicle class
- VHT by speed bin
- Road type distributions
- Ramp fractions

These files are text formatted files with a *.csv extension. The files are provided as inputs within the MOVES county data importer.

VMT Input File: VMT is the primary traffic input that affects emission results. The roadway segment distances and traffic volumes are used to prepare estimates of VMT. PPSUITE performs these calculations and outputs the MOVES annual VMT input file to the County Data Manager (CDM).

VHT by Speed Bin File: As described in the previous section, the PPSUITE software prepares the MOVES VHT by speed bin file which summarizes the distribution of speeds across all links into each of 16 MOVES speed bins for each hour of the day by road type. This robust process ensures that MOVES emission rates are used to the fullest extent and is consistent with the methods and recommendations provided in EPA's technical guidance.

Road Type Distributions: In MOVES, typical drive cycles and associated operating conditions vary by the type of roadway. MOVES defines five different road types as follows:

1 Off-Network
2 Rural Restricted Access

3 Rural Unrestricted Access
4 Urban Restricted Access
5 Urban Unrestricted Access

For this inventory, the MOVES road type distribution file is automatically generated by PPSUITE using defined equivalencies. The off-network road type includes emissions from vehicle starts, extended idle activity, and evaporative emissions. Off-network activity in MOVES is primarily determined by the Source Type Population input. The remaining distribution among road types is determined by equating the functional class with each MOVES road type as follows:

- MOVES Road Type (2) = SHA Functional Class (1)
- MOVES Road Type (3) = SHA Functional Class (2,6,7,8,9)
- MOVES Road Type (4) = SHA Functional Class (11,12)
- MOVES Road Type (5) = SHA Functional Class (14,16,17,19)

Ramp Fractions: Since ramps are not directly represented within the SHA database information, it is assumed that 8% of the Freeway VHT is ramp VHT. This is consistent with national default values within MOVES and recommendations provided in EPA's technical guidance.

6.3.4 MOVES Runs:

After computing speeds and aggregating VMT and VHT, PPSUITE prepares traffic-related inputs needed to run EPA's MOVES2010a software. Additional required MOVES inputs are prepared external to the processing software and include temperatures, I/M program parameters, fuel characteristics, vehicle fleet age distributions and source type population.

The MOVES county importer is run in batch mode. This program converts all data files into the MYSQL formats used by the MOVES model. At that point a MOVES run specification file (*.mrs) is created which specifies options and key data locations for the run. MOVES is then executed in batch mode.

MOVES can be executed using either the *inventory* or *rate-based* approaches. For this highway emissions inventory, MOVES is applied using the *inventory-based* approach. Under this method, actual VMT and population are provided as inputs to the model; MOVES is responsible for producing the total emissions for the region. Under the rate-based approach, MOVES would produce emission factors, after which PPSUITE would apply the emission factors to the link data and calculate total regional emissions.

Appendix B and C provide a summary of all the 13 MOVES CDM input files as well as the MOVES run specification files.

6.4 Fuel Consumption Estimates

The MOVES output energy rates can be converted to fuel consumption values using standard conversion rates for gasoline and diesel fuel. Table 4 below provides the estimated 2011 fuel consumption values. The 2011 values were compared to available information from FHWA and the Energy Information Administration (EIA).

Table 4 - 2011 Fuel Consumption Estimates

Scenario	Fuel Type	MOVES2010a Output	Actual

		Energy Consumption *(Trillion BTU)*	Estimated Fuel Consumption[1] *(Thousand Gallons)*	
2011	Gasoline	298.8	2,405,394	2,668,913
	Diesel	73.3	528,232	501,839

[1] Assumes following conversion rates:

- 1 gallon of gasoline fuel = 124,238 BTU
- 1 gallon of diesel fuel = 138,690 BTU

[2] On-highway Gasoline Fuel Consumption:

- Statement of Gasoline Consumption (CY 2011-2012) Report from the following web page of the Comptroller of MD

http://www.marylandtaxes.com/finances/revenue/motorfuel/gasconsumption/gasconsumptionCY2012.pdf

On-highway Diesel Fuel Consumption:

- 2011 Sale of Distillate Fuel Oil by End Use, Maryland – On Highway Report from U.S Energy Information Administration

http://www.eia.gov/dnav/pet/PET_CONS_821USEA_A_EPD2D_VAH_MGAL_A.htm

6.5 RESOURCES

MOVES model

Modeling Page within EPA's Office of Mobile Sources Website (http://www.epa.gov/omswww/models.htm) contains a downloadable model, MOVES users guide and other information.

***Policy Guidance on the Use of MOVES2010 and Subsequent Minor Revisions for SIP Development, Transportation Conformity, and Other Purposes*, US EPA Office of Air and Radiation, EPA-420-B-12-010, April 2012.**

***Using MOVES to prepare Emission Inventories in State Implementation Plans and Transportation Conformity: Technical Guidance for MOVES2010, 2010a and 2010b.* US EPA Office of Air and Radiation, and Office of Transportation and Air Quality, EPA-420-B-12-028, April 2012.**

***Motor Vehicle Emission Simulator, User Guide for MOVES2010a*, EPA-420-B-10-036, August 2010.**

Traffic Engineering

Highway Capacity Manual, Transportation Research Board, presents current knowledge and techniques for analyzing the transportation system.

Traffic Trends System Report Module, 2011 Data, State Highway Administration

6.6 Highway Vehicle Inventory Glossary

AADT: Average Annual Daily Traffic, average of ALL days.

AWDT: Average Weekday Daily Traffic.

County Data Manager (CDM): User interface developed to simplify importing specific local data for a single county or a user-defined custom domain without requiring direct interaction with the underlying MySQL database.

Emission rate or factor: Expresses the amount of pollution emitted per unit of activity. For highway vehicles, usually in grams of pollutant emitted per mile driven

FC: Functional code, applied in data management to road segments to identify their type (freeway, local, etc.).

Growth factor: Factor used to convert volumes to future years.

HPMS: Highway Performance Monitoring System, MDOT's official source of highway information and a subset of SHA.

I/M: Vehicle emissions inspection/maintenance programs ensure that vehicle emission controls are in good working order throughout the life of the vehicle. The programs require vehicles to be tested for emissions. Most vehicles that do not pass must be repaired.

MOVES: The latest model EPA has developed with which Maryland uses to estimate emissions from highway vehicles.

Pattern data: Extrapolations of traffic patterns (such as how traffic volume on road segment types varies by time of day, or what kinds of vehicles tend to use a road segment type) from segments with observed data to similar segments.

PPSUITE: Post-Processor for Air Quality, a set of programs that estimate speeds and processes MOBILE emission rates.

Road Type: Functional code, applied in data management to road segments to identify their type (rural/urban highways, rural/urban arterials, etc.)

Source Type: One of thirteen vehicle types used in MOVES modeling.

UR: Urban/rural code, applied in data management to identify whether a road segment is urban, small urban or rural.
VHT: Vehicle hours traveled.

VMT: Vehicle miles traveled. In modeling terms, it is the simulated traffic volumes times the link length.

7.0 BIOGENIC EMISSIONS

7.1 INTRODUCTION

Biogenic sources, a subset of natural sources, include only those sources that result from some sort of biological activity. Biogenic emissions represent a significant portion of the natural source emissions, and VOC, NO_x, and the greenhouse gases can be emitted from biogenic sources.

Vegetation is the predominant biogenic source of VOC and is typically the only source that is used to estimate biogenic VOC emissions. Microbial activity is responsible for the emission of NO_x and the greenhouse gases of CO_2, CH_4, and N_2O. Soil microbial activity is responsible for NO_x and N_2O emissions from agricultural lands and grasslands. CH_4 is emitted through microbial action in waterlogged soils or in other anaerobic microenvironments. CO_2 is released through the aerobic decay of biomass (EPA, 1993; EPA, 1990a).

The Biogenic emissions category can not be controlled directly; therefore, a majority of the resources were directed towards other categories of air pollution where direct control is feasible. For this reason, MDE used the data files created and made available by EPA (2011). These emissions were computed on an hourly basis with a specially-modified version of BEIS3[88] that utilized county land use data from EPA's land use inventory and National Weather Service first-order station data of temperature and cloud cover. However, due to the large size of the hourly data files, only the monthly data files were available when MDE gathered this information.

The data files EPA generated contained county-total estimates of 2002 biogenic emissions based on the BEIS3.12 model. The purpose of this spreadsheet is to provide default 2002 estimates to the states for the purpose of biogenic emissions submittals by county required by the Consolidated Emissions Reporting Rule (CERR). These estimates were created using the following data:

1) 2011 annual meteorology
2) BEIS3.14 model via the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system
3) Recently revised BEIS3.14 emission factors file (also provided as a separate file with this spreadsheet)
4) BELD3 land use data (1-km original data aggregated to 36-km grid).
5) Post processing summation of county-total emissions from SMOKE, calculated from 36-km gridded emissions using the "land area" spatial surrogate. This means that when calculating the county-total numbers, the 36-km gridded emissions were assumed to be uniformly distributed over the grid cell for purposes of mapping to the counties.

Monthly emission estimates were given for each county in Maryland for the following pollutants:

- CO: Carbon monoxide (a new species output by BEIS3.14
- NO: Nitrogen oxide
- ALD2: Aldehyde group from CB-IV chemical mechanism
- ETH: Ethane group from CB-IV chemical mechanism

[88] BEIS 3.12 can be downloaded from an EPA website at: http://www.epa.gov/asmdnerl/biogen.html

- FORM: Formaldehyde group from CB-IV chemical mechanism
- ISOP: Isoprene
- NR: Nonreactive VOC
- OLE: Olefin group from CB-IV chemical mechanism
- PAR: Parafin group from CB-IV chemical mechanism
- XYL: Xylene group from CB-IV chemical mechanism
- TOL: Toluene group from CB-IV chemical mechanism
- Total VOC: The sum of ALD2, ETH, FORM, ISOP, NR, OLE, PAR, XYL, and TOL
- TERPB: Terpenes (Note that the same mass accounted for by TERPB is also included in VOC

The daily emissions were calculated by summing the monthly emissions from June, July, and August and dividing by the number of days in those three months (92).

Appendix B
Point Source Files

Point Annual

State County FIPS	State Facility Identifier	Facility Name	Emission Unit ID	CO	NH3	NOX	PM25-PRI	SO2	VOC
24015	015-0005	Mellott Company @ Maryland Materials, Inc.	015-0005-6-0299				1.000215		
24015	015-0005	Mellott Company @ Maryland Materials, Inc.	015-0005-6-0300	0.0000363		0.69168	0.0000022	0.000011	0.0000143
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-4-0084	0.139357		0.196005	0.000073	0.0006935	0.0104025
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-4-0085	0.139357		0.19053	0.000073	0.0006935	0.0104025
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-4-0086	0.2066995		0.28251	0.0260975	0.0009673	0.0155125
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-4-0087	0		0.1228225	0.000146	0.000146	0.0067525
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-4-0088	0		0	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-4-0089	0.1496318		0.2045825	0.000073	0.0007118	0.011315
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-4-0090	0.1496318		0.2045825	0.000073	0.0007118	0.0011315
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-4-0194	0.229366		0.313535	0.000073	0.0018798	0.017155
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-4-0203	0.140963		0.19272	0.000073	0.0020075	0.010585
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-5-0088	0.1195375		0.1801275	0.000073	0.1140078	0.009855
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-5-0093	0.174835		0.2388925	0.000073	0.001241	0.01314
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-5-0100	0.080446		0.1100475	0.006205	0.0005658	0.0060225
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-5-0204	0.1007035		0.137605	0.000073	0.0057488	0.0074825
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-6-0094	0		0	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-6-0096	0		0	0	0	0.01003
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-6-0182	0		0	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-6-0189	0		0	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-6-0250	0		0	0	0	0.00473
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-6-0259	0		0	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-7-0057	0		0	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-7-0058	0		0	0	0	0.03285
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-7-0061	0		0	0	0	0.03553
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-7-0063	0		0	0	0	0.91416
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-9-0041	0		0	0.1419	0	0.0143
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-9-0058	0		0	0	0	0.01377
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-9-0074	0		0	0	0	0.1183
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-9-0075	0		0	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	015-0055-9-0102	0		0	0.67584	0	0
24015	015-0059	Terumo Medical Corporation	015-0059-5-0005	0.443475		0.527425	0.0410625	0.003285	0.0292
24015	015-0059	Terumo Medical Corporation	015-0059-5-0091	0.443475		0.527425	0.0410625	0.003285	0.0292
24015	015-0059	Terumo Medical Corporation	015-0059-6-0213				0		0.046035
24015	015-0059	Terumo Medical Corporation	015-0059-6-0214				0		0.748865
24015	015-0059	Terumo Medical Corporation	015-0059-6-0215				0		0.2345
24015	015-0059	Terumo Medical Corporation	015-0059-6-0218				0		0.0029505
24015	015-0059	Terumo Medical Corporation	015-0059-6-0235				0		1.84175
24015	015-0059	Terumo Medical Corporation	015-0059-6-0236				0		2.272725
24015	015-0059	Terumo Medical Corporation	015-0059-6-0237				0		4.81375
24015	015-0059	Terumo Medical Corporation	015-0059-6-0239				0		1.1136
24015	015-0059	Terumo Medical Corporation	015-0059-6-0241				0		1.83896
24015	015-0059	Terumo Medical Corporation	015-0059-6-0243				0		0

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State County FIPS	State Facility Identifier	Facility Name	Emission Unit ID	CO	NH3	NOX	PM25-PRI	SO2	VOC
24015	015-0059	Terumo Medical Corporation	015-0059-6-0244				0		0.0000888
24015	015-0059	Terumo Medical Corporation	015-0059-6-0245				0		0
24015	015-0059	Terumo Medical Corporation	015-0059-6-0246				0		0.055025
24015	015-0059	Terumo Medical Corporation	015-0059-6-0273				0		0.000023
24015	015-0059	Terumo Medical Corporation	015-0059-6-0284				0		0
24015	015-0059	Terumo Medical Corporation	015-0059-6-0306				0		0.00988
24015	015-0074	BRC Railcar Service Company	015-0074-6-0151	0		0	0	0	0
24015	015-0074	BRC Railcar Service Company	015-0074-6-0313	0		0	0	0	0
24015	015-0074	BRC Railcar Service Company	015-0074-6-0314	0		0	0	0	0
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-4-0156	0.290075		1.161325	0.0902	2.508175	0.011275
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-4-0200	0.21371		0.85484	0.06622	1.84642	0.0086
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-4-0223	0.62458		1.08086	0.058905	0.0025245	0.066385
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-4-0224	0.50434		0.87429	0.047565	0.0020385	0.053605
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-6-0041				0		0.00456
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-6-0073				0		0
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-6-0102	0.60536		1.18657	0.054096	0.002254	0.9177
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-6-0104				0		
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-6-0126	0.44275		0.848375	0.0383625	0.00165	0.71225
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-6-0130				0		0.03700725
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-6-0131	0.0927		0.16074	0.00864	0.000369	0.01242
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-6-0162				0		0.01125
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-6-0173	1.173475		2.034875	0.1095	0.004745	0.12681925
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-6-0260	0.148325		0.591555	0		5.983605
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-6-0275				0		0.0272
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-6-0276	1.06984		2.16892	0.086	0.003784	5.74136
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-6-0278	0.5986		1.23164	0.048052	0.001968	1.71708
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-6-0279				0		0.00341915
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-6-0285				0		0.38674
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-6-0297	0		0	0	0	0
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-7-0045	0.12079		0.32896	0.011308	0.0004883	2.591845
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	015-0079-9-0169	0.00165		0.0062	0	0.0006	0.00016
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-5-0054	0.939875		1.118725	0.085775	0.0067525	0.06205
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-5-0059	0		0	0	0	0
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-5-0067	0		0	0	0	0
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-5-0068	0.09435		0.111925	0.00851	0.0006753	0.0061975
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-5-0069	0		0	0	0	0
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-5-0123	0.12025		0.143375	0.010915	0.0008603	0.0078625
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-5-0124	0.12025		0.143375	0.010915	0.0008603	0.0078625
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-6-0025	0		0	0	0	0
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-6-0093	0		0	0	0	0
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-6-0164	0		0	0	0	0
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-6-0180	1.234285		1.468545	0.31603	0.0087295	1.548105

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State County FIPS	State Facility Identifier	Facility Name	Emission Unit ID	CO	NH3	NOX	PM25-PRI	SO2	VOC
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-6-0187				0		0.10425
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-6-0207				0		2.3425
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-6-0286	0.30222		0.35972	0.0299	0.002162	0.0207
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-6-0294				0		0.05538
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-6-0310	0		0	0	0	0
24015	015-0150	W. L. Gore - Elk Creek Plant	015-0150-7-0085	0.79692		0.94806	0.072135	0.0056105	0.27709
24015	015-0163	Cecil County Central Landfill	015-0163-6-0252	0.12475		0.58	0.038	0.038	0.0565
24015	015-0163	Cecil County Central Landfill	015-0163-9-0096	11.3661		1.91625	0.95995	0.790225	4.288385
24015	015-0163	Cecil County Central Landfill	015-0163-9-0176	0.073		0.34	0.0238	0.0224	0.033
24015	015-0202	Rock Springs Generation Facility	015-0202-5-0076	3.7512		8.5008	2.13264	0.1008	0.1968
24015	015-0202	Rock Springs Generation Facility	015-0202-5-0077	3.10905		10.40025	2.20745	0.10045	0.2009
24015	015-0202	Rock Springs Generation Facility	015-0202-5-0078	5.7996		16.4016	3.17772	0.2988	0.2772
24015	015-0202	Rock Springs Generation Facility	015-0202-5-0079	5.4102		15.3999	1.543185	0.30175	0.2698
24015	015-0202	Rock Springs Generation Facility	015-0202-6-0205	0.41769		0.161525	0.0348075	0	0.010465
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-5-0089	0.647875		0.771975	0.0584	0.0045625	0.041975
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-5-0090	0.647875		0.771975	0.0584	0.0045625	0.041975
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0211				0		0.16632
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0212				0		0.72912
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0216				0		0.09797
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0217				0		0.16539
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0219				0		0
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0220				0		0.16808
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0221				0		0.22154
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0222				0		2.41755
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0223				0		0.609935
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0224				0		0.16524
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0225				0		0.165075
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0226				0		0.0912
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0227				0		11.151075
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0228				0		0.7831
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0229				0		0.77792
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0230				0		0.124135
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0231				0		0.00156
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0232				0		2.01264
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0233				0		2.461185
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0234				0		0.033015
24015	015-0212	Terumo Cardiovascular Systems Corporation	015-0212-6-0255				0		0.002948
24015	015-0222	Quikrete Company	015-0222-6-0251	0		0	0	0	0
24015 Total				43.359199	0	76.18764	13.320569	6.1981718	64.90726925
Grand Total				43.359199	0	76.18764	13.320569	6.1981718	64.90726925

Point Daily

State County FIPS	State Facility Identifier	Facility Name	Ozone NAA	Emission Unit ID	SCC	CO	NOX	VOC
24015	015-0005	Mellott Company @ Maryland Materials, Inc.	Philly	015-0005-6-0300	30502510	2.31E-06	0.044016	9.1E-07
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0084	10200503	0	0.000015	0.0000285
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0084	10200603	0.0003818	0.000522	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0085	10200503	0	0	0.0000285
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0085	10200603	0.0003818	0.000522	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0086	10200503	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0086	10200603	0.0005663	0.000774	0.0000425
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0087	10200503	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0087	10200603	0	0.0003365	0.0000185
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0088	10200503	0	0.0005225	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0089	10200503	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0089	10200603	0.00041	0.0005605	0.000031
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0090	10200503	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0090	10200603	0.00041	0.0005605	0.0000031
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0194	10200503	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0194	10200603	0.0006284	0.000859	0.000047
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0203	10200503	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-4-0203	10200603	0.0003862	0.000528	0.000029
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-5-0088	10200603	0.0003275	0.0004935	0.000027
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-5-0088	10300603	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-5-0093	10200603	0.000479	0.0006545	0.000036
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-5-0093	10300603	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-5-0100	10300503	0.0002204	0.0003015	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-5-0100	10300601	0	0	0.0000165
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-5-0204	10200503	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-5-0204	10200603	0.0002759	0.000377	0.0000205
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-6-0094	40200501	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-6-0096	40200501	0	0	0.00059
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-6-0182	31299999	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-6-0189	39999994	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-6-0250	40200201	0	0	0.00011
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-6-0259	40200501	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-7-0057	30900198	0	0	0
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-7-0058	30119708	0	0	0.00009
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-7-0061	30400711	0	0	0.001045
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-7-0063	40202502	0	0	0.00293
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-9-0041	50300205	0	0	0.0013
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-9-0058	30119708	0	0	0.00009
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-9-0074	40600305	0	0	0.000455
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-9-0075	49000599	0	0	0

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State County FIPS	State Facility Identifier	Facility Name	Ozone NAA	Emission Unit ID	SCC	CO	NOX	VOC
24015	015-0055	Alliant Techsystems, Inc - Atk Elkton Division	Philly	015-0055-9-0102	20400299	0	0	0
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-5-0005	10200603	0.001215	0.001445	0.00008
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-5-0091	10200603	0.001215	0.001445	0.00008
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-6-0213	39999999			0.000165
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-6-0214	39999999			0.002665
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-6-0215	39999999			0.000875
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-6-0218	39999999			0.0000105
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-6-0235	39999999			0.00695
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-6-0236	39999999			0.011655
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-6-0237	39999999			0.019255
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-6-0239	39999999			0.00464
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-6-0241	39999999			0.00724
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-6-0243	39999999			0
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-6-0244	39999999			0.0000004
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-6-0245	40500301			0
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-6-0246	40500301			0.000775
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-6-0273	39999999			0.0000001
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-6-0284	39999993			0
24015	015-0059	Terumo Medical Corporation	Philly	015-0059-6-0306	39999993			0.00019
24015	015-0074	BRC Railcar Service Company	Philly	015-0074-6-0151	40200501	0	0	0
24015	015-0074	BRC Railcar Service Company	Philly	015-0074-6-0313	40200501	0	0	0
24015	015-0074	BRC Railcar Service Company	Philly	015-0074-6-0314	30999999	0	0	0
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-4-0156	10201301	0	0	0
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-4-0156	10201302	0	0	0
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-4-0200	10200503	0	0	0
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-4-0223	10200503	0	0	0
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-4-0223	10201002	0.00334	0.00578	0.000355
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-4-0224	10200503	0	0	0
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-4-0224	10201002	0.00334	0.00579	0.000355
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-6-0041	30101852			0.00024
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-6-0073	39999994			0
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-6-0102	30800720	0.00188	0.003685	0.00285
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-6-0126	50400201	0.00161	0.003085	0.00259
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-6-0130	30101820			0.0003525
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-6-0131	30890004	0.00515	0.00893	0.00069
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-6-0162	40200501			0.0001125
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-6-0173	30101852	0.00643	0.005575	0.0003475
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-6-0260	40200855	0.000425	0.00339	0.02786
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-6-0275	30103599			0.0004
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-6-0276	30101852	0.00311	0.006305	0.01669

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State County FIPS	State Facility Identifier	Facility Name	Ozone NAA	Emission Unit ID	SCC	CO	NOX	VOC
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-6-0278	30101852	0.00365	0.003755	0.005235
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-6-0279	30101820			0.0004885
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-6-0285	30899999			0.00317
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-6-0297	30801002	0	0	0
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-7-0045	30101852	0.00047	0.00128	0.010085
24015	015-0079	W. L. Gore And Associates, Inc. - Cherry Hill Plant	Philly	015-0079-9-0169	20300101	0.000165	0.00062	0.000032
24015	015-0150	W. L. Gore - Elk Creek Plant	Philly	015-0150-5-0054	10200603	0.00103	0.001226	0.000068
24015	015-0150	W. L. Gore - Elk Creek Plant	Philly	015-0150-5-0059	10200603	0	0	0
24015	015-0150	W. L. Gore - Elk Creek Plant	Philly	015-0150-5-0067	10200603	0	0	0
24015	015-0150	W. L. Gore - Elk Creek Plant	Philly	015-0150-5-0068	10200603	0.000204	0.000242	0.0000134
24015	015-0150	W. L. Gore - Elk Creek Plant	Philly	015-0150-5-0069	10200603	0	0	0
24015	015-0150	W. L. Gore - Elk Creek Plant	Philly	015-0150-5-0123	10300603	0	0	0
24015	015-0150	W. L. Gore - Elk Creek Plant	Philly	015-0150-5-0124	10300603	0	0	
24015	015-0163	Cecil County Central Landfill	Philly	015-0163-9-0096	50100433	0.02845	0.00525	0.000249
24015	015-0163	Cecil County Central Landfill	Philly	015-0163-9-0176	20200102	0.01825	0.085	0.00825
24015	015-0202	Rock Springs Generation Facility	Philly	015-0202-5-0076	20300202	0.12504	0.5218383	0.00656
24015	015-0202	Rock Springs Generation Facility	Philly	015-0202-5-0077	20300202	0.06345	0.6016286	0.0041
24015	015-0202	Rock Springs Generation Facility	Philly	015-0202-5-0078	20300202	0.08055	0.6550355	0.00385
24015	015-0202	Rock Springs Generation Facility	Philly	015-0202-5-0079	20300202	0.0762	0.6545276	0.0038
24015	015-0202	Rock Springs Generation Facility	Philly	015-0202-6-0205	10100602	0.00459	0.001775	0.000115
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-5-0089	10200603	0.001775	0.002115	0.000115
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-5-0090	10200603	0.001775	0.002115	0.000115
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0211	39990021			0.000945
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0212	39999999			0.00217
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0216	39999999			0.000485
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0217	39999999			0.000745
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0219	39999999			0
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0220	39999999			0.00191
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0221	39999999			0.00106
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0222	39999999			0.01135
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0223	39999999			0.003065
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0224	39999999			0.00081
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0225	39999999			0.000775
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0226	39999999			0.00057
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0227	39999999			0.057185
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0228	39999999			0.00382
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0229	39999999			0.00442
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0230	39999999			0.003355
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0231	39999999			0.000008
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0232	39999999			0.00599

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State County FIPS	State Facility Identifier	Facility Name	Ozone NAA	Emission Unit ID	SCC	CO	NOX	VOC
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0233	39999999			0.041715
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0234	39999999			0.000155
24015	015-0212	Terumo Cardiovascular Systems Corporation	Philly	015-0212-6-0255	39999999			0.000011
24015	015-0222	Quikrete Company	Philly	015-0222-6-0251	30501109	0	0	0
24015 Total						0.4377835	2.6328805	0.3011523
Grand Total						0.4377835	2.6328805	0.3011523

Appendix C
Quasi-Point Source Files

Quasi-Point

The Maryland Department of the Environment Air and Radiation Management has identified several facilities that due to size and/or function are considered quasi-point sources. These establishments contain a wide variety of air emission sources, including traditional point sources, on-road mobile sources, off-road mobile sources and area sources. For each particular establishment, the emissions from these sources are totaled under a single point source and summary documents include these

MDE has not identified any facilities that meet these requirements within Cecil County, MD

Appendix D
Area/Nonpoint Source Files

NonPoint Annual

State FIPS	Source Classification Code	SCC Description	CO	NH3	NOX	PM25-PRI	SO2	VOC
24015	2103002000	Commercial/institutional bituminous coal combustion.	1.0339089		1.0339089		5.0357444	0.0821045
24015	2103004000	Commercial/institutional distillate oil combustion.	8.9266066	1.4282571	35.706426	3.8027344	77.125881	0.6070092
24015	2103005000	Commercial/institutional residual oil combustion.	0.0251533	0.0040245	0.2766863	0.0327556	1.5997501	0.0056846
24015	2103006000	Commercial/institutional natural gas combustion.	16.852504	0.0983063	20.062505	0.0862688	0.120375	1.1034378
24015	2103007000	Commercial/institutional LPG combustion.	15.825815	0.0992837	28.256128	0.0794269	0.1191404	1.03255
24015	2103011000	Commercial/institutional kerosene combustion.	0.1163462	0.0232692	0.4188462	0.0495635	1.0052309	0.016591
24015	2104002000	Residential bituminous coal combustion.	19.535142		0.6464356		2.6425719	0.7103688
24015	2104004000	Residential distillate oil combustion.	13.365825	2.673165	48.116969	5.6938414	115.48073	1.9059666
24015	2104006000	Residential natural gas combustion.	6.164588	3.082294	14.486782		0.0924688	0.8476309
24015	2104007000	Residential LPG combustion.	17.525446	0.2143463	61.800256	0.1881069	0.2624748	2.4060185
24015	2104008100	Fireplace: general	177.54169	2.144799	3.0980429	28.120697	0.476622	22.520389
24015	2104008210	Fireplaces: Insert; non-EPA certified	60.158978	0.4431121	0.7298316	7.9760171	0.1042617	13.81467
24015	2104008220	Fireplaces: Insert; EPA certified; non-catalytic	14.822172	0.094744	0.2400181	2.0633138	0.0421084	1.2632533
24015	2104008230	Woodstove: fireplace inserts; EPA certified; catalytic	3.6508886	0.0314732	0.0699404	0.713392	0.0139881	0.524553
24015	2104008310	Woodstove: freestanding, non-EPA certified	59.243697	0.4363704	0.7187277	7.8546669	0.1026754	13.604488
24015	2104008320	Woodstove: freestanding, EPA certified, non-catalytic	14.619129	0.0934461	0.2367302	2.0350492	0.0415316	1.2459485
24015	2104008330	Woodstove: freestanding, EPA certified, catalytic	3.6508886	0.0314732	0.0699404	0.713392	0.0139881	0.524553
24015	2104008400	Woodstove: pellet-fired, general (freestanding or FP insert)	0.307188	0.005796	0.073416	0.0591192	0.0061824	0.0007921
24015	2104008510	Furnace: Indoor, cordwood-fired, non-EPA certified	14.959169	0.1466585	0.1500259	2.248764	0.1653982	0.9614281
24015	2104008610	Hydronic heater: outdoor	22.323244	0.1116162	0.114179	3.9685766	0.1258783	4.1794073
24015	2104008700	Outdoor wood burning device, NEC (fire-pits, chimeas, etc)	0.8354289	0.0100924	0.014578	0.132323	0.0022428	0.1059705
24015	2104009000	Total: All Boiler Types	10.128978		0.6222503	2.299832		3.2035688
24015	2104011000	Residential kerosene combustion(SAF base on HDD Activities)	0.5966	0.1193	2.1477	0.2541	5.1545	0.0851
24015	2294000000	Paved Roads				117.6872		
24015	2296000000	Unpaved Roads				1.3414		
24015	2302002100	Commercial Charbroiling - Conveyorized Charbroiling	2.5			2.9		0.75
24015	2302002200	Commercial Charbroiling - Under-fired Charbroiling	7.16			17.63		2.19
24015	2302003000	Commercial Deep Fat Frying - Total						0.4
24015	2302003100	Commercial Deep Fat Frying - Flat Griddle Frying	0.58			3.54		0.28
24015	2302003200	Commercial Deep Fat Frying - Clamshell Griddle Frying				0.32		0.01
24015	2302070005	Wineries - Small						0.021536
24015	2311010000	Construction Residential Fugitive Dust				1.4		
24015	2311020000	Construction Industrial/Commercial/Institutional Dust				9.97		
24015	2311030000	Construction Road Construction Dust				12.97		
24015	2325000000	Mining and Quarrying.				23		
24015	2399010000	Refrigerant Losses from Industrial Refrigeration		4.99				
24015	2401002000	Architectural surface coatings - Solvent-Based						39.728
24015	2401003000	Architectural surface coatings - Water-Based						34.0327
24015	2401005000	Automobile refinishing.						15.8386
24015	2401008000	Surface Coating /Traffic Markings /Total: All Solvent Types						5.8272
24015	2401015000	Industrial surface coatings - Finished wood products.						1.0649
24015	2401020000	Industrial Surface Coating/Wood Furniture/Total						2.0686
24015	2401065000	Industrial surface coatings -Electronic and Other Electrical Coatings.						4.511
24015	2401075000	Industrial surface coatings -Aircraft.						5.511
24015	2401090000	Industrial Surface coatings - Misc. manufacturing.						41.4929
24015	2401100000	Industrial surface coatings - industrial maintenance.						22.454
24015	2401200000	Industrial Surface coatings - other categories.						22.454
24015	2415300000	Cleaning Products/Degreasing: Industrial and Institutional Cleaning.Cold cleaning solvents.						73.63
24015	2420000000	Dry Cleaning						3.7868
24015	2425000000	Graphic arts Screen & Plateless printing						2.86
24015	2425010000	Graphic arts Offset Lithography printing						12.43
24015	2425020000	Graphic arts Letterpress printing						5.29
24015	2425030000	Graphic arts Rotogravure printing						5.9
24015	2425040000	Graphic arts Flexography printing						6.76

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State FIPS	Source Classification Code	SCC Description	CO	NH3	NOX	PM25-PRI	SO2	VOC
24015	2440020000	Industrial Adhesive Application						19.91
24015	2460100000	Commercial & Consumer Products - Personal Care Products						89.133242
24015	2460200000	Commercial & Consumer Products - Household Products						26.786521
24015	2460400000	Commercial & Consumer Products - Automotive Aftermarket Products						48.665685
24015	2460500000	Commercial & Consumer Products - Coatings and Related Products						40.916916
24015	2460600000	Commercial & Consumer Products - Adhesives and Sealants						21.710076
24015	2460800000	Commercial & Consumer Products - FIFRA - Regulated Products						71.617704
24015	2460900000	Commercial & Consumer Products - Miscellanous Products						2.9549549
24015	2461020000	Misc. Asphalt Application						5.71
24015	2461021000	Cutback Asphalt Application						2.18
24015	2461022000	Emulsified asphalt.						3.63
24015	2461023000	Asphalt Roofing.						8.15
24015	2461800000	Pesticides						41.90764
24015	2501011011	Residential Portable Gas Cans /Permeation						2.097
24015	2501011012	Residential Portable Gas Cans /Evaporation (includes Diurnal losses)						23.31
24015	2501011013	Residential Portable Gas Cans /Spillage During Transport						2.833
24015	2501011014	Residential Portable Gas Cans /Refilling at the Pump - Vapor Displacement						2.2462
24015	2501011015	Residential Portable Gas Cans /Refilling at the Pump - Spillage						0.2298
24015	2501012011	Commercial Portable Gas Cans /Permeation						0.011
24015	2501012012	Commercial Portable Gas Cans /Evaporation (includes Diurnal losses)						0.205
24015	2501012013	Commercial Portable Gas Cans /Spillage During Transport						1.146
24015	2501012014	Commercial Portable Gas Cans /Refilling at the Pump - Vapor Displacement						1.13
24015	2501012015	Commercial Portable Gas Cans /Refilling at the Pump - Spillage						0.116
24015	2501060051	Gasoline Marketing - Tank truck unloading - Submerged						12.542
24015	2501060053	Gasoline Marketing - Tank truck unloading - Balanced Submerged						5.21
24015	2501060100	Gasoline Marketing - Stage II refueling.						25.64
24015	2501060201	Gasoline Marketing - Underground tank breathing.						20.823
24015	2501080050	Petroleum Products Airports : Aviation Gasoline /Stage 1						0.3762612
24015	2501080100	Petroleum Products Airports : Aviation Gasoline /Stage 2						0.2078
24015	2505030120	Gasoline Marketing - Tank trucks in transit.						1.719
24015	2610000100	Open Burning - Yard Waste - Leaf Species Unspecified	47.6		2.64	9.36	0.323	11.9
24015	2610000400	Open Burning - Yard Waste - Brush Species Unspecified	33.5		1.2	3.64	0.397	4.55
24015	2610000500	Open Burning - Land Clearing Debris	601.34		17.79	60.49		41.28
24015	2610030000	Open Burning - Residential Household Waste	0.304		0.0215	0.125	0.00358	0.0307
24015	2620030000	Landfills - Municipal						7.0582
24015	2630020000	POTWs.						0.35
24015	2660000000	Soil/groundwater remediation.						1.68
24015	2801000003	Agricultural - Crops /Tilling				122.13		
24015	2805001100	Agric - Livestock /Beef cattle - finishing operations on feedlots (drylots) /Confinement		1.1997558				
24015	2805001200	Agric - Livestock /Beef cattle - finishing operations on feedlots (drylots) /Manure handling & storage		0.0004802				
24015	2805001300	Agric - Livestock /Beef cattle - finishing operations on feedlots (drylots) /Confinement		0.9113911				
24015	2805002000	Agric - Livestock /Beef cattle production composite /Not Elsewhere Classified		7.8308209				
24015	2805003100	Agric - Livestock /Beef cattle - finishing operations on pasture/range /Confinement		6.111215				
24015	2805007100	Chickens Composite		187.83388				
24015	2805007300	Chickens Composite		4.2196484				
24015	2805008100	Chickens Composite		2.777825				
24015	2805008200	Chickens Composite		7.4604442				
24015	2805008300	Chickens Composite		1.2592807				
24015	2805009100	Chickens Composite		3.4392119				
24015	2805009200	Chickens Composite		0.6230265				
24015	2805009300	Chickens Composite		2.8042805				
24015	2805010100	Poultry production - turkeys /Confinement		0.3796361				
24015	2805010200	Poultry production - turkeys /Manure handling and storage		0.0683874				
24015	2805010300	Poultry production - turkeys /Land application of manure		0.3412756				

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State FIPS	Source Classification Code	SCC Description	CO	NH3	NOX	PM25-PRI	SO2	VOC
24015	2805018000	Agric - Livestock /Dairy cattle composite /Not Elsewhere Classified		37.963608				
24015	2805019100	Agric - Livestock /Dairy cattle - flush dairy /Confinement		1.5079621				
24015	2805019200	Agric - Livestock /Dairy cattle - flush dairy /Manure handling and storage		4.2196484				
24015	2805019300	Agric - Livestock /Dairy cattle - flush dairy /Land application of manure		0.3994777				
24015	2805021100	Agric - Livestock /Dairy cattle - scrape dairy /Confinement		17.857446				
24015	2805021200	Agric - Livestock /Dairy cattle - scrape dairy /Manure handling and storage		19.577052				
24015	2805021300	Agric - Livestock /Dairy cattle - scrape dairy /Land application of manure		39.154104				
24015	2805022100	Agric - Livestock /Dairy cattle - deep pit dairy /Confinement		1.8915665				
24015	2805022200	Agric - Livestock /Dairy cattle - deep pit dairy /Manure handling and storage		0.088229				
24015	2805022300	Agric - Livestock /Dairy cattle - deep pit dairy /Land application of manure		1.0608646				
24015	2805023100	Agric - Livestock /Dairy cattle - drylot/pasture dairy /Confinement		13.04255				
24015	2805023200	Agric - Livestock /Dairy cattle - drylot/pasture dairy /Manure handling and storage		0.2037072				
24015	2805023300	Agric - Livestock /Dairy cattle - drylot/pasture dairy /Land application of manure		17.460614				
24015	2805030000	Misc Poultry		0.0391541				
24015	2805030007	Ducks		0.0771177				
24015	2805030008	Geese		0.0486781				
24015	2805035000	HORSES		36.905389				
24015	2805039100	Agric - Livestock /Swine production - operations with lagoons (unspecified animal age) /Confinement		3.3069345				
24015	2805039200	Agric - Livestock /Swine production - operations with lagoons (unspecified animal age) /Manure handling & storage		8.1615143				
24015	2805039300	Agric - Livestock /Swine production - operations with lagoons (unspecified animal age) /Land application of manure		0.5502739				
24015	2805040000	Sheep Composite		2.3809928				
24015	2805045000	Goats Composite		9.6562487				
24015	2805047100	Agric - Livestock /Goats Waste Emissions /Not Elsewhere Classified		10.899656				
24015	2805047300	Livestock /Swine production - deep-pit house operations (unspecified animal age) /Land application of manure		6.7461464				
24015	2805053100	Agric - Livestock /Swine production - outdoor operations (unspecified animal age) /Confinement		0.1117744				
24015	2810001000	Wild Fires (old Forest fires)	17.913221	0.29614	0.354621	1.627719	0.168328	4.257066
24015	2810015000	Prescribed burning (Area SCC 2810015000 not being used for EPA's EIS Events)	36.876		0.791		0.217	1.735
24015	2810030000	Structural fires	4.38		0.1			0.8
24015	2810050000	Motor Vehicle Fires	0.67		0.02			0.17
24015	2810060100	Cremation - Humans	0.03		0.01			
24015	2830000000	Catastrophic/accidental releases/oil spills.						0.809
24015 Total			1235.0626	477.14924	242.01745	456.50326	210.84265	937.77749
Grand Total			1235.0626	477.14924	242.01745	456.50326	210.84265	937.77749

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State And County FIPS Code	Source Classification Code	SCC Description	CO	NOX	VOC
24015	2103002000	Commercial/institutional bituminous coal combustion.	2.22E-06	2.22E-06	1.763E-07
24015	2103004000	Commercial/institutional distillate oil combustion.	1.917E-05	7.666E-05	1.303E-06
24015	2103005000	Commercial/institutional residual oil combustion.	5.401E-08	5.941E-07	1.221E-08
24015	2103006000	Commercial/institutional natural gas combustion.	0.0341568	0.0406629	0.0022365
24015	2103007000	Commercial/institutional LPG combustion.	0.0320759	0.0572698	0.0020928
24015	2103011000	Commercial/institutional kerosene combustion.	2.498E-07	8.993E-07	3.562E-08
24015	2104002000	Residential bituminous coal combustion.	4.194E-05	1.388E-06	1.525E-06
24015	2104004000	Residential distillate oil combustion.	2.87E-05	0.0001033	4.092E-06
24015	2104006000	Residential natural gas combustion.	0.0124945	0.029362	0.001718
24015	2104007000	Residential LPG combustion.	0.0355208	0.1252574	0.0048765
24015	2104008100	Fireplace: general	0.0003812	6.652E-06	4.835E-05
24015	2104008210	Fireplaces: Insert; non-EPA certified	0.0001292	1.567E-06	2.966E-05
24015	2104008220	Fireplaces: Insert; EPA certified; non-catalytic	3.182E-05	5.153E-07	2.712E-06
24015	2104008230	Woodstove: fireplace inserts; EPA certified; catalytic	7.839E-06	1.502E-07	1.126E-06
24015	2104008310	Woodstove: freestanding, non-EPA certified	0.0001272	1.543E-06	2.921E-05
24015	2104008320	Woodstove: freestanding, EPA certified, non-catalytic	3.139E-05	5.083E-07	2.675E-06
24015	2104008330	Woodstove: freestanding, EPA certified, catalytic	7.839E-06	1.502E-07	1.126E-06
24015	2104008400	Woodstove: pellet-fired, general (freestanding or FP insert)	6.596E-07	1.576E-07	1.701E-09
24015	2104008510	Furnace: Indoor, cordwood-fired, non-EPA certified	3.212E-05	3.221E-07	2.064E-06
24015	2104008610	Hydronic heater: outdoor	4.793E-05	2.451E-07	8.973E-06
24015	2104008700	Outdoor wood burning device, NEC (fire-pits, chimeas, etc)	1.794E-06	3.13E-08	2.275E-07
24015	2104009000	Total: All Boiler Types	2.175E-05	1.336E-06	6.878E-06
24015	2104011000	Residential kerosene combustion(SAF base on HDD Activities)	1.281E-06	4.611E-06	1.827E-07
24015	2302002100	Commercial Charbroiling - Conveyorized Charbroiling	0.0091324		0.0027397
24015	2302002200	Commercial Charbroiling - Under-fired Charbroiling	0.0261553		0.008
24015	2302003000	Commercial Deep Fat Frying - Total			0.0014612
24015	2302003100	Commercial Deep Fat Frying - Flat Griddle Frying	0.0021187		0.0010228
24015	2302003200	Commercial Deep Fat Frying - Clamshell Griddle Frying			3.653E-05
24015	2302070005	Wineries - Small			8.283E-05
24015	2401002000	Architectural surface coatings - Solvent-Based			0.1436739
24015	2401003000	Architectural surface coatings - Water-Based			0.1727814
24015	2401005000	Automobile refinishing.			0.0609177
24015	2401008000	Surface Coating /Traffic Markings /Total: All Solvent Types			0.0224123
24015	2401015000	Industrial surface coatings - Finished wood products.			0.0040958
24015	2401020000	Industrial Surface Coating/Wood Furniture/Total			0.0079562
24015	2401065000	Industrial surface coatings -Electronic and Other Electrical Coatings.			0.01735
24015	2401075000	Industrial surface coatings -Aircraft.			0.0211962
24015	2401090000	Industrial Surface coatings - Misc. manufacturing.			0.1595881
24015	2401100000	Industrial surface coatings - industrial maintenance.			0.1139972
24015	2401200000	Industrial Surface coatings - other categories.			0.1139972
24015	2415300000	Cleaning Products/Degreasing: Industrial and Institutional Cleaning.Cold cleaning solvents.			0.2359936

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State And County FIPS Code	Source Classification Code	SCC Description	CO	NOX	VOC
24015	2420000000	Dry Cleaning			0.0121372
24015	2425000000	Graphic arts Screen & Plateless printing			0.011
24015	2425010000	Graphic arts Offset Lithography printing			0.0478077
24015	2425020000	Graphic arts Letterpress printing			0.0203462
24015	2425030000	Graphic arts Rotogravure printing			0.0226923
24015	2425040000	Graphic arts Flexography printing			0.026
24015	2440020000	Industrial Adhesive Application			0.0610937
24015	2460100000	Commercial & Consumer Products - Personal Care Products			0.2442007
24015	2460200000	Commercial & Consumer Products - Household Products			0.0733877
24015	2460400000	Commercial & Consumer Products - Automotive Aftermarket Products			0.1333306
24015	2460500000	Commercial & Consumer Products - Coatings and Related Products			0.1121011
24015	2460600000	Commercial & Consumer Products - Adhesives and Sealants			0.0594797
24015	2460800000	Commercial & Consumer Products - FIFRA - Regulated Products			0.1962129
24015	2460900000	Commercial & Consumer Products - Miscellanous Products			0.0080958
24015	2461020000	Misc. Asphalt Application			0.0284977
24015	2461021000	Cutback Asphalt Application			0.0130561
24015	2461022000	Emulsified asphalt.			0.0217401
24015	2461023000	Asphalt Roofing.			0.0488105
24015	2461800000	Pesticides			0.1343194
24015	2501011011	Residential Portable Gas Cans /Permeation			0.0086843
24015	2501011012	Residential Portable Gas Cans /Evaporation (includes Diurnal losses)			0.0965336
24015	2501011013	Residential Portable Gas Cans /Spillage During Transport			0.0117323
24015	2501011014	Residential Portable Gas Cans /Refilling at the Pump - Vapor Displacement			0.0093022
24015	2501011015	Residential Portable Gas Cans /Refilling at the Pump - Spillage			0.0009517
24015	2501012011	Commercial Portable Gas Cans /Permeation			4.555E-05
24015	2501012012	Commercial Portable Gas Cans /Evaporation (includes Diurnal losses)			0.000849
24015	2501012013	Commercial Portable Gas Cans /Spillage During Transport			0.0047459
24015	2501012014	Commercial Portable Gas Cans /Refilling at the Pump - Vapor Displacement			0.0046797
24015	2501012015	Commercial Portable Gas Cans /Refilling at the Pump - Spillage			0.0004804
24015	2501060051	Gasoline Marketing - Tank truck unloading - Submerged			0.0360833
24015	2501060053	Gasoline Marketing - Tank truck unloading - Balanced Submerged			0.0149891
24015	2501060100	Gasoline Marketing - Stage II refueling.			0.0737661
24015	2501060201	Gasoline Marketing - Underground tank breathing.			0.0599076
24015	2501080050	Petroleum Products Airports : Aviation Gasoline /Stage 1			0.0013044
24015	2501080100	Petroleum Products Airports : Aviation Gasoline /Stage 2			0.0007204
24015	2505030120	Gasoline Marketing - Tank trucks in transit.			0.0057857
24015	2610000100	Open Burning - Yard Waste - Leaf Species Unspecified	0	0	0
24015	2610000400	Open Burning - Yard Waste - Brush Species Unspecified	0	0	0
24015	2610000500	Open Burning - Land Clearing Debris	1.6475068	0.0487397	0.1130959
24015	2610030000	Open Burning - Residential Household Waste	0.0008329	5.89E-05	8.411E-05
24015	2620030000	Landfills - Municipal			0.0193375

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State And County FIPS Code	Source Classification Code	SCC Description	CO	NOX	VOC
24015	2630020000	POTWs.			0.0013425
24015	2660000000	Soil/groundwater remediation.			0.0046027
24015	2810001000	Wild Fires (old Forest fires)	0.0490773	0.0009716	0.0116632
24015	2810015000	Prescribed burning (Area SCC 2810015000 not being used for EPA's EIS Events)	0.1010301	0.0021671	0.0047534
24015	2810030000	Structural fires	0.0096	0.0002192	0.0017534
24015	2810050000	Motor Vehicle Fires	0.0018356	5.479E-05	0.0004658
24015	2810060100	Cremation - Humans	0.0001154	3.846E-05	
24015	2830000000	Catastrophic/accidental releases/oil spills.			0.0025929
24015 Total			1.9625669	0.3050047	2.8629286
Grand Total			1.9625669	0.3050047	2.8629286

Appendix E
Nonroad Source Files

NMIM Annual

FIPs Code	SCC	Short Name	CO	NH3	NOX	PM25-PRI	SO2	VOC
24015	2260001010	Off-highway Gasoline, 2-Stroke /Recreational Equipt /Motorcycles: Off-road	165.69	0.018764	1.2922	6.5456	0.015355	193.33
24015	2260001020	Off-highway Gasoline, 2-Stroke /Recreational Equipt /Snowmobiles	0	0	0	0	0	0
24015	2260001030	Off-highway Gasoline, 2-Stroke /Recreational Equipt /All Terrain Vehicles	242.26	0.020337	1.832	7.4116	0.016141	224.31
24015	2260001060	Off-highway Gasoline, 2-Stroke /Recreational Equipt /Specialty Vehicles/Carts	77.432	0.0037038	1.117	0.032822	0.0050708	4.2327
24015	2260002006	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Tampers/Rammers	6.4321	0.00028506	0.037416	0.21265	0.00031385	1.5358
24015	2260002009	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Plate Compactors	0.24111	0.00001662	0.0024991	0.0075107	0.000020437	0.055385
24015	2260002021	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Paving Equipt	0.29094	0.000019903	0.0029927	0.0090548	0.00002443	0.065966
24015	2260002027	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Signal Boards/Light Plants	0.0022817	1.5046E-07	0.000022624	0.000070969	1.8288E-07	0.0005842
24015	2260002039	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Concrete/Industrial Saws	16.752	0.00073783	0.098342	0.55437	0.00081099	3.9063
24015	2260002054	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Crushing/Processing Equipt	0.059413	3.9178E-06	0.00058911	0.001848	0.000004762	0.013436
24015	2260003030	Off-highway Gasoline, 2-Stroke /Industrial Equipt /Sweepers/Scrubbers	0.042058	2.7734E-06	0.00041703	0.0013082	0.000003371	0.01023
24015	2260003040	Off-highway Gasoline, 2-Stroke /Industrial Equipt /Other General Industrial Equipt	0.0033124	2.1843E-07	0.000032845	0.00010303	2.655E-07	0.0007772
24015	2260004015	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Rotary Tillers < 6 HP (Residential)	0.69779	0.000051273	0.0074255	0.02221	0.000062622	0.23358
24015	2260004016	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Rotary Tillers < 6 HP (Commercial)	1.4707	0.00010804	0.01617	0.047469	0.00013375	0.36811
24015	2260004020	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Chain Saws < 6 HP (Residential)	9.6719	0.00069518	0.10383	0.30254	0.00086051	3.4675
24015	2260004021	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Chain Saws < 6 HP (Commercial)	29.589	0.0013361	0.17977	0.9762	0.0014801	8.2011
24015	2260004025	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Trimmers/Edgers/Brush Cutters (Residential)	12.417	0.00096428	0.1456	0.43647	0.0011949	4.3787
24015	2260004026	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Trimmers/Edgers/Brush Cutters (Commercial)	16.17	0.0010643	0.15781	0.50962	0.0012979	4.2092
24015	2260004030	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Leafblowers/Vacuums (Residential)	8.4653	0.00062106	0.093085	0.27331	0.00076915	2.8395
24015	2260004031	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Leafblowers/Vacuums (Commercial)	18.019	0.001025	0.14631	0.57946	0.0012106	4.1625
24015	2260004035	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Snowblowers (Residential)	10.345	0.00041387	0.03355	0.10437	0.00036611	4.3101
24015	2260004036	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Snowblowers (Commercial)	10.679	0.00042727	0.034636	0.10775	0.00037796	4.0036
24015	2260004071	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Turf Equipt (Commercial)	0.0063869	4.4871E-07	0.000067471	0.00019947	5.5421E-07	0.0013507
24015	2260005035	Off-highway Gasoline, 2-Stroke /Agricultural Equipt /Sprayers	0.16229	0.000012938	0.0019756	0.0060362	0.000016045	0.041112
24015	2260006005	Off-highway Gasoline, 2-Stroke /Commercial Equipt /Generator Sets	0.70545	0.000049358	0.00743	0.022266	0.0000608	0.20259
24015	2260006010	Off-highway Gasoline, 2-Stroke /Commercial Equipt /Pumps	4.6121	0.00033382	0.05068	0.16466	0.00040556	1.4354
24015	2260006015	Off-highway Gasoline, 2-Stroke /Commercial Equipt /Air Compressors	0.0019509	1.2865E-07	0.000019344	0.000060681	1.5637E-07	0.0005343
24015	2260006035	Off-highway Gasoline, 2-Stroke /Commercial Equipt /Hydro-power Units	0.030697	2.0242E-06	0.00030438	0.0009548	2.4604E-06	0.0088541
24015	2260007005	Off-highway Gasoline, 2-Stroke /Logging Equipt /Chain Saws : 6 HP	0.3045	0.000012902	0.0016935	0.010123	0.000014004	0.076978
24015	2265001010	Off-highway Gasoline, 4-Stroke /Recreational Equipt /Motorcycles: Off-road	68.69	0.0058106	1.1458	0.11928	0.0078654	7.821
24015	2265001030	Off-highway Gasoline, 4-Stroke /Recreational Equipt /All Terrain Vehicles	769.38	0.060793	10.174	1.1784	0.082764	87.568
24015	2265001050	Off-highway Gasoline, 4-Stroke /Recreational Equipt /Golf Carts	91.019	0.0044906	0.89254	0.04068	0.0061658	2.4631
24015	2265001060	Off-highway Gasoline, 4-Stroke /Recreational Equipt /Specialty Vehicles/Carts	97.811	0.0037286	1.2824	0.028761	0.0050656	4.2976
24015	2265002003	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Pavers	3.5848	0.00020545	0.064517	0.0017779	0.0002821	0.1123
24015	2265002006	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Tampers/Rammers	0.031204	1.5152E-06	0.00044216	0.000011434	2.0779E-06	0.0010302
24015	2265002009	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Plate Compactors	6.5266	0.00038339	0.10142	0.0071668	0.00051667	0.39166
24015	2265002015	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Rollers	6.3074	0.00036181	0.094074	0.0029962	0.00049757	0.1791
24015	2265002021	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Paving Equipt	13.891	0.00072259	0.21001	0.0085736	0.0009844	0.58172
24015	2265002024	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Surfacing Equipt	5.756	0.00030378	0.079495	0.0037205	0.00041392	0.22253
24015	2265002027	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Signal Boards/Light Plants	0.28599	0.000015763	0.0040371	0.00025977	0.000021324	0.013213
24015	2265002030	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Trenchers	10.686	0.00063865	0.20211	0.0075512	0.00087228	0.41896
24015	2265002033	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Bore/Drill Rigs	3.2735	0.00022022	0.086145	0.0041897	0.00029676	0.23944
24015	2265002039	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Concrete/Industrial Saws	24.723	0.0013225	0.28485	0.011576	0.0018183	0.64376
24015	2265002042	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Cement & Mortar Mixers	13.724	0.00064446	0.1936	0.0076204	0.00087329	0.70076
24015	2265002045	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Cranes	0.53691	0.000051728	0.037273	0.00033256	0.000071502	0.023867
24015	2265002054	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Crushing/Processing Equipt	1.5874	0.000085937	0.025879	0.00096593	0.00011732	0.058148
24015	2265002057	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Rough Terrain Forklifts	0.58642	0.000079141	0.049877	0.00051002	0.00010983	0.027526
24015	2265002060	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Rubber Tire Loaders	0.94698	0.00018598	0.082309	0.0012509	0.00025912	0.043003
24015	2265002066	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Tractors/Loaders/Backhoes	8.528	0.00043491	0.11214	0.0035204	0.00059696	0.23026
24015	2265002072	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Skid Steer Loaders	4.169	0.00030221	0.15765	0.0020873	0.0004168	0.14932
24015	2265002078	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Dumpers/Tenders	2.2281	0.00010011	0.03259	0.00092334	0.00013644	0.10123
24015	2265002081	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Other Construction Equipt	0.65366	0.000071194	0.058743	0.00043633	0.00009847	0.032477
24015	2265003010	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Aerial Lifts	4.1966	0.00029462	0.24577	0.0019451	0.00040512	0.17857
24015	2265003020	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Forklifts	6.1263	0.00090912	0.53658	0.0060944	0.0012631	0.27591
24015	2265003030	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Sweepers/Scrubbers	2.4193	0.00022444	0.07306	0.0020207	0.00031003	0.091608
24015	2265003040	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Other General Industrial Equipt	6.8322	0.00041836	0.11769	0.0084836	0.00056272	0.4221
24015	2265003050	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Other Material H&ling Equipt	0.30352	0.000020633	0.015638	0.00013979	0.00002837	0.012154
24015	2265003060	Off-highway Gasoline, 4-Stroke /Industrial Equipt /AC\Refrigeration	0.23896	0.000011686	0.0033117	0.000092895	0.000016017	0.0076561
24015	2265003070	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Terminal Tractors	0.20027	0.000089231	0.018758	0.00063703	0.00012489	0.0089456
24015	2265004010	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Lawn Mowers (Residential)	171.66	0.0080683	2.066	0.16463	0.010547	19.927
24015	2265004011	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Lawn Mowers (Commercial)	40.908	0.002764	0.64896	0.07142	0.0036854	4.2829
24015	2265004015	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Rotary Tillers < 6 HP (Residential)	14.403	0.00067877	0.17368	0.014003	0.00088577	1.69
24015	2265004016	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Rotary Tillers < 6 HP (Commercial)	26.814	0.0014329	0.3508	0.031605	0.0018909	2.5704
24015	2265004025	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Trimmers/Edgers/Brush Cutters (Residential)	0.82439	0.000044408	0.010848	0.00098934	0.00005858	0.10446
24015	2265004026	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Trimmers/Edgers/Brush Cutters (Commercial)	1.1162	0.000064094	0.01559	0.001147	0.000086497	0.087552
24015	2265004030	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Leafblowers/Vacuums (Residential)	1.5719	0.000084779	0.020704	0.0018944	0.00011179	0.18464

FIPs Code	SCC	Short Name	CO	NH3	NOX	PM25-PRI	SO2	VOC
24015	2265004031	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Leafblowers/Vacuums (Commercial)	47.363	0.0026577	0.83959	0.021949	0.0036496	1.8674
24015	2265004035	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Snowblowers (Residential)	27.549	0.00089202	0.23503	0.0052936	0.0012021	1.8748
24015	2265004036	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Snowblowers (Commercial)	28.439	0.00092089	0.24264	0.0054647	0.001241	1.0975
24015	2265004040	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Rear Engine Riding Mowers (Residential)	33.378	0.001577	0.44557	0.011758	0.0021623	1.8665
24015	2265004041	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Rear Engine Riding Mowers (Commercial)	6.2917	0.00030539	0.079564	0.0023771	0.00041884	0.18604
24015	2265004046	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Front Mowers (Commercial)	8.14	0.00035349	0.10725	0.00266	0.00048356	0.28373
24015	2265004051	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Shredders < 6 HP (Commercial)	3.3116	0.00016551	0.041398	0.0035106	0.00021749	0.31054
24015	2265004055	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Lawn & Garden Tractors (Residential)	446.51	0.021147	5.98	0.15764	0.028996	19.782
24015	2265004056	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Lawn & Garden Tractors (Commercial)	85.539	0.0041504	1.0813	0.032198	0.0056925	2.378
24015	2265004066	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Chippers/Stump Grinders (Commercial)	9.5156	0.00069515	0.1963	0.0053519	0.00096021	0.27012
24015	2265004071	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Turf Equipt (Commercial)	242.06	0.013371	3.2529	0.1456	0.018277	8.2685
24015	2265004075	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Other Lawn & Garden Equipt (Residential)	17.432	0.00076647	0.21503	0.011122	0.0010234	1.1718
24015	2265004076	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Other Lawn & Garden Equipt (Commercial)	9.5628	0.00042145	0.11925	0.0061007	0.0005628	0.63649
24015	2265005010	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /2-Wheel Tractors	0.58716	0.000028441	0.0072468	0.00022769	0.000038992	0.016098
24015	2265005015	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Agricultural Tractors	0.93837	0.0001119	0.044044	0.00077801	0.00015538	0.032715
24015	2265005020	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Combines	0.0070527	7.0917E-07	0.00061835	4.2004E-06	9.7948E-07	0.0004109
24015	2265005025	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Balers	0.76166	0.000076552	0.066774	0.00045343	0.00010573	0.051182
24015	2265005030	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Agricultural Mowers	0.51195	0.000023736	0.0067843	0.0001812	0.00003252	0.01596
24015	2265005035	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Sprayers	4.8273	0.00026073	0.11586	0.0028667	0.00035461	0.24514
24015	2265005040	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Tillers : 6 HP	16.053	0.00056808	0.15446	0.0036708	0.00077092	0.62804
24015	2265005045	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Swathers	1.2087	0.00012148	0.10596	0.00071954	0.00016778	0.072671
24015	2265005055	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Other Agricultural Equipt	2.2898	0.00017565	0.12712	0.0011412	0.000242	0.1025
24015	2265005060	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Irrigation Sets	0.82092	0.00019129	0.058176	0.001465	0.00026662	0.040226
24015	2265006005	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Generator Sets	191.19	0.0092103	2.7816	0.085626	0.012585	8.2446
24015	2265006010	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Pumps	37.552	0.0022924	0.72188	0.035384	0.0031104	2.2928
24015	2265006015	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Air Compressors	18.133	0.001221	0.41079	0.01574	0.0016674	0.94106
24015	2265006025	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Welders	47.716	0.0026141	0.79388	0.0219	0.0035892	1.5901
24015	2265006030	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Pressure Washers	74.83	0.0041057	1.142	0.060271	0.0055695	4.1507
24015	2265006035	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Hydro-power Units	3.6832	0.00019295	0.051847	0.0021614	0.00026335	0.14387
24015	2265007010	Off-highway Gasoline, 4-Stroke /Logging Equipt /Shredders : 6 HP	0.54808	0.000023622	0.0077027	0.00017674	0.000032305	0.020752
24015	2265007015	Off-highway Gasoline, 4-Stroke /Logging Equipt /Forest Equipt - Feller/Bunch/Skidder	0.004548	2.7168E-07	0.000070121	5.9375E-06	3.6425E-07	0.0002837
24015	2265008005	Airport Ground Support Equipment, 4-Stroke Gasoline	0	0	0	0	0	0
24015	2265010010	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Other Oil Field Equipt	0	0	0	0	0	0
24015	2267001060	Off-highway LPG /Recreational Equipt /Specialty Vehicles/Carts	1.1913	0	0.26175	0.0017136	0.0003723	0.072047
24015	2267002003	Off-highway LPG /Construction & Mining Equipt /Pavers	0.1288	0	0.021762	0.00028925	0.00005695	0.0059968
24015	2267002015	Off-highway LPG /Construction & Mining Equipt /Rollers	0.15395	0	0.020934	0.0004987	0.000093777	0.0054823
24015	2267002021	Off-highway LPG /Construction & Mining Equipt /Paving Equipt	0.045422	0	0.0090272	0.000075948	0.00001585	0.002504
24015	2267002024	Off-highway LPG /Construction & Mining Equipt /Surfacing Equipt	0.020939	0	0.0033241	0.000050628	9.8284E-06	0.0009096
24015	2267002030	Off-highway LPG /Construction & Mining Equipt /Trenchers	0.41244	0	0.070536	0.00088902	0.00017586	0.019532
24015	2267002033	Off-highway LPG /Construction & Mining Equipt /Bore/Drill Rigs	0.19443	0	0.042307	0.00028925	0.000062691	0.011596
24015	2267002039	Off-highway LPG /Construction & Mining Equipt /Concrete/Industrial Saws	0.17874	0	0.024038	0.00085947	0.00015801	0.0056473
24015	2267002045	Off-highway LPG /Construction & Mining Equipt /Cranes	0.18544	0	0.036729	0.00031079	0.000064781	0.010201
24015	2267002054	Off-highway LPG /Construction & Mining Equipt /Crushing/Processing Equipt	0.029507	0	0.0057638	0.000050319	0.000010439	0.0016026
24015	2267002057	Off-highway LPG /Construction & Mining Equipt /Rough Terrain Forklifts	0.28964	0	0.051373	0.00056448	0.00011341	0.014326
24015	2267002060	Off-highway LPG /Construction & Mining Equipt /Rubber Tire Loaders	0.58884	0	0.085496	0.0014157	0.0002724	0.023641
24015	2267002066	Off-highway LPG /Construction & Mining Equipt /Tractors/Loaders/Backhoes	0.051413	0	0.006603	0.00014927	0.000028087	0.0017722
24015	2267002072	Off-highway LPG /Construction & Mining Equipt /Skid Steer Loaders	0.64302	0	0.12203	0.0011549	0.00023682	0.033808
24015	2267002081	Off-highway LPG /Construction & Mining Equipt /Other Construction Equipt	0.28672	0	0.058182	0.00046605	0.000098063	0.016114
24015	2267003010	Off-highway LPG /Industrial Equipt /Aerial Lifts	2.1205	0	0.42066	0.0036197	0.0007546	0.11618
24015	2267003020	Off-highway LPG /Industrial Equipt /Forklifts	142.79	0	20.75	0.34445	0.066395	5.7284
24015	2267003030	Off-highway LPG /Industrial Equipt /Sweepers/Scrubbers	0.70401	0	0.10084	0.0026455	0.00049498	0.025574
24015	2267003040	Off-highway LPG /Industrial Equipt /Other General Industrial Equipt	0.28142	0	0.037935	0.00081236	0.00015388	0.010165
24015	2267003050	Off-highway LPG /Industrial Equipt /Other Material H&ling Equipt	0.11281	0	0.021957	0.00019543	0.000040525	0.0060931
24015	2267003070	Off-highway LPG /Industrial Equipt /Terminal Tractors	0.27117	0	0.037023	0.0016202	0.0002981	0.0078998
24015	2267004066	Off-highway LPG /Lawn & Garden Equipt /Chippers/Stump Grinders (Commercial)	0.67123	0	0.091438	0.0018053	0.0003433	0.02484
24015	2267005055	Off-highway LPG /Agricultural Equipt /Other Agricultural Equipt	0.0053732	0	0.0011897	7.5314E-06	1.6375E-06	0.0003289
24015	2267005060	Off-highway LPG /Agricultural Equipt /Irrigation Sets	0.0042555	0	0.00054941	0.000011752	2.2137E-06	0.0001493
24015	2267006005	Off-highway LPG /Commercial Equipt /Generator Sets	3.5524	0	1.051	0.0081335	0.0017603	0.21719
24015	2267006010	Off-highway LPG /Commercial Equipt /Pumps	0.72083	0	0.1835	0.0019146	0.00039445	0.037893
24015	2267006015	Off-highway LPG /Commercial Equipt /Air Compressors	0.78767	0	0.17779	0.0023289	0.0004652	0.036717
24015	2267006025	Off-highway LPG /Commercial Equipt /Welders	1.3896	0	0.23558	0.0029003	0.0005791	0.065274
24015	2267006030	Off-highway LPG /Commercial Equipt /Pressure Washers	0.021173	0	0.0041647	0.000037141	0.000007764	0.0011434
24015	2267006035	Off-highway LPG /Commercial Equipt /Hydro-power Units	0.010532	0	0.0021862	0.000036686	7.1702E-06	0.0004385
24015	2267008005	Airport Ground Support Equipment, LPG	0	0	0	0	0	0
24015	2268002081	Off-highway CNG /Construction & Mining Equipt /Other Construction Equipt	0.011271	0	0.0022913	0.000018319	0.000003448	3.746E-05
24015	2268003020	Off-highway CNG /Industrial Equipt /Forklifts	10.103	0	1.4821	0.024104	0.0043601	0.024196

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24015	2268003030	Off-highway CNG /Industrial Equipt /Sweepers/Scrubbers	0.01135	0	0.0016451	0.000027408	4.9517E-06	2.683E-05
24015	2268003040	Off-highway CNG /Industrial Equipt /Other General Industrial Equipt	0.0057877	0	0.00078554	0.000014928	2.6909E-06	1.269E-05
24015	2268003060	Off-highway CNG /Industrial Equipt /AC\Refrigeration	0.022316	0	0.0033682	0.000067155	0.000012145	5.277E-05
24015	2268003070	Off-highway CNG /Industrial Equipt /Terminal Tractors	0.01897	0	0.0026576	0.0001124	0.00002022	3.369E-05
24015	2268005055	Off-highway CNG /Agricultural Equipt /Other Agricultural Equipt	0.0037011	0	0.00082954	4.2225E-06	7.3707E-07	1.439E-05
24015	2268005060	Off-highway CNG /Agricultural Equipt /Irrigation Sets	0.016863	0	0.0037576	0.000019419	0.000003376	6.531E-05
24015	2268006005	Off-highway CNG /Commercial Equipt /Generator Sets	1.0544	0	0.32265	0.0022874	0.00045593	0.0039639
24015	2268006010	Off-highway CNG /Commercial Equipt /Pumps	0.049209	0	0.01373	0.00011754	0.000022931	0.0001692
24015	2268006015	Off-highway CNG /Commercial Equipt /Air Compressors	0.06051	0	0.014142	0.00016821	0.000031886	0.000174
24015	2268006020	Off-highway CNG /Commercial Equipt /Gas Compressors	0.55355	0	0.10627	0.0065414	0.0010969	0.0010694
24015	2268006035	Off-highway CNG /Commercial Equipt /Hydro-power Units	0	0	0	0	0	0
24015	2268010010	Off-highway CNG /Industrial Equipt /Other Oil Field Equipt	0	0	0	0	0	0
24015	2270001060	Off-highway Diesel /Recreational Equipt /Specialty Vehicles/Carts	3.432	0.0029002	3.4743	0.47716	0.006703	0.8922
24015	2270002003	Off-highway Diesel /Construction & Mining Equipt /Pavers	1.51	0.0036899	3.1116	0.24484	0.0085202	0.25286
24015	2270002006	Off-highway Diesel /Construction & Mining Equipt /Tampers/Rammers	0.0058171	6.0297E-06	0.0072105	0.000747	0.000014065	0.0010915
24015	2270002009	Off-highway Diesel /Construction & Mining Equipt /Plate Compactors	0.083542	0.000099307	0.11343	0.010944	0.00023173	0.016671
24015	2270002015	Off-highway Diesel /Construction & Mining Equipt /Rollers	4.5203	0.0092374	8.2406	0.70155	0.021449	0.68651
24015	2270002018	Off-highway Diesel /Construction & Mining Equipt /Scrapers	3.8861	0.010045	8.6589	0.48467	0.022895	0.51924
24015	2270002021	Off-highway Diesel /Construction & Mining Equipt /Paving Equipt	0.27584	0.00055372	0.52012	0.044094	0.0012874	0.046006
24015	2270002024	Off-highway Diesel /Construction & Mining Equipt /Surfacing Equipt	0.21441	0.00034184	0.38302	0.029193	0.00079138	0.031349
24015	2270002027	Off-highway Diesel /Construction & Mining Equipt /Signal Boards/Light Plants	0.55391	0.0010215	1.0857	0.085327	0.0023855	0.12988
24015	2270002030	Off-highway Diesel /Construction & Mining Equipt /Trenchers	2.7109	0.0043835	4.2618	0.39428	0.010206	0.38719
24015	2270002033	Off-highway Diesel /Construction & Mining Equipt /Bore/Drill Rigs	1.7105	0.0037713	4.9798	0.28836	0.0087254	0.40829
24015	2270002036	Off-highway Diesel /Construction & Mining Equipt /Excavators	12.516	0.037424	28.615	2.1321	0.085717	2.1798
24015	2270002039	Off-highway Diesel /Construction & Mining Equipt /Concrete/Industrial Saws	0.20643	0.00031063	0.29937	0.030241	0.00072615	0.028381
24015	2270002042	Off-highway Diesel /Construction & Mining Equipt /Cement & Mortar Mixers	0.092038	0.00014692	0.19471	0.014934	0.00034159	0.021636
24015	2270002045	Off-highway Diesel /Construction & Mining Equipt /Cranes	2.1523	0.008549	8.2457	0.37993	0.019643	0.56078
24015	2270002048	Off-highway Diesel /Construction & Mining Equipt /Graders	2.7298	0.0093111	7.093	0.48934	0.021232	0.551
24015	2270002051	Off-highway Diesel /Construction & Mining Equipt /Off-highway Trucks	10.147	0.032014	28.224	1.3232	0.071901	1.683
24015	2270002054	Off-highway Diesel /Construction & Mining Equipt /Crushing/Processing Equipt	0.53075	0.0015074	1.5338	0.08204	0.0034827	0.10928
24015	2270002057	Off-highway Diesel /Construction & Mining Equipt /Rough Terrain Forklifts	7.3905	0.011985	11.214	1.1057	0.027969	1.0214
24015	2270002060	Off-highway Diesel /Construction & Mining Equipt /Rubber Tire Loaders	16.21	0.040744	38.711	2.4471	0.09356	2.7227
24015	2270002066	Off-highway Diesel /Construction & Mining Equipt /Tractors/Loaders/Backhoes	26.652	0.024781	27.508	4.0544	0.057741	5.5787
24015	2270002069	Off-highway Diesel /Construction & Mining Equipt /Crawler Tractor/Dozers	14.109	0.037284	32.458	2.0503	0.085339	2.2406
24015	2270002072	Off-highway Diesel /Construction & Mining Equipt /Skid Steer Loaders	22.314	0.017013	19.019	3.3144	0.03958	4.9474
24015	2270002075	Off-highway Diesel /Construction & Mining Equipt /Off-highway Tractors	1.8591	0.0040112	4.2723	0.22374	0.0091631	0.27292
24015	2270002078	Off-highway Diesel /Construction & Mining Equipt /Dumpers/Tenders	0.069453	0.000052465	0.061855	0.010465	0.00012195	0.017004
24015	2270002081	Off-highway Diesel /Construction & Mining Equipt /Other Construction Equipt	1.9814	0.003844	4.1672	0.26695	0.0088415	0.29655
24015	2270003010	Off-highway Diesel /Industrial Equipt /Aerial Lifts	0.6476	0.00049858	0.59397	0.092902	0.0011592	0.15729
24015	2270003020	Off-highway Diesel /Industrial Equipt /Forklifts	4.1648	0.0071962	5.103	0.55495	0.016716	0.39329
24015	2270003030	Off-highway Diesel /Industrial Equipt /Sweepers/Scrubbers	1.0042	0.0031419	2.691	0.17438	0.0073036	0.21403
24015	2270003040	Off-highway Diesel /Industrial Equipt /Other General Industrial Equipt	1.0235	0.0031898	3.0996	0.18846	0.0074074	0.24789
24015	2270003050	Off-highway Diesel /Industrial Equipt /Other Material H&ling Equipt	0.10981	0.000123	0.16005	0.017619	0.00028503	0.028612
24015	2270003060	Off-highway Diesel /Industrial Equipt /AC\Refrigeration	6.4323	0.012876	11.575	0.82277	0.030116	0.95066
24015	2270003070	Off-highway Diesel /Industrial Equipt /Terminal Tractors	1.5239	0.0045309	3.1409	0.25954	0.010306	0.25442
24015	2270004031	Off-highway Diesel /Lawn & Garden Equipt /Leafblowers/Vacuums (Commercial)	0.0001686	2.0984E-07	0.00027647	0.000025044	4.8906E-07	4.558E-05
24015	2270004036	Off-highway Diesel /Lawn & Garden Equipt /Snowblowers (Commercial)	0.021153	0.000055291	0.066561	0.003322	0.00012717	0.0052408
24015	2270004046	Off-highway Diesel /Lawn & Garden Equipt /Front Mowers (Commercial)	0.80008	0.0014644	1.5773	0.13037	0.0034204	0.18737
24015	2270004056	Off-highway Diesel /Lawn & Garden Equipt /Lawn & Garden Tractors (Commercial)	0.16836	0.00030226	0.31328	0.024321	0.00070597	0.039526
24015	2270004066	Off-highway Diesel /Lawn & Garden Equipt /Chippers/Stump Grinders (Commercial)	0.95451	0.0019931	2.3541	0.16027	0.0046189	0.21855
24015	2270004071	Off-highway Diesel /Lawn & Garden Equipt /Turf Equipt (Commercial)	0.089464	0.00023483	0.22084	0.015109	0.00054923	0.017536
24015	2270004076	Off-highway Diesel /Lawn & Garden Equipt /Other Lawn & Garden Equipt (Commercial)	0.0035204	5.6016E-06	0.0064023	0.00058851	0.000013079	0.0007984
24015	2270005010	Off-highway Diesel /Agricultural Equipt /2-Wheel Tractors	0.0014573	1.2358E-06	0.0011895	0.00014394	2.8852E-06	0.0001818
24015	2270005015	Off-highway Diesel /Agricultural Equipt /Agricultural Tractors	30.211	0.053362	59.133	5.0367	0.12351	5.4608
24015	2270005020	Off-highway Diesel /Agricultural Equipt /Combines	2.4613	0.0047899	6.2213	0.53909	0.011087	0.53708
24015	2270005025	Off-highway Diesel /Agricultural Equipt /Balers	0.021538	0.000026652	0.030677	0.0035445	0.000062173	0.0045579
24015	2270005030	Off-highway Diesel /Agricultural Equipt /Agricultural Mowers	0.0053125	5.4682E-06	0.0061916	0.00085329	0.000012766	0.0008128
24015	2270005035	Off-highway Diesel /Agricultural Equipt /Sprayers	0.24803	0.00040683	0.4867	0.043261	0.00094098	0.06104
24015	2270005040	Off-highway Diesel /Agricultural Equipt /Tillers : 6 HP	0.0006774	1.0182E-06	0.0012271	0.000083264	2.3463E-06	0.0001079
24015	2270005045	Off-highway Diesel /Agricultural Equipt /Swathers	0.29959	0.00037602	0.45931	0.053499	0.00087793	0.051848
24015	2270005055	Off-highway Diesel /Agricultural Equipt /Other Agricultural Equipt	0.63429	0.0010439	1.2553	0.11419	0.0024139	0.12558
24015	2270005060	Off-highway Diesel /Agricultural Equipt /Irrigation Sets	0.31503	0.00076708	0.79219	0.057979	0.0017869	0.07249
24015	2270006005	Off-highway Diesel /Commercial Equipt /Generator Sets	2.4789	0.0042864	5.1517	0.42167	0.0099755	0.61039
24015	2270006010	Off-highway Diesel /Commercial Equipt /Pumps	0.59267	0.0010112	1.2156	0.10274	0.002356	0.13737
24015	2270006015	Off-highway Diesel /Commercial Equipt /Air Compressors	1.3062	0.002803	2.7911	0.21141	0.0065272	0.24971
24015	2270006020	Off-highway Diesel /Commercial Equipt /Gas Compressors	0	0	0	0	0	0

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24015	2270006025	Off-highway Diesel /Commercial Equipt /Welders	1.8656	0.001429	1.55	0.26704	0.0033231	0.43668
24015	2270006030	Off-highway Diesel /Commercial Equipt /Pressure Washers	0.07342	0.00013691	0.1709	0.011516	0.00031778	0.02034
24015	2270006035	Off-highway Diesel /Commercial Equipt /Hydro-power Units	0.057139	0.00012131	0.12159	0.0093726	0.00028332	0.011096
24015	2270007010	Off-highway Diesel /Logging Equipt /Shredders : 6 HP	0	0	0	0	0	0
24015	2270007015	Off-highway Diesel /Logging Equipt /Forest Equipt - Feller/Bunch/Skidder	0.063794	0.00020991	0.14881	0.011294	0.00047767	0.011458
24015	2270008005	Airport Ground Support Equipment, Diesel	0	0	0	0	0	0
24015	2270009010	Off-highway Diesel /Underground Mining Equipt /Other Underground Mining Equipt	0	0	0	0	0	0
24015	2270010010	Off-highway Diesel /Industrial Equipt /Other Oil Field Equipt	0	0	0	0	0	0
24015	2282005010	Pleasure Craft /Gasoline 2-Stroke /Outboard	419.04	0.049483	17.342	3.2135	0.058718	225.45
24015	2282005015	Pleasure Craft /Gasoline 2-Stroke /Personal Water Craft	279.68	0.0302	10.523	1.4123	0.037577	86.766
24015	2282010005	Pleasure Craft /Gasoline 4-Stroke /Inboard/Sterndrive	456.78	0.04947	39.348	0.26933	0.068157	37.94
24015	2282020005	Pleasure Craft /Diesel /Inboard/Sterndrive	6.4568	0.024113	33.04	0.74556	0.063683	1.6583
24015	2282020010	Pleasure Craft /Diesel /Outboard	0.036883	0.00005633	0.060706	0.0061971	0.00014823	0.012125
24015	2285002015	Railroad Equipt /Diesel /Railway Maintenance	1.0643	0.001181	1.4318	0.16801	0.0027347	0.24681
24015	2285004015	Railroad Equipt /Gasoline, 4-Stroke /Railway Maintenance	1.67	0.000086401	0.026122	0.00083667	0.00011816	0.062108
24015	2285006015	Railroad Equipt /LPG /Railway Maintenance	0.01198	0	0.0022645	0.000021309	4.3684E-06	0.0006317
24015 Total			4941.7852	0.741698176	529.0220624	56.96568074	1.435937083	1054.9268
Grand Total			4941.7852	0.741698176	529.0220624	56.96568074	1.435937083	1054.9268

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24015	2260001010	Off-highway Gasoline, 2-Stroke /Recreational Equipt /Motorcycles: Off-road	0.733	0.005716452	0.860032258
24015	2260001020	Off-highway Gasoline, 2-Stroke /Recreational Equipt /Snowmobiles	0	0	0
24015	2260001030	Off-highway Gasoline, 2-Stroke /Recreational Equipt /All Terrain Vehicles	1.071709677	0.008104194	0.998322581
24015	2260001060	Off-highway Gasoline, 2-Stroke /Recreational Equipt /Specialty Vehicles/Carts	0.342548387	0.00494129	0.019860323
24015	2260002006	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Tampers/Rammers	0.020292903	0.000118045	0.004894516
24015	2260002009	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Plate Compactors	0.00076071	7.88452E-06	0.000178332
24015	2260002021	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Paving Equipt	0.000917903	9.44194E-06	0.000211619
24015	2260002027	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Signal Boards/Light Plants	7.19871E-06	7.13774E-08	1.85281E-06
24015	2260002039	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Concrete/Industrial Saws	0.052851613	0.000310268	0.012352903
24015	2260002054	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Crushing/Processing Equipt	0.000187445	1.85865E-06	4.28419E-05
24015	2260003030	Off-highway Gasoline, 2-Stroke /Industrial Equipt /Sweepers/Scrubbers	0.000113058	1.12103E-06	2.77213E-05
24015	2260003040	Off-highway Gasoline, 2-Stroke /Industrial Equipt /Other General Industrial Equipt	8.90452E-06	8.82935E-08	2.10316E-06
24015	2260004015	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Rotary Tillers < 6 HP (Residential)	0.002996742	3.18897E-05	0.001068226
24015	2260004016	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Rotary Tillers < 6 HP (Commercial)	0.006316129	6.94452E-05	0.001586935
24015	2260004020	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Chain Saws < 6 HP (Residential)	0.026	0.000279126	0.010130645
24015	2260004021	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Chain Saws < 6 HP (Commercial)	0.079541935	0.000483258	0.022113226
24015	2260004025	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Trimmers/Edgers/Brush Cutters (Residential)	0.053329032	0.00062529	0.020147097
24015	2260004026	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Trimmers/Edgers/Brush Cutters (Commercial)	0.069445161	0.000677742	0.018159032
24015	2260004030	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Leafblowers/Vacuums (Residential)	0.036354839	0.000399774	0.013430645
24015	2260004031	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Leafblowers/Vacuums (Commercial)	0.077383871	0.000628323	0.017933226
24015	2260004035	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Snowblowers (Residential)	0	0	0.002508839
24015	2260004036	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Snowblowers (Commercial)	0	0	0.000159084
24015	2260004071	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Turf Equipt (Commercial)	2.74294E-05	2.89765E-07	0.00000582
24015	2260005035	Off-highway Gasoline, 2-Stroke /Agricultural Equipt /Sprayers	0.000697	8.48452E-06	0.00018041
24015	2260006005	Off-highway Gasoline, 2-Stroke /Commercial Equipt /Generator Sets	0.001896355	1.99732E-05	0.000560323
24015	2260006010	Off-highway Gasoline, 2-Stroke /Commercial Equipt /Pumps	0.012398065	0.000136239	0.003907097
24015	2260006015	Off-highway Gasoline, 2-Stroke /Commercial Equipt /Air Compressors	5.24419E-06	0.000000052	1.44665E-06
24015	2260006035	Off-highway Gasoline, 2-Stroke /Commercial Equipt /Hydro-power Units	8.25194E-05	8.18226E-07	2.39048E-05
24015	2260007005	Off-highway Gasoline, 2-Stroke /Logging Equipt /Chain Saws : 6 HP	0.000818548	4.55258E-06	0.000207461
24015	2265001010	Off-highway Gasoline, 4-Stroke /Recreational Equipt /Motorcycles: Off-road	0.318374194	0.004213871	0.036532258
24015	2265001030	Off-highway Gasoline, 4-Stroke /Recreational Equipt /All Terrain Vehicles	3.566129032	0.037419355	0.404451613
24015	2265001050	Off-highway Gasoline, 4-Stroke /Recreational Equipt /Golf Carts	0.421870968	0.003282581	0.010792903
24015	2265001060	Off-highway Gasoline, 4-Stroke /Recreational Equipt /Specialty Vehicles/Carts	0.453354839	0.004716452	0.020420968
24015	2265002003	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Pavers	0.011952903	0.000162165	0.00035671
24015	2265002006	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Tampers/Rammers	0.000104045	1.11139E-06	3.3971E-06
24015	2265002009	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Plate Compactors	0.021761935	0.000254935	0.001260839
24015	2265002015	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Rollers	0.021030968	0.000236458	0.000569032
24015	2265002021	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Paving Equipt	0.046316129	0.000527871	0.001984032
24015	2265002024	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Surfacing Equipt	0.019192258	0.000199813	0.000711355
24015	2265002027	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Signal Boards/Light Plants	0.000953581	1.01474E-05	4.19355E-05
24015	2265002030	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Trenchers	0.035632258	0.000508032	0.001334129
24015	2265002033	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Bore/Drill Rigs	0.010914839	0.000216529	0.000808613
24015	2265002039	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Concrete/Industrial Saws	0.082435484	0.000716	0.002029613
24015	2265002042	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Cement & Mortar Mixers	0.04576129	0.000486613	0.002571806
24015	2265002045	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Cranes	0.001790226	9.36871E-05	7.69742E-05

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24015	2265002054	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Crushing/Processing Equipt	0.005292903	6.50484E-05	0.0001882
24015	2265002057	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Rough Terrain Forklifts	0.001955323	0.000125368	8.79516E-05
24015	2265002060	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Rubber Tire Loaders	0.003157548	0.000206887	0.000137026
24015	2265002066	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Tractors/Loaders/Backhoes	0.028435161	0.000281865	0.000730742
24015	2265002072	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Skid Steer Loaders	0.013900968	0.000396258	0.000494419
24015	2265002078	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Dumpers/Tenders	0.007429355	8.19161E-05	0.000379161
24015	2265002081	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Other Construction Equipt	0.002179516	0.000147652	0.000104581
24015	2265003010	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Aerial Lifts	0.011960968	0.000518323	0.000509355
24015	2265003020	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Forklifts	0.017460968	0.001131613	0.000737548
24015	2265003030	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Sweepers/Scrubbers	0.006895161	0.000154081	0.000250655
24015	2265003040	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Other General Industrial Equipt	0.019472903	0.000248206	0.001138129
24015	2265003050	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Other Material H&ling Equipt	0.000865065	3.29806E-05	3.45161E-05
24015	2265003060	Off-highway Gasoline, 4-Stroke /Industrial Equipt /AC\Refrigeration	0.000681065	6.98452E-06	2.1409E-05
24015	2265003070	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Terminal Tractors	0.000570806	3.95613E-05	2.4309E-05
24015	2265004010	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Lawn Mowers (Residential)	0.771193548	0.007463548	0.091016129
24015	2265004011	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Lawn Mowers (Commercial)	0.183790323	0.002344387	0.018333226
24015	2265004015	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Rotary Tillers < 6 HP (Residential)	0.064709677	0.000627419	0.007684194
24015	2265004016	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Rotary Tillers < 6 HP (Commercial)	0.120470968	0.001267258	0.010976452
24015	2265004025	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Trimmers/Edgers/Brush Cutters (Residential)	0.003703871	3.91871E-05	0.000468129
24015	2265004026	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Trimmers/Edgers/Brush Cutters (Commercial)	0.005014839	5.63161E-05	0.000375032
24015	2265004030	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Leafblowers/Vacuums (Residential)	0.007062258	7.47935E-05	0.000863129
24015	2265004031	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Leafblowers/Vacuums (Commercial)	0.212790323	0.003033032	0.008009677
24015	2265004035	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Snowblowers (Residential)	0	0	0.004763548
24015	2265004036	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Snowblowers (Commercial)	0	0	0.000317806
24015	2265004040	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Rear Engine Riding Mowers (Residential)	0.14996129	0.001609613	0.009037419
24015	2265004041	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Rear Engine Riding Mowers (Commercial)	0.028267097	0.000287426	0.000803645
24015	2265004046	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Front Mowers (Commercial)	0.036570968	0.000387452	0.001312387
24015	2265004051	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Shredders < 6 HP (Commercial)	0.014878387	0.000149552	0.001344161
24015	2265004055	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Lawn & Garden Tractors (Residential)	2.006096774	0.021602903	0.093867742
24015	2265004056	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Lawn & Garden Tractors (Commercial)	0.384290323	0.003906452	0.010226452
24015	2265004066	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Chippers/Stump Grinders (Commercial)	0.042751613	0.000709161	0.00116571
24015	2265004071	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Turf Equipt (Commercial)	1.087516129	0.011750968	0.035522581
24015	2265004075	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Other Lawn & Garden Equipt (Residential)	0.078319355	0.000776806	0.005342581
24015	2265004076	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Other Lawn & Garden Equipt (Commercial)	0.042964516	0.000430806	0.002912032
24015	2265005010	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /2-Wheel Tractors	0.002637968	2.6179E-05	6.9271E-05
24015	2265005015	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Agricultural Tractors	0.004215806	0.000159106	0.000139742
24015	2265005020	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Combines	3.16861E-05	2.23377E-06	1.77545E-06
24015	2265005025	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Balers	0.003421935	0.000241219	0.000222806
24015	2265005030	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Agricultural Mowers	0.002300065	2.45084E-05	7.11194E-05
24015	2265005035	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Sprayers	0.021688065	0.000418548	0.001103194
24015	2265005040	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Tillers : 6 HP	0.072122581	0.000557968	0.002831968
24015	2265005045	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Swathers	0.005430323	0.000382774	0.000314506
24015	2265005055	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Other Agricultural Equipt	0.010287419	0.000459226	0.000449258
24015	2265005060	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Irrigation Sets	0.003688065	0.000210161	0.000171584
24015	2265006005	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Generator Sets	0.544935484	0.005866452	0.026328387

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24015	2265006010	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Pumps	0.107029032	0.001522419	0.006378387
24015	2265006015	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Air Compressors	0.051680645	0.000866355	0.002562935
24015	2265006025	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Welders	0.135996774	0.00167429	0.004327742
24015	2265006030	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Pressure Washers	0.213277419	0.002408355	0.011994194
24015	2265006035	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Hydro-power Units	0.010497742	0.000109345	0.000394903
24015	2265007010	Off-highway Gasoline, 4-Stroke /Logging Equipt /Shredders : 6 HP	0.001562129	1.62448E-05	6.66194E-05
24015	2265007015	Off-highway Gasoline, 4-Stroke /Logging Equipt /Forest Equipt - Feller/Bunch/Skidder	1.29626E-05	1.47884E-07	7.51516E-07
24015	2265008005	Airport Ground Support Equipment, 4-Stroke Gasoline	0	0	0
24015	2265010010	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Other Oil Field Equipt	0	0	0
24015	2267001060	Off-highway LPG /Recreational Equipt /Specialty Vehicles/Carts	0.00527	0.001157935	0.000318723
24015	2267002003	Off-highway LPG /Construction & Mining Equipt /Pavers	0.000406355	6.86581E-05	1.89197E-05
24015	2267002015	Off-highway LPG /Construction & Mining Equipt /Rollers	0.00048571	6.60452E-05	1.72965E-05
24015	2267002021	Off-highway LPG /Construction & Mining Equipt /Paving Equipt	0.000143306	2.84806E-05	0.0000079
24015	2267002024	Off-highway LPG /Construction & Mining Equipt /Surfacing Equipt	6.60613E-05	1.04874E-05	2.86987E-06
24015	2267002030	Off-highway LPG /Construction & Mining Equipt /Trenchers	0.001301258	0.000222539	6.16226E-05
24015	2267002033	Off-highway LPG /Construction & Mining Equipt /Bore/Drill Rigs	0.000613419	0.000133477	3.65871E-05
24015	2267002039	Off-highway LPG /Construction & Mining Equipt /Concrete/Industrial Saws	0.000563903	7.58387E-05	1.78171E-05
24015	2267002045	Off-highway LPG /Construction & Mining Equipt /Cranes	0.000585065	0.000115877	3.21855E-05
24015	2267002054	Off-highway LPG /Construction & Mining Equipt /Crushing/Processing Equipt	9.30935E-05	1.81848E-05	5.05645E-06
24015	2267002057	Off-highway LPG /Construction & Mining Equipt /Rough Terrain Forklifts	0.000913806	0.000162081	4.51968E-05
24015	2267002060	Off-highway LPG /Construction & Mining Equipt /Rubber Tire Loaders	0.001857774	0.000269739	7.45871E-05
24015	2267002066	Off-highway LPG /Construction & Mining Equipt /Tractors/Loaders/Backhoes	0.000162206	2.08323E-05	5.59129E-06
24015	2267002072	Off-highway LPG /Construction & Mining Equipt /Skid Steer Loaders	0.00202871	0.000385	0.000106665
24015	2267002081	Off-highway LPG /Construction & Mining Equipt /Other Construction Equipt	0.000904613	0.000183565	5.08419E-05
24015	2267003010	Off-highway LPG /Industrial Equipt /Aerial Lifts	0.005700323	0.001130806	0.000312323
24015	2267003020	Off-highway LPG /Industrial Equipt /Forklifts	0.38383871	0.055780645	0.015399032
24015	2267003030	Off-highway LPG /Industrial Equipt /Sweepers/Scrubbers	0.001892516	0.000271065	6.87452E-05
24015	2267003040	Off-highway LPG /Industrial Equipt /Other General Industrial Equipt	0.000756484	0.000101974	2.73255E-05
24015	2267003050	Off-highway LPG /Industrial Equipt /Other Material H&ling Equipt	0.000303242	5.90258E-05	1.63794E-05
24015	2267003070	Off-highway LPG /Industrial Equipt /Terminal Tractors	0.000728935	9.95226E-05	2.12361E-05
24015	2267004066	Off-highway LPG /Lawn & Garden Equipt /Chippers/Stump Grinders (Commercial)	0.002882677	0.000392677	0.000106677
24015	2267005055	Off-highway LPG /Agricultural Equipt /Other Agricultural Equipt	2.30758E-05	5.10935E-06	1.41232E-06
24015	2267005060	Off-highway LPG /Agricultural Equipt /Irrigation Sets	1.82758E-05	2.35952E-06	0.000000641
24015	2267006005	Off-highway LPG /Commercial Equipt /Generator Sets	0.009549355	0.002825194	0.000583871
24015	2267006010	Off-highway LPG /Commercial Equipt /Pumps	0.00193771	0.00049329	0.000101861
24015	2267006015	Off-highway LPG /Commercial Equipt /Air Compressors	0.002117387	0.000477935	9.87032E-05
24015	2267006025	Off-highway LPG /Commercial Equipt /Welders	0.003735484	0.00063329	0.000175468
24015	2267006030	Off-highway LPG /Commercial Equipt /Pressure Washers	5.69161E-05	1.11955E-05	3.07371E-06
24015	2267006035	Off-highway LPG /Commercial Equipt /Hydro-power Units	2.83106E-05	5.8771E-06	1.17884E-06
24015	2267008005	Airport Ground Support Equipment, LPG	0	0	0
24015	2268002081	Off-highway CNG /Construction & Mining Equipt /Other Construction Equipt	3.55581E-05	7.22871E-06	1.1819E-07
24015	2268003020	Off-highway CNG /Industrial Equipt /Forklifts	0.027157419	0.003984194	6.50419E-05
24015	2268003030	Off-highway CNG /Industrial Equipt /Sweepers/Scrubbers	0.00003051	4.42226E-06	7.21258E-08
24015	2268003040	Off-highway CNG /Industrial Equipt /Other General Industrial Equipt	1.55584E-05	2.11168E-06	3.41E-08
24015	2268003060	Off-highway CNG /Industrial Equipt /AC\Refrigeration	5.99903E-05	9.05419E-06	1.41845E-07

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24015	2268003070	Off-highway CNG /Industrial Equipt /Terminal Tractors	5.09968E-05	7.14419E-06	9.05581E-08
24015	2268005055	Off-highway CNG /Agricultural Equipt /Other Agricultural Equipt	1.58945E-05	3.56258E-06	6.18E-08
24015	2268005060	Off-highway CNG /Agricultural Equipt /Irrigation Sets	7.24194E-05	1.61374E-05	2.805E-07
24015	2268006005	Off-highway CNG /Commercial Equipt /Generator Sets	0.002834419	0.000867355	1.06558E-05
24015	2268006010	Off-highway CNG /Commercial Equipt /Pumps	0.000132284	3.69097E-05	4.54742E-07
24015	2268006015	Off-highway CNG /Commercial Equipt /Air Compressors	0.000162661	3.80161E-05	4.67677E-07
24015	2268006020	Off-highway CNG /Commercial Equipt /Gas Compressors	0.001488032	0.000285677	2.87471E-06
24015	2268006035	Off-highway CNG /Commercial Equipt /Hydro-power Units	0	0	0
24015	2268010010	Off-highway CNG /Industrial Equipt /Other Oil Field Equipt	0	0	0
24015	2270001060	Off-highway Diesel /Recreational Equipt /Specialty Vehicles/Carts	0.015182581	0.015369677	0.003946774
24015	2270002003	Off-highway Diesel /Construction & Mining Equipt /Pavers	0.004764194	0.009817097	0.000797774
24015	2270002006	Off-highway Diesel /Construction & Mining Equipt /Tampers/Rammers	1.83526E-05	2.2749E-05	3.44355E-06
24015	2270002009	Off-highway Diesel /Construction & Mining Equipt /Plate Compactors	0.000263574	0.000357871	5.25968E-05
24015	2270002015	Off-highway Diesel /Construction & Mining Equipt /Rollers	0.014261613	0.02599871	0.002165935
24015	2270002018	Off-highway Diesel /Construction & Mining Equipt /Scrapers	0.012260645	0.02731871	0.001638194
24015	2270002021	Off-highway Diesel /Construction & Mining Equipt /Paving Equipt	0.000870258	0.001640968	0.000145148
24015	2270002024	Off-highway Diesel /Construction & Mining Equipt /Surfacing Equipt	0.000676452	0.001208419	9.89032E-05
24015	2270002027	Off-highway Diesel /Construction & Mining Equipt /Signal Boards/Light Plants	0.001747548	0.003425484	0.000409774
24015	2270002030	Off-highway Diesel /Construction & Mining Equipt /Trenchers	0.008552581	0.013446129	0.001221581
24015	2270002033	Off-highway Diesel /Construction & Mining Equipt /Bore/Drill Rigs	0.005396452	0.01571129	0.001288161
24015	2270002036	Off-highway Diesel /Construction & Mining Equipt /Excavators	0.039487097	0.090277419	0.006877097
24015	2270002039	Off-highway Diesel /Construction & Mining Equipt /Concrete/Industrial Saws	0.00065129	0.000944516	8.95419E-05
24015	2270002042	Off-highway Diesel /Construction & Mining Equipt /Cement & Mortar Mixers	0.000290377	0.00061429	6.82613E-05
24015	2270002045	Off-highway Diesel /Construction & Mining Equipt /Cranes	0.006790645	0.026015161	0.001769226
24015	2270002048	Off-highway Diesel /Construction & Mining Equipt /Graders	0.008612581	0.022378065	0.001738419
24015	2270002051	Off-highway Diesel /Construction & Mining Equipt /Off-highway Trucks	0.032014516	0.089048387	0.005309677
24015	2270002054	Off-highway Diesel /Construction & Mining Equipt /Crushing/Processing Equipt	0.001674516	0.004839032	0.000344774
24015	2270002057	Off-highway Diesel /Construction & Mining Equipt /Rough Terrain Forklifts	0.023317097	0.035377419	0.003222516
24015	2270002060	Off-highway Diesel /Construction & Mining Equipt /Rubber Tire Loaders	0.051141935	0.122132258	0.00859
24015	2270002066	Off-highway Diesel /Construction & Mining Equipt /Tractors/Loaders/Backhoes	0.084087097	0.086787097	0.017600645
24015	2270002069	Off-highway Diesel /Construction & Mining Equipt /Crawler Tractor/Dozers	0.044512903	0.102406452	0.007069032
24015	2270002072	Off-highway Diesel /Construction & Mining Equipt /Skid Steer Loaders	0.0704	0.060003226	0.015609032
24015	2270002075	Off-highway Diesel /Construction & Mining Equipt /Off-highway Tractors	0.005865484	0.013479032	0.000861065
24015	2270002078	Off-highway Diesel /Construction & Mining Equipt /Dumpers/Tenders	0.000219123	0.000195152	5.36484E-05
24015	2270002081	Off-highway Diesel /Construction & Mining Equipt /Other Construction Equipt	0.00625129	0.013147419	0.000935613
24015	2270003010	Off-highway Diesel /Industrial Equipt /Aerial Lifts	0.001740871	0.001596677	0.000422806
24015	2270003020	Off-highway Diesel /Industrial Equipt /Forklifts	0.011195484	0.013717742	0.001057226
24015	2270003030	Off-highway Diesel /Industrial Equipt /Sweepers/Scrubbers	0.002699548	0.007233871	0.000575355
24015	2270003040	Off-highway Diesel /Industrial Equipt /Other General Industrial Equipt	0.002751323	0.008332258	0.000666387
24015	2270003050	Off-highway Diesel /Industrial Equipt /Other Material H&ling Equipt	0.000295197	0.000430226	7.69161E-05
24015	2270003060	Off-highway Diesel /Industrial Equipt /AC\Refrigeration	0.01729129	0.031114516	0.002555548
24015	2270003070	Off-highway Diesel /Industrial Equipt /Terminal Tractors	0.004096452	0.008443226	0.000683935
24015	2270004031	Off-highway Diesel /Lawn & Garden Equipt /Leafblowers/Vacuums (Commercial)	7.23968E-07	1.18732E-06	1.95729E-07
24015	2270004036	Off-highway Diesel /Lawn & Garden Equipt /Snowblowers (Commercial)	0	0	0
24015	2270004046	Off-highway Diesel /Lawn & Garden Equipt /Front Mowers (Commercial)	0.003436129	0.006773871	0.000804677

NMIM Daily

FIPS Code	SCC	Short Name	CO	NOX	VOC
24015	2270004056	Off-highway Diesel /Lawn & Garden Equipt /Lawn & Garden Tractors (Commercial)	0.000723032	0.001345419	0.000169748
24015	2270004066	Off-highway Diesel /Lawn & Garden Equipt /Chippers/Stump Grinders (Commercial)	0.004099355	0.010109677	0.000938581
24015	2270004071	Off-highway Diesel /Lawn & Garden Equipt /Turf Equipt (Commercial)	0.000384226	0.000948419	7.53097E-05
24015	2270004076	Off-highway Diesel /Lawn & Garden Equipt /Other Lawn & Garden Equipt (Commercial)	1.51187E-05	2.74952E-05	3.42903E-06
24015	2270005010	Off-highway Diesel /Agricultural Equipt /2-Wheel Tractors	6.25839E-06	5.10871E-06	7.80581E-07
24015	2270005015	Off-highway Diesel /Agricultural Equipt /Agricultural Tractors	0.129745161	0.253954839	0.023452258
24015	2270005020	Off-highway Diesel /Agricultural Equipt /Combines	0.010570323	0.026718065	0.002306548
24015	2270005025	Off-highway Diesel /Agricultural Equipt /Balers	0.0000925	0.000131748	1.95742E-05
24015	2270005030	Off-highway Diesel /Agricultural Equipt /Agricultural Mowers	2.28152E-05	2.65906E-05	3.49065E-06
24015	2270005035	Off-highway Diesel /Agricultural Equipt /Sprayers	0.001065194	0.002090194	0.000262145
24015	2270005040	Off-highway Diesel /Agricultural Equipt /Tillers : 6 HP	2.9091E-06	0.00000527	4.63161E-07
24015	2270005045	Off-highway Diesel /Agricultural Equipt /Swathers	0.001286613	0.001972548	0.000222665
24015	2270005055	Off-highway Diesel /Agricultural Equipt /Other Agricultural Equipt	0.002724032	0.005390968	0.000539323
24015	2270005060	Off-highway Diesel /Agricultural Equipt /Irrigation Sets	0.001352968	0.003402258	0.000311316
24015	2270006005	Off-highway Diesel /Commercial Equipt /Generator Sets	0.006663548	0.01384871	0.001640839
24015	2270006010	Off-highway Diesel /Commercial Equipt /Pumps	0.001593194	0.003267742	0.00036929
24015	2270006015	Off-highway Diesel /Commercial Equipt /Air Compressors	0.00351129	0.007502903	0.000671258
24015	2270006020	Off-highway Diesel /Commercial Equipt /Gas Compressors	0	0	0
24015	2270006025	Off-highway Diesel /Commercial Equipt /Welders	0.005014839	0.004166774	0.001173871
24015	2270006030	Off-highway Diesel /Commercial Equipt /Pressure Washers	0.000197365	0.000459419	5.46774E-05
24015	2270006035	Off-highway Diesel /Commercial Equipt /Hydro-power Units	0.0001536	0.000326871	2.98287E-05
24015	2270007010	Off-highway Diesel /Logging Equipt /Shredders : 6 HP	0	0	0
24015	2270007015	Off-highway Diesel /Logging Equipt /Forest Equipt - Feller/Bunch/Skidder	0.000171487	0.000400032	0.0000308
24015	2270008005	Airport Ground Support Equipment, Diesel	0	0	0
24015	2270009010	Off-highway Diesel /Underground Mining Equipt /Other Underground Mining Equipt	0	0	0
24015	2270010010	Off-highway Diesel /Industrial Equipt /Other Oil Field Equipt	0	0	0
24015	2282005010	Pleasure Craft /Gasoline 2-Stroke /Outboard	2.570903226	0.106396774	1.365870968
24015	2282005015	Pleasure Craft /Gasoline 2-Stroke /Personal Water Craft	1.715870968	0.06456129	0.531612903
24015	2282010005	Pleasure Craft /Gasoline 4-Stroke /Inboard/Sterndrive	2.905290323	0.211748387	0.220987097
24015	2282020005	Pleasure Craft /Diesel /Inboard/Sterndrive	0.039612903	0.202706452	0.010173871
24015	2282020010	Pleasure Craft /Diesel /Outboard	0.000226284	0.000372452	7.43903E-05
24015	2285002015	Railroad Equipt /Diesel /Railway Maintenance	0.002860935	0.003849032	0.000663452
24015	2285004015	Railroad Equipt /Gasoline, 4-Stroke /Railway Maintenance	0.00476	5.50903E-05	0.000185961
24015	2285006015	Railroad Equipt /LPG /Railway Maintenance	3.22039E-05	6.0871E-06	1.69819E-06
24015 Total			22.551482	2.006393688	5.12700232
Grand Total			22.551482	2.006393688	5.12700232

MAR Annual

State And County FIPS Code	Source Classification Code	Emissions Type Code	SCC Level Four	CO	NOX	PM25-PRI	SO2	VOC
24015	2275050000	Mobile - Aircraft	Total	89.6845	0.4852		0.747	2.855
24015	2280002200	Marine Vessel Cruise	Underway emissions	0.368477493	4.30696107		0.642682139	0.157002447
24015	2280003200	Marine Vessel Cruise	Underway emissions	3.141174075	40.6108934		23.11006641	1.346217461
24015	2285002006	Mobile - Locomotives	Line Haul Locomotives: Class I Operations	21.71321366	121.5170085	3.480769077	0.040837543	6.61256414
24015	2285002009	Mobile - Locomotives	Line Haul Locomotives: Commuter Lines	0.1404	0.7858	0.0225	0.0003	0.0428
24015	2285002010	Mobile - Locomotives	Yard Locomotives	0.03	0.26	0.01		0.02
24015 Total				115.0777652	167.965863	3.513269077	24.54088609	11.03358405
Grand Total				115.0777652	167.965863	3.513269077	24.54088609	11.03358405

Appendix F
Onroad Mobile Source Files

ONROAD Daily & Annual

MOBILE EMISSIONS ARE CALCULATED BY MOVES MODEL AND INPUTS ARE GIVEN TO EPA
THE CHART BELOW IS A REPERSENTATION OF ONROAD EMISSIONS DAILY(TPD - TONS PER DAY) AND (TPY -TONS PER YEAR)

	VOC	NOx	CO	VOC	NOx	CO	SOx	PM2.5	NH3
Counties	**TPD**	**TPD**	**TPD**	**TPY**	**TPY**	**TPY**	**TPY**	**TPY**	**TPY**
Cecil	2.29	7.50	5.33	791.98	2,730.44	9,421.97	11.04	94.74	52.21
Total Philly (Cecil) NAA:	**2.29**	**7.50**	**5.33**	**791.98**	**2,730.44**	**9,421.97**	**11.04**	**94.74**	**52.21**

APPENDIX B

Baltimore Area MOVES Sample Input Files

July Weekday MOVES Run Specification File Settings

Sample xml file format


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                <filters>
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                (Specify County to be run)
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                <day id="5"/>
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                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="61" sourcetypename="Combination Short-haul Truck"/>
                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="41" sourcetypename="Intercity Bus"/>
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                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="54" sourcetypename="Motor Home"/>
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        </agedistribution>

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Sample mrs file format – first MOVES run for modeling without the evaporative permeation processes

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```
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<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="51" sourcetypename="Refuse Truck"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="43" sourcetypename="School Bus"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="53" sourcetypename="Single Unit Long-haul Truck"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="52" sourcetypename="Single Unit Short-haul Truck"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="42" sourcetypename="Transit Bus"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="62" sourcetypename="Combination Long-haul Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="61" sourcetypename="Combination Short-haul Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="41" sourcetypename="Intercity Bus"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="32" sourcetypename="Light Commercial Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="54" sourcetypename="Motor Home"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="11" sourcetypename="Motorcycle"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="21" sourcetypename="Passenger Car"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="31" sourcetypename="Passenger Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="51" sourcetypename="Refuse Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="43" sourcetypename="School Bus"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="53" sourcetypename="Single Unit Long-haul Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="52" sourcetypename="Single Unit Short-haul Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="42" sourcetypename="Transit Bus"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="62" sourcetypename="Combination Long-haul Truck"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="61" sourcetypename="Combination Short-haul Truck"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="41" sourcetypename="Intercity Bus"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="32" sourcetypename="Light Commercial Truck"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="54" sourcetypename="Motor Home"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="11" sourcetypename="Motorcycle"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="21" sourcetypename="Passenger Car"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="31" sourcetypename="Passenger Truck"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="51" sourcetypename="Refuse Truck"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="43" sourcetypename="School Bus"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="53" sourcetypename="Single Unit Long-haul Truck"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="52" sourcetypename="Single Unit Short-haul Truck"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="42" sourcetypename="Transit Bus"/>
    </onroadvehicleselections>
    <offroadvehicleselections>
    </offroadvehicleselections>
    <offroadvehiclesccs>
    </offroadvehiclesccs>
    <roadtypes>
        <roadtype roadtypeid="1" roadtypename="Off-Network"/>
        <roadtype roadtypeid="2" roadtypename="Rural Restricted Access"/>
        <roadtype roadtypeid="3" roadtypename="Rural Unrestricted Access"/>
        <roadtype roadtypeid="4" roadtypename="Urban Restricted Access"/>
        <roadtype roadtypeid="5" roadtypename="Urban Unrestricted Access"/>
    </roadtypes>
    <pollutantprocessassociations>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="12" processname="Evap Fuel Vapor Venting"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="13" processname="Evap Fuel Leaks"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
```

```
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="12" processname="Evap Fuel Vapor Venting"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="13" processname="Evap Fuel Leaks"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="90" processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="1" processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="2" processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="12" processname="Evap Fuel Vapor Venting"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="13" processname="Evap Fuel Leaks"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="15" processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="16" processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="90" processname="Extended Idle Exhaust"/>

     </pollutantprocessassociations>
     <databaseselections>
<databaseselection servername="localhost" databasename="early_NLEV" description=""/>
<databaseselection servername="localhost" databasename="calevii2011" description=""/>
                              <databaseselection servername="localhost" databasename="md_stageii" description=""/>
     </databaseselections>
     <inputdatabase servername="" databasename="" description=""/>
     <uncertaintyparameters uncertaintymodeenabled="false" numberofrunspersimulation="0" numberofsimulations="0"/>
<geographicoutputdetail description="COUNTY"/>
     <outputemissionsbreakdownselection>
<modelyear selected="false"/>
<fueltype selected="false"/>
<emissionprocess selected="true"/>
          <onroadoffroad selected="true"/>
<roadtype selected="true"/>
<sourceusetype selected="true"/>
          <movesvehicletype selected="false"/>
<onroadscc selected="false"/>
          <offroadscc selected="false"/>
          <estimateuncertainty selected="false" numberOfIterations="2" keepSampledData="false" keepIterations="false"/>
          <sector selected="false"/>
       <engtechid selected="false"/>
          <hpclass selected="false"/>
     </outputemissionsbreakdownselection>
     (Specify output database file name for county being run)
     <outputdatabase servername="localhost" databasename="24003_2011_07_05_JulyWkd_mo" description=""/>>
<outputtimestep value="Hour"/>
     <outputvmtdata value="true"/>
     <outputsho value="true"/>
     <outputsh value="true"/>
     <outputshp value="true"/>
     <outputshidling value="true"/>
     <outputstarts value="true"/>
     <outputpopulation value="true"/>
     (Specify input database file name for county being run)
     <scaleinputdatabase servername="localhost" databasename="24003_2011_07_05_JulyWkd_mi" description=""/>
     <pmsize value="0"/>
     <outputfactors>
          <timefactors selected="true" units="Hours"/>
          <distancefactors selected="false" units="Miles"/>
          <massfactors selected="false" units="Grams" energyunits="Million BTU"/>
     </outputfactors>
     <savedata>
     </savedata>
     <donotexecute>
     </donotexecute>
     <generatordatabase shouldsave="false" servername="" databasename="" description=""/>
          <donotperformfinalaggregation selected="false"/>
<lookuptableflags scenarioid="" truncateoutput="false" truncateactivity="false"/>
     <internalcontrolstrategies>
```

```
<internalcontrolstrategy classname="gov.epa.otaq.moves.master.implementation.ghg.internalcontrolstrategies.rateofprogress.RateOfProgressStrategy"><![CDATA[
useParameters       No

]]></internalcontrolstrategy>
     </internalcontrolstrategies>
</runspec>
```


Sample mrs file format – second MOVES run for modeling the evaporative permeation processes for the California Zero Emission Vehicle (ZEV) Program


```
<runspec>
     <description><![CDATA[MOVES2010 RunSpec Created by CENTRAL4 Scenario: Anne 2011 JULWKD JulyWkd Emission Inventory with user's data]]></description>
<modelscale value="INV"/>
     <modeldomain value="SINGLE"/>
     <geographicselections>
          (Specify County to be run)
          <geographicselection type="COUNTY" key="24003" description="MARYLAND - Anne Arundel County"/>
     </geographicselections>
     <timespan>
          <year key="2011"/>
<month id="07"/>
<day id="5"/>
          <beginhour id="1"/>
          <endhour id="24"/>
<aggregateBy key="Hour"/>
     </timespan>
     <onroadvehicleselections>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)" sourcetypeid="62" sourcetypename="Combination Long-haul Truck"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)" sourcetypeid="61" sourcetypename="Combination Short-haul Truck"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)" sourcetypeid="41" sourcetypename="Intercity Bus"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)" sourcetypeid="32" sourcetypename="Light Commercial Truck"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)" sourcetypeid="54" sourcetypename="Motor Home"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)" sourcetypeid="11" sourcetypename="Motorcycle"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)" sourcetypeid="21" sourcetypename="Passenger Car"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)" sourcetypeid="31" sourcetypename="Passenger Truck"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)" sourcetypeid="51" sourcetypename="Refuse Truck"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)" sourcetypeid="43" sourcetypename="School Bus"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)" sourcetypeid="53" sourcetypename="Single Unit Long-haul Truck"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)" sourcetypeid="52" sourcetypename="Single Unit Short-haul Truck"/>
<onroadvehicleselection fueltypeid="3" fueltypedesc="Compressed Natural Gas (CNG)" sourcetypeid="42" sourcetypename="Transit Bus"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="62" sourcetypename="Combination Long-haul Truck"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="61" sourcetypename="Combination Short-haul Truck"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="41" sourcetypename="Intercity Bus"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="32" sourcetypename="Light Commercial Truck"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="54" sourcetypename="Motor Home"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="11" sourcetypename="Motorcycle"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="21" sourcetypename="Passenger Car"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="31" sourcetypename="Passenger Truck"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="51" sourcetypename="Refuse Truck"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="43" sourcetypename="School Bus"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="53" sourcetypename="Single Unit Long-haul Truck"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="52" sourcetypename="Single Unit Short-haul Truck"/>
<onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="42" sourcetypename="Transit Bus"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="62" sourcetypename="Combination Long-haul Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="61" sourcetypename="Combination Short-haul Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="41" sourcetypename="Intercity Bus"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="32" sourcetypename="Light Commercial Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="54" sourcetypename="Motor Home"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="11" sourcetypename="Motorcycle"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="21" sourcetypename="Passenger Car"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="31" sourcetypename="Passenger Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="51" sourcetypename="Refuse Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="43" sourcetypename="School Bus"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="53" sourcetypename="Single Unit Long-haul Truck"/>
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="52" sourcetypename="Single Unit Short-haul Truck"/>
```

```
<onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="42" sourcetypename="Transit Bus"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="62" sourcetypename="Combination Long-haul Truck"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="61" sourcetypename="Combination Short-haul Truck"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="41" sourcetypename="Intercity Bus"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="32" sourcetypename="Light Commercial Truck"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="54" sourcetypename="Motor Home"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="11" sourcetypename="Motorcycle"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="21" sourcetypename="Passenger Car"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="31" sourcetypename="Passenger Truck"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="51" sourcetypename="Refuse Truck"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="43" sourcetypename="School Bus"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="53" sourcetypename="Single Unit Long-haul Truck"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="52" sourcetypename="Single Unit Short-haul Truck"/>
<onroadvehicleselection fueltypeid="9" fueltypedesc="Electricity" sourcetypeid="42" sourcetypename="Transit Bus"/>
     </onroadvehicleselections>
     <offroadvehicleselections>
     </offroadvehicleselections>
     <offroadvehiclesccs>
     </offroadvehiclesccs>
     <roadtypes>
          <roadtype roadtypeid="1" roadtypename="Off-Network"/>
          <roadtype roadtypeid="2" roadtypename="Rural Restricted Access"/>
          <roadtype roadtypeid="3" roadtypename="Rural Unrestricted Access"/>
          <roadtype roadtypeid="4" roadtypename="Urban Restricted Access"/>
          <roadtype roadtypeid="5" roadtypename="Urban Unrestricted Access"/>
     </roadtypes>
     <pollutantprocessassociations>
<pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane Hydrocarbons" processkey="11" processname="Evap Permeation"/>
<pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous Hydrocarbons" processkey="11" processname="Evap Permeation"/>
<pollutantprocessassociation pollutantkey="87" pollutantname="Volatile Organic Compounds" processkey="11" processname="Evap Permeation"/>
     </pollutantprocessassociations>
     <databaseselections>
<databaseselection servername="localhost" databasename="early_NLEV" description=""/>
<databaseselection servername="localhost" databasename="calevii2011" description=""/>
                              <databaseselection servername="localhost" databasename="md_stageii" description=""/>
     </databaseselections>
     <inputdatabase servername="" databasename="" description=""/>
     <uncertaintyparameters uncertaintymodeenabled="false" numberofrunspersimulation="0" numberofsimulations="0"/>
<geographicoutputdetail description="COUNTY"/>
     <outputemissionsbreakdownselection>
<modelyear selected="false"/>
<fueltype selected="false"/>
<emissionprocess selected="true"/>
          <onroadoffroad selected="true"/>
<roadtype selected="true"/>
<sourceusetype selected="true"/>
          <movesvehicletype selected="false"/>
<onroadscc selected="false"/>
          <offroadscc selected="false"/>
          <estimateuncertainty selected="false" numberOfIterations="2" keepSampledData="false" keepIterations="false"/>
          <sector selected="false"/>
       <engtechid selected="false"/>
          <hpclass selected="false"/>
     </outputemissionsbreakdownselection>
```

(Specify output database file name for county being run)

```
     <outputdatabase servername="localhost" databasename="24003_2011_07_05_JulyWkd_mo" description=""/>>
<outputtimestep value="Hour"/>
     <outputvmtdata value="true"/>
     <outputsho value="true"/>
     <outputsh value="true"/>
     <outputshp value="true"/>
     <outputshidling value="true"/>
     <outputstarts value="true"/>
     <outputpopulation value="true"/>
```

(Specify input database file name for county being run)

```
     <scaleinputdatabase servername="localhost" databasename="24003_2011_07_05_JulyWkd_mi" description=""/>
     <pmsize value="0"/>
     <outputfactors>
```

```
          <timefactors selected="true" units="Hours"/>
          <distancefactors selected="false" units="Miles"/>
          <massfactors selected="false" units="Grams" energyunits="Million BTU"/>
     </outputfactors>
     <savedata>
     </savedata>
     <donotexecute>
     </donotexecute>
     <generatordatabase shouldsave="false" servername="" databasename="" description=""/>
          <donotperformfinalaggregation selected="false"/>
<lookuptableflags scenarioid="" truncateoutput="false" truncateactivity="false"/>
     <internalcontrolstrategies>
<internalcontrolstrategy classname="gov.epa.otaq.moves.master.implementation.ghg.internalcontrolstrategies.avft.AVFTControlStrategy"><![CDATA[
dataSourceFileName     C:\MDMOVES\COMMON\ZEV_AVFT_MD_2010a.xls
dataSourceFileType  XLS
dataSourceWorksheetName       AVFT
description         (default)
sourceTypeID        year      Category  fuelTypeID          engTechID Amount
11        1960      ALL       1         1         1.000000
11        1961      ALL       1         1         1.000000
11        1962      ALL       1         1         1.000000
11        1963      ALL       1         1         1.000000
11        1964      ALL       1         1         1.000000
11        1965      ALL       1         1         1.000000
11        1966      ALL       1         1         1.000000
11        1967      ALL       1         1         1.000000
11        1968      ALL       1         1         1.000000
11        1969      ALL       1         1         1.000000
11        1970      ALL       1         1         1.000000
11        1971      ALL       1         1         1.000000
11        1972      ALL       1         1         1.000000
11        1973      ALL       1         1         1.000000
11        1974      ALL       1         1         1.000000
11        1975      ALL       1         1         1.000000
11        1976      ALL       1         1         1.000000
11        1977      ALL       1         1         1.000000
11        1978      ALL       1         1         1.000000
11        1979      ALL       1         1         1.000000
```

(Note: This sample mrs file contains only a portion of the AVFT inputs for demonstration purpose. The rest of the inputs for AVFT strategy are in the same format as listed above.)

```
]]></internalcontrolstrategy>
<internalcontrolstrategy classname="gov.epa.otaq.moves.master.implementation.ghg.internalcontrolstrategies.rateofprogress.RateOfProgressStrategy"><![CDATA[
useParameters       No

]]></internalcontrolstrategy>
     </internalcontrolstrategies>
</runspec>
```

Appendix G
Public Hearing Notices/Comments/Responses