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*Note: Appendix A-8a, Onroad Source Inventory, and Appendix A-8b, Onroad Mobile SO2 Modeling Files 2014-2021, are available separately from this document.

Maryland
Department of
the Environment

Larry Hogan
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APPENDIX A-1

2014 Base Year SIP Emissions Inventory Methodologies

Prepared By:

Maryland Department of the Environment

Maryland Department of the Environment
2014 Base Year Emissions Inventory Methodologies

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1.0 INTRODUCTION

The 2014 Emissions Inventory and Methodologies is being prepared for the purpose of describing the Scope of Work required to prepare an emission inventory of sulfur dioxide (SO2), nitrogen dioxide (NO2), ammonia (NH3), particulate matter (PM10 and PM2.5), and volatile organic compounds (VOC) emissions for the State of Maryland. 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 federal ambient air quality standards. These federal standards are designed to protect the public health and welfare from these six criteria pollutants. These standards are referred to as the National Ambient Air Quality Standards (NAAQS). Areas that meet the NAAQS are referred to as “attainment areas”; those that do not are referred to as “nonattainment areas.” The document will provide an outline for content and organization review of the inventory. The goal is to provide guidance on the development of a reliable inventory, the quality of emissions data collected and provide for acceptable documentation and reporting of this information. The Maryland Department of the Environment Air and Radiation Administration (MDE-ARA), the Maryland Department of Transportation (MDOT), and the Metropolitan Washington Council of Government (MWCOG) will be involved in preparing various portions of the inventory by contributing information that is necessary for developing emissions estimates.

The final inventory document will include emissions from point sources, quasi-point sources, mobile sources, biogenic emissions, non-road mobile sources, and area sources. MDE-ARA will use the MOVES NOROAD Model for small engine emissions. MDE-ARA will supply emissions for major point sources and area sources, and will accept EPA estimates for biogenic emissions. Mobile source emissions will be estimated using the MOVES Model.

The applications for emissions inventory data include use of the data in annual trends reports, State Implementation Plans (SIPs), compliance demonstrations, emissions trading, emissions fees programs, and in modeling activities designed to evaluate ambient air concentrations encountered by the general public. For the SIP program, the air emission inventory is a fundamental building block in developing an air quality control and maintenance strategy. Section 172, Part C, of the Clean Air Act (CAA) as amended in 1990, which addresses SIP requirements, states that “. . . plan provisions shall include a comprehensive, accurate, current inventory of actual emissions from all sources or the relevant pollutants or pollutants in such area . . .”. Regulatory agencies and industrial facilities rely on emission inventories on an ongoing basis 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. They are the foundation of air quality decisions. Inventory quality is critical to defining realistic regulations and attainment strategies. Deficiencies and inconsistencies in existing compilation processes accentuate the need for developing and implementing more uniform and systematic approaches to collecting and reporting data. One of the primary goals of the document is to improve the quality of inventory data collection so that it is a reliable source of information for sound decision-making.

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

2.0 INTRODUCTION

The Maryland Department of the Environment Air and Radiation Administration (ARA) 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 2014 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.”

2.1 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 ARA to ensure the point source inventory is as complete as possible. The primary data source is the Permitting Program, which oversees 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 ARA. 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 EMISSION CALCULATIONS

The ARA 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 ARA'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 ARA's Registration File for Facilities and Equipment.

2.2.1 Seasonal Adjustments

ARA has collected extensive data for the temporal allocation of emissions. Companies send us annual, quarterly, monthly, and daily usage, activity, and emission estimates. More specific information allows allocation of emissions to time of 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.

2.2.2 Temporal Adjustments

Temporal adjustments are made because of seasonal differences in the rate of emissions or activity, or to apportion emissions to a particular season, day or hour. The best method for temporal adjustment is the one that produces the most accurate activity or adjustment factors for a source category reflecting the inventory time period and locality.

ARA accounts for temporal adjustment calculations by using the following methods:

- Seasonal Adjustments Factory (SAF) was applied to the calculated annual emission estimates within a period.

$$\text{SAF} = \frac{\text{Emissions per year}}{(\text{Operating days/week})\ (\text{Operating weeks/year})}$$

For example, if a VOC source category has one third more emissions during the 3-month ozone ratio: seasonal adjustment factor, the ratio of seasonal activity or emissions to average period emissions would equal SAF = 0.33/0.25 = 1.33.

- Heat Degree Days (HDD) or Average Temperature (**TEMP** $_{\mathbf{AVG}}$) Seasonal Adjustments Factory (SAF) was applied to the calculated annual emission estimates within a period.

$$\text{HDD SAF} = \frac{\text{Emissions per year}}{(\text{TEMP}_{AVG}\ \text{period/month})\ (\text{TEMP}_{AVG}\text{/year})}$$

For example, if a VOC source category has one third more emissions during the 3-month ozone ratio that is June, July and August: HDD seasonal adjustment factor, the ratio of seasonal activity emissions to average period emission TEMP_{AVG} HDD SAF = 5339/15763 = 0.338701.

Nonroad:
For this source calculations were estimated using the NMIM model for nonroad emissions. The daily emissions function for the model was not working. Monthly emissions were generated and the summer months June, July, and August were averaged to give us an average summer day emission for each source represent in the model.

Ammonia Sources:
These source calculations were estimated using the Carnegie Mellon Ammonia (CMU) model for Nonpoint ammonia emissions. The sources represented in the model are constant all year and therefore the annual were divided by 365 to obtain average daily emissions.

2.2.3 Consolidated Emissions Reporting Rule (CERR)

MDE-ARA compiled a 2002 point source emission inventory in order to satisfy EPA reporting requirements under the Consolidated Emissions Reporting Rule. This will be the primary resource for developing refined estimates of $PM_{2.5}$ and NH_3 emissions.

3.0 QUASI - POINT SOURCES

3.0 INTRODUCTION

The Maryland Department of the Environment Air and Radiation 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.

3.1 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, SO2, 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 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 MOVES2014 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 MOVES2014 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 MOVES2014 model.

APG government-owned vehicles were grouped into vehicle categories according to vehicle type, gross vehicle weight (GVW), and fuel type. The CY 2014 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 2014 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 2014. 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 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. Emission factors were updated as Nonroad model updates were posted by the EPA.

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.

3.2 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, SO2, 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.

3.3 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 NMIM 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 MOVES2014 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 MOVES2014 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 2014. 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/ARA 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 AP-42 Table 5.2-1)

P = true vapor pressure of liquid loaded, pounds per square inch absolute (psia)

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

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.

Proportioning the loading factors yields

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

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

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 and put in the Quazi Point.

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

Monthly temporal allocation activity data was provided through 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. Also, a SAF was applied to emissions and were averaged according to period of operation to a daily estimate. See section 2.2.1.1

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 2014

$F_{i\,(fm)}$ = Fraction of gasoline dispensed per county i per filling method (balanced submerged or submerged) during 2014

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)

Tank Truck Unloading Sample Calculation (Howard County)

To calculate fuel usage for Howard County:

Filling Method	Howard County Adjusted Emission Factor Lb. VOC per 1,000 gallon
Balanced Submerged	0.2695
Submerged	6.5581
Diesel Fuel Unloading	0.014

Total fuel sold in Maryland in 2014[3] = 2,763,987,450 gallons

Allocate gallons of fuel sold to the county level by the 2014 county vehicle registration proportion:

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

$$\frac{\text{Howard County vehicle registration}^{4}}{\text{Total MD vehicle registration}} = \frac{251{,}783}{4{,}604{,}616} = 0.0547$$

G = 2,763,987,450 **x** 0.0547 = 151,136,393 gallons sold in **Howard County**

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

EMbs = (151,136,393* 91% * 0.2695/ 1000) / 2000 = **18.53 tons $_{VOC}$ per year**
EMs = (151,136,393* 9% * 6.5581/ 1000) / 2000 = **44.60 tons $_{VOC}$ per year**

Tank Truck Unloading was found to have a
SAF = seasonal adjustment factor of 0.262525702
POS = peak ozone period of 0.25
Days of the Period 365
Daily adjusted EMda = (EM / 365)*(SAF / POS)

EMbsda = (18.53 / 365)*(0.262525702 / 0.25) = **0.13 VOC tons/day** balanced submerged
EMsda = (44.60 / 365)*(0.262525702 / 0.25) = **0.05 VOC tons/day** submerged

[4] State of Maryland Motor Vehicle Administration and MDE Mobile Sources Control Program

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. If you are running MOVES in rates mode, you will need to use the results from both the rate per distance output table and the rate per vehicle output table. The rates for emissions processes 18 and 19 by source type in the rate per distance table should be multiplied by the local VMT by source type. In addition, the rates for emission processes 18 and 19 by source type in the rate per vehicle need to be multiplied by the local vehicle population by source type. The sum of these two values is the total refueling emissions.

Activity

Input activity data such as VMT, vehicle registration, and gasoline sales are collected by MDE's Mobile section from the Maryland Department of Transportation and the Maryland State Comptroller's Office, Tax Motor Unit Division.

Emission Factors

ARA mobile sources staff ran the MOVES2014 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 (MOVES2014) model.

Spatial and Temporal Allocations

Spatial

The MOVES2014 model spatially allocates input files specify state county-level gasoline sales data to spatially allocate emission estimates.

Temporal

The MOVES2014 model allocates monthly activity data per state county-level and national level estimates.

Emissions Calculation

A sample equation for estimating emissions from stage II refueling 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 2014

EF_{StII} = emission factor for stage II refueling from the MOVES2014 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 MOVES2014 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. 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.

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

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

Temporal

Monthly temporal allocation activity data was provided through the Maryland Comptroller of the Treasury, Gasoline Tax Division 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. Also, a SAF was applied to emissions and were averaged according to period of operation to a daily estimate. See section 2.2.1.1

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 2014

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

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

To calculate fuel usage for Harford County:

Total fuel sold in Maryland in 2014[6] = **2,763,987** kgallons
Allocate gallons of fuel sold to the county level by the 2014 county vehicle registration proportion:

$$\frac{\text{Harford County vehicle registration}^{7}}{\text{Total MD vehicle registration}} = \frac{218,786}{4,604,616} = 0.0475$$

Gcarr = 2,763,987 **x** 0.0475 = **131,329** kgallons sold in **Harford County** in 2014.

EF_{utb} = **0.9123** lbs. VOC/1000 gallon

$$E_{utb} = \frac{(131,329 \text{ x } 1000 \text{ x } 0.9123 / 1000)}{2000}$$

E_{utb} = 59.90 tons VOC per year

Underground Tank Breathing was found to have a
SAF = seasonal adjustment factor of 0.262525702
POS = peak ozone period of 0.25
Days of the Period 365
Daily adjusted **E_{utbda}** = (E_{utb} / 365)*(SAF / POS)

E_{utbda} = (**59.90** / 365)*(0.262525702 / 0.25) = **0.17 VOC tons/day**

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[6] Annual sales of gasoline from Maryland Comptroller of the Treasury, Gasoline Tax Division
[7] State of Maryland Motor Vehicle Administration and MDE Mobile Sources Control Program (see Appendices).

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 AP-42 Table 11.3-1. The AP-42 emission factors represent a typical range of values. EIIP averages the "typical range values" within 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**

[8] 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

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

2014 Gasoline Tank Trucks in Transit Sample Calculation (Harford County)

To calculate fuel usage for Harford County:

Total on-road and non-road fuel sold in Harford County **=** **131,329** kgallons

G = **131,329** kgallons sold in Harford County

$$E_{tt} = \frac{(\mathbf{131{,}329} \times 1.09 \times 0.06)}{2000}$$

E_{tt} = **4.29** tons VOC per year emitted from tank trucks in transit in **Harford County**.

Underground Tank Breathing was found to have a
SAF = seasonal adjustment factor of 0.262525702
POS = peak ozone period of 0.25
Days of the Period 312
Daily adjusted $E_{tt\mathbf{da}}$ = (E_{tt} / 312)*(SAF / POS)

$E_{tt\mathbf{da}}$ = (**4.29** / 312)*(0.262525702 / 0.25) = **0.014 VOC tons/day**

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 2014 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 2014 Operations Count for Public-Use Airports to obtain operational counts. A few airports, such as Andrews Air Force Base, provided their own operations count.

Fuel Type	Fuel Consumption (1,000 Gallons)
Commercial Jet	82,362
Aviation Gasoline	1,470
Military Jet	823.62

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

2014 Sample Calculation for Stage I AvGas Distribution (**Harford County**)

$F_{\_Allegany}$ = 1,470,000 gallons

$$\text{Fraction of LTOs} = \frac{CA\_{Allegany}}{SA} = \frac{11{,}535}{403{,}554} = 0.0286$$

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

$EM_{\_Allegany\ Stage\ I}$ = (0.0246 **x** 0.0286 **x** 1,470,000)/2000 = **0.517 tons $_{VOC}$ / year**

Stage I AvGas Distribution was found to have a
SAF = seasonal adjustment factor of 0.26
POS = peak ozone period of 0.25
Days of the Period 300
Daily adjusted $EM_{\_Allegany\ Stage\ I\mathbf{da}}$ = ($EM_{\_Allegany\ Stage\ I}$ / 300)*(SAF / POS)

$EM_{\_Allegany\ Stage\ I\mathbf{da}}$ = (**0.517** / 300)*(0.26 / 0.25) = **1.79E-03 VOC tons/day**

2014 Sample Calculation for Stage II AvGas Distribution (**Harford County**)

$F_{\_Allegany}$ = 1,470,000 gallons

$$\text{Fraction of LTOs} = \frac{CA\_{Allegany}}{SA} = \frac{11{,}535}{403{,}554} = 0.0286$$

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

$EM_{\_Allegany\ Stage\ II}$ = (0.0136 **x** 0.0286 **x** 1,470,000)/2000 = **0.286** tons $_{VOC}$ /year

Stage I AvGas Distribution was found to have a
SAF = seasonal adjustment factor of 0.26
POS = peak ozone period of 0.25
Days of the Period 300
Daily adjusted $EM_{\_Allegany\ Stage\ II\mathbf{da}}$ = ($EM_{\_Allegany\ Stage\ II}$ / 300)*(SAF / POS)

EM $_{\text{Allegany Stage II}}$**da** = (**0.286** / 300)*(0.26 / 0.25) = **9.904E-04 VOC tons/day**

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, 2014 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 2014. Tonnages of petroleum delivered were converted into Kgals (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)

2014 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	**55,943**	**7,042**	**328,571**	**14,688**	**232,608**	**85,429**

Tonnage of distillate oil shipped in Baltimore Harbor (from Waterborne Commerce of the U.S., 2014) were converted in thousands of gallons (Kgals) 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 EIIP 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 = 328,571 Kgal
Baltimore gas Total = (0.00 + 0.00 + 0.00 + 328,571) = 328,571 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 (328,571 Kgal/yr) x (0.25/7wk) ÷ 2,000 lbs/ton
PV_{GAS} = **15.84 voc** tons/year

$EM_{\_BCitytotal}$ **Vessel Loading** total VOC emissions are calculated as follows:
$EM_{\_BCitytotal}$ = **0.00** tons/year + **0.00** tons/year + **0.00** tons/year + **15.84** tons/year
$EM_{\_BCitytotal}$ **= 15.84 tons/yr** (gasoline)

Petroleum Vessel Unloading was found to have a
SAF = seasonal adjustment factor of 0.25
POS = peak ozone period of 0.25
Days of the Period 312
Daily adjusted $EM_{\_BCitytotal\mathbf{da}}$ = ($EM_{\_BCitytotal}$ / 312)*(SAF / POS)

$EM_{\_BCitytotal\mathbf{da}}$ = (**15.84** / 312*(0.25 / 0.25) = **5.08E-02 VOC tons/day**

4.1.1.7 **Portable Fuel Containers**

SCC: 25 01 011 012 (Residential – Permeation)
25 01 011 012 (Residential – Diurnal)
25 01 011 013 (Residential – Transport)
25 01 012 011 (Commercial – Permeation)
25 01 012 012 (Commercial – Diurnal)
25 01 012 013 (Commercial – Transport)

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.

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]. 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.

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[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, 441, 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 (SCC) code the total quantity of gasoline supplied from PFCs.

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

No subtraction of emissions from point sources is necessary.

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. (2014 control efficiency of 58% and a control factor of 77.18%). COMAR weblink: http://www.dsd.state.md.us/comar/title_search/Title_List.aspx

[13] Total 2014 employment and business establishments by 6 digit NAICS code and by county, County Business Patterns

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

Temporal allocation in part due to the number of days in a month with greater than or equal to 0.1 inch of precipitation, but > 0.01 inches a day as part of the emission estimations and seasonal adjustments.

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	=	**0.002204623 lbs/g conversion factor**

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	=	**0.002204623 lbs/g conversion factor**

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:

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

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 = **0.002204623 lbs/g conversion factor**

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

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

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 = **0.002204623 lbs/g conversion factor**

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

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

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 = **0.002204623 lbs/g conversion factor**

The commercial-transport-spillage emissions are determined as:

$$HC_{TC} = (Pop_{C})*(S)*(B_{C})*(Refill_{C})*(EF_{TC}) \quad \text{(Eq. 9)}$$

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 = **0.002204623 lbs/g conversion factor**

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 (SAF * 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 2013 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 factor from the Pechan/ERTAC Study, 2007, base on employment activity data. VOC = 467 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
SAF was applied to emissions and were averaged according to period of operation to a daily estimate. See section 2.2.1.1

Emissions Calculation

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

$E_{xy} = EMP_x \times EF_y$

where:

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

2014 Sample Calculation Dry-Cleaning Emissions (Howard County)

$E_{Howardvoc}$ = $EMP_{Howard} \times EFvoc$
$E_{Howardvoc}$ = 394 person × 467 lbs voc/person (in calculation in is 394.31 persons)
$E_{Howardvoc}$ = 183,998 lbs. voc
$E_{Howardvoc}$ = 92.07 tons voc per year

Dry-Cleaning was found to have a
SAF = seasonal adjustment factor of 0.25
POS = peak ozone period of 0.25
Days of the Period 312
Daily adjusted $E_{Howardvoc\mathbf{da}}$ = ($E_{Howardvoc}$ / 312)*(SAF / POS)

$E_{Howardvoc\mathbf{da}}$ = (92.07 / 312*(0.25 / 0.25) = **2.95E-01 VOC tons/day**

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 2013 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. 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. Pechan/ERTAC Study, 2007 determine 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 $\text{lbs.}_{\text{Trichloroethylene}}$/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:

Conveyor degreasing operations considered point sources that are listed in the MDE/ARA registration files. Point source emissions were then subtracted from the area source inventory by taking the reported emissions and back calculating to get the number of employees, which was then subtracted from the county business total employment before final estimation.

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

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

Emissions Calculation

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

Equation:

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

Where:

E_{cc} = Emissions of VOC in tons/day from cold cleaners
$EMPL_j$ = 2013 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

2014 Sample Calculation for Cold Cleaning Degreasing Products Industrial and Institutional **(Baltimore City)**

Reported Point Source Emissions = 6.34088 tons VOC
Point Source Employment = (6.34088 *2000 tons/lb./ 87 lbs. $_{\text{VOC/employee}}$) = 145.77 employees
$EMPL_{Baltmore}$ = (13,481 [15] – 145.77) = 13,335.23 employees
EF_{cc} = 87 lbs. VOC /employee/year
$E_{ccBaltimore}$ = (13,335.23 employee x 87 lbs. VOC /employee/year) / (tons/2000 lbs.)
$E_{ccBaltimore}$ = 580.08 tons VOC /year

To adjust for controls
$E_{ccBaltControlled}$ = 580.08 tons VOC /year **x** [1 – (0.67 x 0.80 x 1.00)] **= 269.2 tons VOC** / year

Cold Cleaning Degreasing was found to have a
SAF = seasonal adjustment factor of 0.25
POS = peak ozone period of 0.25
Days of the Period 312
Daily adjusted $E_{ccBaltControlled\mathbf{da}}$ = ($E_{ccBaltControlled}$ / 312)*(SAF / POS)

$E_{ccBaltControlled\mathbf{da}}$ = (**269.2** / 312*(0.25 / 0.25) = **8.63E-01 VOC tons/day**

[15] *County Business Patterns* 2013 employment data for Maryland by Counties (see appendices)

4.1.2.3 **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.

4.1.2.4 **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[1], 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 with an emission factor to calculate VOC emissions.

Activity

Determine the per capita usage factor by dividing the national total architectural surface coating quantities[2] for solvent- and water-based coatings by the U.S. population[3] 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 paints are identified as being either solvent- or water-based paints, except for the two

[1] Emission Inventory Improvement Program
[2] 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.
[3] Population data from the U.S. Bureau of the Census, Population Estimates Branch (see Appendices).

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 control efficiency of 44.8%.

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

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 = 2014 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[4] for architectural surface coatings
RE_{ASC} = Rule effectiveness[5] 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 = 2014 population of county i
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

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

2014 Example Calculation Architectural Surface Coating (Carroll County)

Solvent-Based

$POP_{Carroll}$ = 167830 persons

UF_{ASC-SB} = 0.3574 gal/capita

EF_{SB} = 3.87 lbs. VOC/gal/year

CE_{ASC} = 44.8%

RE_{ASC} = 100%

RP_{ASC} = 100%

EM_{ASC-SB} = ((167830 x 0.3574 x 3.87) x [1 – (0.448 x 1.00 x 1.00)]) / 2000

EM_{ASC-SB} = 64.07 tons $_{VOC}$ per year Carroll County

Architectural Surface Coating Solvent-Based was found to have a

SAF = seasonal adjustment factor of 0.33

POS = peak ozone period of 0.25

Days of the Period 365

Daily adjusted **$EM_{ASC-SBda}$** = (**EM_{ASC-SB}** / 365)*(SAF / POS)

$EM_{ASC-SBda}$ = (**64.07** / 365*(0.33 / 0.25) = 2**.32E-01 VOC tons/day**

Water-Based

$POP_{Carroll}$ = 167830 persons

UF_{ASC-WB} = 1.6012 gal/capita

EF_{WB} = 0.74 lbs. VOC/gal/year

CE_{ASC} = 44.8%

RE_{ASC} = 100%

RP_{ASC} = 100%

EM_{ASC-WB} = ((167830 x 1.6012 x 0.74) x [1 – (0.448 x 1.00 x 1.00)]) / 2000

EM_{ASC-WB} = 54.89 tons $_{VOC}$ per year Carroll County

Architectural Surface Coating Solvent-Based was found to have a

SAF = seasonal adjustment factor of 0.33

POS = peak ozone period of 0.25

Days of the Period 260

Daily adjusted **$EM_{ASC-WBda}$** = (**EM_{ASC-WB}** / 260)*(SAF / POS)

$EM_{ASC-WBda}$ = (**54.89** / 260*(0.33 / 0.25) = 2**.79E-01 VOC tons/day**

4.1.2.5 **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[6], 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 710.7176 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 213,758 for NAICS 811121: 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.

Maryland has an auto body regulation which allowed MDE to take an 8% reduction in emissions. The autobody refinishing category does not include new car coating.

Emission Factor:

710.7176 lbs of VOC per employee per year

[6] Emission Inventory Improvement Program

Point Source Adjustments

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

Adjustment for Controls

Maryland's auto body regulation allowed MDE to apply an 8% control.

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

Emissions Calculation

The equation used to estimate emissions from automobile refinishing is:

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

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

$Emp_{Point\ AR}$ = Employment back calculated from point source emissions

<u>2014 Example Calculation Auto Refinishing (Baltimore City)</u>

$$E_{AR} = \frac{(350 - 0) \times 710.7176 \times [1-(1.0 \times 1.0 \times .08)]}{2000}$$

E_{AR} = 114.43 Tons $_{VOC}$ / year

Auto Refinishing was found to have a
SAF = seasonal adjustment factor of 0.25
POS = peak ozone period of 0.25
Days of the Period 260

Daily adjusted $\mathbf{E}_{\mathbf{ARda}}$ = ($\mathbf{E}_{\mathbf{AR}}$ / 260)*(SAF / POS)

$\mathbf{E}_{\mathbf{ARda}}$ = (**114.43** / 260*(0.25 / 0.25) = **4.40E-01 VOC tons/day**

4.1.2.6 **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 not by 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. Several counties have been using thermoplastic and glass beads to help in traffic marking which also give off VOCs. A ratio of 14.1 and 13.5 pounds per gallon of white and yellow thermoplastic respectively were equated and added to the amount of paint used. A ratio of 17.5 gallons of white paint was used for every 148.75 pounds of beads used. VOC content for thermoplastic and beads came from Material Safety Data Sheets and ratios were estimated with the help of paint suppliers and contractors.

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

Gallons of yellow traffic paint and solvent used in 2014
Gallons of white traffic paint and solvent used in 2014

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

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

Emissions Calculation

Traffic Paint Sample Calculation (Harford County)

(1) Calculate VOC emissions from yellow and white traffic paints for year 2014

a. State Highway Administration (SHA) and Local Government (LG) Traffic Paint Use

Total yellow gallons used in 2014 = 6,420 gallons LG
Total VOC per gallon of yellow paint used[22] = 0.78 lbs. VOC /gallon
Total white gallons used 2014 = 1,041 gallons LG
Total VOC per gallon of white paint used[23] = 0.78 lbs. VOC /gallon

Total yellow gallons used in 2014 = 13,107 gallons SHA
Total VOC per gallon of yellow paint used[24] = 0.57 lbs. VOC /gallon
Total white gallons used 2014 = 17,374 gallons SHA
Total VOC per gallon of white paint used[25] = 0.57 lbs. VOC /gallon

$$E_{\text{Yellow Paint}} = \frac{((6{,}420 \times 0.78) + (13{,}107 \times 0.57))}{(2{,}000 \text{ lbs./ton})}$$

$$\mathbf{E_{\text{Yellow Paint}} = 6.24 \text{ tons / year}}$$

$$E_{\text{White Paint}} = \frac{((1{,}041 \times 0.78) + (17{,}374 \times 0.57))}{(2{,}000 \text{ lbs./ton})}$$

$$\mathbf{E_{\text{White Paint}} = 5.36 \text{ tons / year}}$$

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

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.

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

$E_{\text{Paint Total}} = \mathbf{6.24} + \mathbf{5.36} + 0.0 + 0.0 + 0.0$

$E_{\text{Paint Total}}$ = 11.60 tons / year VOC emissions for Harford County.

Traffic Paint was found to have a
SAF = seasonal adjustment factor of 0.25
POS = peak ozone period of 0.25
Days of the Period 260
Daily adjusted $\mathbf{E_{ARda}} = (\mathbf{E_{AR}} / 260)*(SAF / POS)$

$\mathbf{E_{ARda}} = (\mathbf{11.60} / 260*(0.25 / 0.25) =$ **4.46E-02 VOC tons/day**

4.1.2.7 **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[26], Chapter 8 Industrial Surface Coatings, dated September 1997. Applicable point source emissions (those within the same NAICS) are taken from the MDE/ARA registration files have been subtracted from the emissions calculated on a per capita and per employee basis that 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/ 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 statistics for the counties of

[26] Emission Inventory Improvement Program

Maryland. Population statistics for 2014 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 2013 was the last year employment data was available per NAICS, MDE used the 2013 County Business Patterns as the source for employment figures.

Emission Factor

Per employee factors were used for the industry surrogate employment 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 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

Industrial Maintenance Coatings (NAICS) and **Other Coatings (NAICS)**, emission factors are listed in a document prepared by Dennis Beauregard at EPA and named "Freedonia EFs 06-16-09.xls". The file has been modified by E.H Pechan and Associates, Inc. to correct for an error in NAICS code 441 for Cleaning Products: Industrial and Institutional (2415000000). The Freedonia emissions factor calculation file can be obtain from EPA for further detail on how each of the factors below were estimated.

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/ARA registration files have been subtracted from the calculated emissions, and their emissions are separated from the totals presented below.

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

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

Emissions Calculation

Equation:

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

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}[27] = VOC emission factor for finished wood which is 43 lbs. $_{VOC}$ per employee per year

2014 Example Calculation Industrial Surface Coating – Finish Wood Product Manufacturing (Baltimore City)

Number of employees in NAICS 321 in Baltimore City (2013 County Business Patterns):
$EMPL_{BC}$ = **39**

Emission factor for finish wood product manufacturing (lbs. VOC/employee/year):
EF_{FW} = **43**

5 days per week activity level, no seasonal adjustment factor

$$E_{FW\ (Baltimore\ City)} = \frac{(39\ \mathbf{x}\ 43)}{2000}$$

$\mathbf{E_{FW\ (Baltimore\ City)} = 0.84}$ **tons** $_{\mathbf{VOC}}$ **per year**

Traffic Paint was found to have a
SAF = seasonal adjustment factor of 0.25
POS = peak ozone period of 0.25
Days of the Period 260
Daily adjusted $\mathbf{E_{ARda}}$ = ($\mathbf{E_{FW\ (Baltimore\ City)}}$ / 260)*(SAF / POS)

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

E_{ARda} = (**0.84** / 260*(0.25 / 0.25) = **3.22E-03 VOC tons/day**

4.1.2.8 **Industrial Adhesives**

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, 2014 population statistic estimates for the counties of Maryland[28].

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)[29].

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

[28] 2014 estimated population from U.S. Bureau of the Census, Population Estimation Branch (see Appendices).
[29] 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

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

Emissions Calculation

Equation:

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

where:

E_{OC}[30] = VOC emissions in tons per year from industrial adhesives.

POP_i = 2014 population of county i

EF_{OC}[31] = VOC emission factor for industrial adhesives.

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[30] 2014 estimated population from U.S. Bureau of the Census, Population Estimation Branch (see Appendices).

[31] Emission Inventory Imporvement Program Vol III, Ch. 6, September 1997.

CE = Control Efficiency
RE = Rule Effectiveness
RP = Rule Penetration
To adjust for control efficiency OTC-PECHAN Control Measure Report:
2014 base year where:
CE = 0.644, RE = RP = 1.

[1 – (CE x RE x RP)] = [1 – (0.644 x 1 x 1)] = 0.356

2014 Per Capital Sample Calculation for Industrial Adhesives in Harford County:

2014 U.S. Census Bureau Population Estimate for Harford County:
EF_{OC} = 250,105
Emission factor for industrial adhesives (lbs. VOC/person/year):
EF_{OC} = 1.10

5 days per week activity level, no seasonal adjustment factor

Equation:

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

$$\mathbf{E_{OCHarford} = \frac{250{,}105 \times 1.10 \times [1 - (0.644 \times 1.0 \times 1.0)]}{2000} = 48.97\ tons_{VOC}\ per\ year.}$$

Industrial Adhesives was found to have a
SAF = seasonal adjustment factor of 0.28
POS = peak ozone period of 0.25
Days of the Period 365
Daily adjusted $\mathbf{E_{OCHarfordda}}$ = ($\mathbf{E_{OCHarford}}$ / 365)*(SAF / POS)

$\mathbf{E_{OCHarfordda}}$ = (**48.97** / 365)*(0.28 / 0.25) = 1**.50E-01 VOC tons/day**

4.1.2.9 **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 ARA registration files for 2014 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.

Control	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

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

Emissions Calculation

The equation used to estimate emissions from graphic arts is:

Equation:

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

Where:

E_{GA} = VOC emissions in tons per year from graphic arts
MS_{type} = Market share percent of the type of printing
POP_i = 2014 population of county i
EF_{GA} = VOC emission factor for graphic arts (1.3[32] 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

2014 Example Calculation Graphic Arts (Anne Arundel County)

$$E_{GAL} = \frac{0.47 \mathbf{x}\ 560{,}133 \mathbf{x}\ 1.3}{2000} \times (1 - 0.600)$$

$$E_{GALP} = \frac{0.08 \mathbf{x}\ 560{,}133 \mathbf{x}\ 1.3}{2000} \times (1 - 0.0)$$

$$E_{GAR} = \frac{0.18 \mathbf{x}\ 560{,}133 \mathbf{x}\ 1.3}{2000} \times (1 - 0.504)$$

$$E_{GAF} = \frac{0.18 \mathbf{x}\ 560{,}133 \mathbf{x}\ 1.3}{2000} \times (1 - 0.432)$$

$$E_{GAS} = \frac{0.06 \mathbf{x}\ 560{,}133 \mathbf{x}\ 1.3}{2000} \times (1 - 0.280)$$

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

$$E_{GAsum} = (68.45 + 29.13 + 32.51 + 37.22 + 15.73)$$

E_{GAsum} = 183.03 tons VOC per person year (Totals may be slightly different due to rounding)

Graphic Arts was found to have a
SAF = seasonal adjustment factor of 0.25
POS = peak ozone period of 0.25
Days of the Period 260

[32] Emission factor from EIIP Chapter 7 Graphic Arts

Daily adjusted $E_{GAsum\mathbf{da}}$ = (E_{GAsum} / 260)*(SAF / POS)

$E_{GAsum\mathbf{da}}$ = (**183.03** / 260)*(0.25 / 0.25) = **7.04E-01 VOC tons/day**

4.1.2.10 **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 2,724,000 barrels of asphalt in 2013. Also, 2014 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

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

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:	**2,506,080**
Emulsified:	**136,200**
Road Oils:	**54,480**
Cutback	**27,240**
Roofing	**544,800**

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

The equation used to estimate emissions from asphalt paving is:

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

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

2014 Road Oils Asphalt Sample Calculations: Anne Arundel County

Total Maryland Population for 2014 was 5,976,407 people.
Anne Arundel County population for 2014 was 560,133 people.

Usage ratio for Anne Arundel County is USEa = (560,133 / 5,976,407) = 0.0937
Total barrels of asphalt used in Maryland in 2014 were 2,724,000 and minus 20% for roofing leaves 2,179,200 barrels. 2% is road oils, which is 43,584 barrels.

$$CLA_{AA} = \frac{(43{,}584 \text{ barrel} \times 350 \text{ lbs per barrel})}{2000} \times 0.0937 = 714.85 \text{ tons road used}$$

$$E_{AARoadOils} = \frac{714.85 \times 70.4}{2000} \times (1 - (1 \times 1 \times 0))$$

$E_{AARoadOils}$ = 25.16 tons $_{VOC}$ Anne Arundel County per year

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

Road Oils Asphalt was found to have a

SAF = seasonal adjustment factor of 0.39

POS = peak ozone period of 0.25

Days of the Period 312

Daily adjusted $E_{AARoadOils\mathbf{da}} = (E_{AARoadOils} / 312)*(SAF / POS)$

$\mathbf{E_{AARoadOilsda}}$ = (25.16 / 312)*(0.39 / 0.25) = **1.26E-01 VOC tons/day**

4.1.2.11 **Synthetic Organic Chemical Storage Tanks**

This category is fully represented in the point source inventory.

4.1.2.12 **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:

Pesticide usage data used to calculate pesticide emissions came from a 2011 survey conducted by the Pesticide Regulation Section of the Maryland Department of Agriculture and the U.S. Department of Agriculture. Also, the Maryland and National Agricultural Statistics services in cooperation with the Departments of Agriculture compiled information for the document, Maryland Pesticide Statistics for 2011, which reported pesticide usage in pounds used in a year by active ingredient for each Maryland County.

EPA post new guidance for calculating pesticide emissions on its FTP site under the document, “**Agricultural Pesticide Application**”. The site also included files containing new estimated emission factors for several different pesticides and a weighted average emission factor (EF_{avg}) value of 0.4 pounds of VOC per pound of active ingredient (default factor). Since Maryland had over 200 pesticides reported and about 50 of the pesticides listed in the Maryland Pesticide Statistics were not found in any of EPA’s files or any of the other country wide databases, an estimation of emissions were split into those calculated from EPA factors and the rest were defaulted from the EF_{avg} value.

The emissions were calculated by multiplying the amount of active ingredient by its emission factor. The total amounts of emissions were estimated, but the amount used in each county was not given, therefore reported harvest acres were used to divide emissions into each county. Pesticide use was not reported for a particular pesticide-by-crop, but the Maryland Department of Agriculture's, "Harvested Acres 2014-2015 MD Annual Bulletin" reported the types of crops and the amount of each harvest in each county. In Maryland pesticides for soybean and corn are normally applied to soil and wheat and barley are applied to the surface. A percentage based on the portion of each crop type was also used to further divide emissions by county and by soil or surface application and reported by SCC. Pesticides used to estimate emissions are shown below.

Pesticides Used in Maryland 2011 to 2014

COMPOUND	Emissions Factor	EF Numerator	EF Denominator	PESTICIDES	Active Ingredient lbs	VOC lbs	VOC tons
2,4-D	0.827317385	LB	LB	2,4-D	439538	363,637.43	1.82E+02
ABAMECTIN	15.23561412	LB	LB	Abamectin	21	319.95	1.60E-01
ACEPHATE	0.275041704	LB	LB	Acephate	6302	1,733.31	8.67E-01
ACETOCHLOR	0.400383954	LB	LB	Acetochlor	25082	10,042.43	5.02E+00
ALACHLOR	0.513361927	LB	LB	Alachlor	3941	2,023.16	1.01E+00
ALUMINUM PHOSPHIDE	0.054556719	LB	LB	Aluminum Phosphide	603	32.90	1.64E-02
ATRAZINE	0.148401799	LB	LB	Atrazine	381321	56,588.72	2.83E+01
AZADIRACHTIN	10.0915389	LB	LB	Azadirachtin - AZAD	5	50.46	2.52E-02
AZINPHOS-METHYL	0.464016872	LB	LB	Azinphos-Methyl	524	243.14	1.22E-01
AZOXYSTROBIN	0.343670293	LB	LB	Azoxystrobin	5213	1,791.55	8.96E-01
BACILLUS THURINGIENSIS	0.487106569	LB	LB	Bacillus thuringiensis	477	232.35	1.16E-01
BENSULIDE	0.553077954	LB	LB	Bensulide	725	400.98	2.00E-01
BENTAZONE	0.052626728	LB	LB	Bentazone	149	7.84	3.92E-03
BIFENAZATE	0.083591796	LB	LB	Bifenazate	289	24.16	1.21E-02
BIFENTHRIN	1.565896363	LB	LB	Bifenthrin	34527	54,065.70	2.70E+01
BROMACIL	0.849596002	LB	LB	Bromacil	62	52.67	2.63E-02
BROMOXYNIL	0.400383954	LB	LB	Bromoxynil	18	7.21	3.60E-03
CAPTAN	0.144094541	LB	LB	Captan	7127	1,026.96	5.13E-01
CARBARYL	0.320840195	LB	LB	Carbaryl	9295	2,982.21	1.49E+00
CHLORMEQUAT	0.58559322	LB	LB	Chlormequat / Chlormequat Trimethylammonium Chloride	160	93.69	4.68E-02
CHLORONEB	0.073553859	LB	LB	Chloroneb	245	18.02	9.01E-03
CHLOROPICRIN	1.272361758	LB	LB	Chloropicrin	6	7.63	3.82E-03
CHLOROTHALONIL	0.1129023	LB	LB	Chlorothalonil	61069	6,894.83	3.45E+00
CHLORPYRIFOS	1.537880735	LB	LB	Chlorpyrifos	8840	13,594.87	6.80E+00

CHLORSULFURON	**0.027708333**	**LB**	**LB**	**Chlorsulfuron**	**98**	**2.72**	**1.36E-03**
CLETHODIM	**1.839959947**	**LB**	**LB**	**Clethodim**	**1680**	**3,091.13**	**1.55E+00**
CLOMAZONE	**0.148722416**	**LB**	**LB**	**Clomazone**	**47698**	**7,093.76**	**3.55E+00**
CLOPYRALID	**0.050478293**	**LB**	**LB**	**Clopyralid**	**2832**	**142.95**	**7.15E-02**
CLORANSULAM-METHYL	**0.400383954**	**LB**	**LB**	**Cloransulam-methyl**	**421**	**168.56**	**8.43E-02**
COPPER	**0.218167983**	**LB**	**LB**	**Copper**	**1044**	**227.77**	**1.14E-01**
COPPER HYDROXIDE	**0.059585448**	**LB**	**LB**	**Copper Hydroxide**	**3390**	**201.99**	**1.01E-01**
COPPER OXYCHLORIDE S	**0.025917034**	**LB**	**LB**	**Copper Oxychloride Sulfate**	**143**	**3.71**	**1.85E-03**
COPPER SULFATE	**0.061965322**	**LB**	**LB**	**Copper Sulfate**	**6462**	**400.42**	**2.00E-01**
CYCLOATE	**0.506874154**	**LB**	**LB**	**Cycloate**	**14**	**7.10**	**3.55E-03**
CYFLUTHRIN	**1.735956923**	**LB**	**LB**	**Cyfluthrin**	**1432**	**2,485.89**	**1.24E+00**
CYPERMETHRIN	**1.521227778**	**LB**	**LB**	**Cypermethrin**	**97844**	**148,843.01**	**7.44E+01**
CYPRODINIL	**0.049082716**	**LB**	**LB**	**Cyprodinil**	**193**	**9.47**	**4.74E-03**
DAMINOZIDE	**0.045436404**	**LB**	**LB**	**Daminozide**	**58**	**2.64**	**1.32E-03**
DCPA	**0.400383954**	**LB**	**LB**	**DCPA**	**86**	**34.43**	**1.72E-02**
DELTAMETHRIN	**3.948853616**	**LB**	**LB**	**Deltamethrin**	**1350**	**5,330.95**	**2.67E+00**
DIAZINON	**0.760312174**	**LB**	**LB**	**Diazinon**	**3331**	**2,532.60**	**1.27E+00**
DICAMBA	**0.084360404**	**LB**	**LB**	**Dicamba**	**51343**	**4,331.32**	**2.17E+00**
DICHLOBENIL	**0.43419938**	**LB**	**LB**	**Dichlobenil**	**5168**	**2,243.94**	**1.12E+00**
DICLORAN	**0.08749595**	**LB**	**LB**	**Dicloran**	**99**	**8.66**	**4.33E-03**
DIFENOCONAZOLE	**1.120455469**	**LB**	**LB**	**Difenoconazole**	**4448**	**4,983.79**	**2.49E+00**
DIFLUFENZOPYR	**0.158742894**	**LB**	**LB**	**Diflufenzopyr**	**361**	**57.31**	**2.87E-02**
DIMETHENAMID	**0.134539705**	**LB**	**LB**	**Dimethenamid**	**5125**	**689.52**	**3.45E-01**
DIMETHOATE	**0.83005574**	**LB**	**LB**	**Dimethoate**	**243677**	**202,265.49**	**1.01E+02**
DIQUAT	**1.456185648**	**LB**	**LB**	**Diquat Dibromide**	**10835**	**15,777.77**	**7.89E+00**
DITHIOPYR	**0.955493833**	**LB**	**LB**	**Dithiopyr**	**52005**	**49,690.46**	**2.48E+01**
DIURON	**0.072313516**	**LB**	**LB**	**Diuron**	**527**	**38.11**	**1.91E-02**
EPTC	**0.517446714**	**LB**	**LB**	**EPTC**	**2905**	**1,503.18**	**7.52E-01**
ESFENVALERATE	**8.919447472**	**LB**	**LB**	**Esfenvalerate**	**808**	**7,206.91**	**3.60E+00**
ETHALFLURALIN	**1.554014599**	**LB**	**LB**	**Ethalfluralin**	**1376**	**2,138.32**	**1.07E+00**
ETHEPHON	**0.302374472**	**LB**	**LB**	**Ethephon**	**1056**	**319.31**	**1.60E-01**
ETHOFUMESATE	**0.690939895**	**LB**	**LB**	**Ethofumesate**	**5**	**3.45**	**1.73E-03**
ETRIDIAZOLE	**0.400383954**	**LB**	**LB**	**Etridiazole**	**118384**	**47,399.05**	**2.37E+01**
FENARIMOL	**1.40425992**	**LB**	**LB**	**Fenarimol**	**11**	**15.45**	**7.72E-03**
FENBUCONAZOLE	**0.048981043**	**LB**	**LB**	**Fenbuconazole**	**29**	**1.42**	**7.10E-04**
FENHEXAMID	**0.036836803**	**LB**	**LB**	**Fenhexamid**	**258**	**9.50**	**4.75E-03**
FENOXAPROP	**3.132**	**LB**	**LB**	**Fenoxaprop-Ethyl**	**408**	**1,277.86**	**6.39E-01**
FENPROPATHRIN	**1.469129721**	**LB**	**LB**	**Fenpropathrin**	**133**	**195.39**	**9.77E-02**
FIPRONIL	**6.462993609**	**LB**	**LB**	**Fipronil**	**21380**	**138,178.80**	**6.91E+01**
FLUAZIFOP	**1.464201878**	**LB**	**LB**	**Fluazifop-P-Butyl**	**618**	**904.88**	**4.52E-01**

FLUDIOXONIL	**0.307704511**	**LB**	**LB**	**Fludioxonil**	**41**	**12.62**	**6.31E-03**
FLUMETSULAM	**0.400383954**	**LB**	**LB**	**Flumetsulam**	**139**	**55.65**	**2.78E-02**
FLUMICLORAC	**0.565346535**	**LB**	**LB**	**Flumiclorac-pentyl ester**	**28**	**15.83**	**7.91E-03**
FLURIDONE	**0.628558861**	**LB**	**LB**	**Fluridone**	**33**	**20.74**	**1.04E-02**
FLUTOLANIL	**0.03072934**	**LB**	**LB**	**Flutolanil**	**283**	**8.70**	**4.35E-03**
FOMESAFEN	**0.400383954**	**LB**	**LB**	**Fomesafen**	**1326**	**530.91**	**2.65E-01**
FOSETYL	**0.04897535**	**LB**	**LB**	**Fosetyl Aluminum**	**1681**	**82.33**	**4.12E-02**
GAMMA AMINOBUTYRIC ACID	**0.400383954**	**LB**	**LB**	**Gibberellic Acid**	**1**	**0.40**	**2.00E-04**
GLUFOSINATE	**0.441993604**	**LB**	**LB**	**Glufosinate-ammonium**	**8350**	**3,690.65**	**1.85E+00**
GLYPHOSATE	**0.158572216**	**LB**	**LB**	**Glyphosate**	**721154**	**114,354.99**	**5.72E+01**
HALOSULFURON	**0.032232225**	**LB**	**LB**	**Halosulfuron-methyl**	**1189**	**38.32**	**1.92E-02**
HEXAZINONE	**0.141677658**	**LB**	**LB**	**Hexazinone**	**74**	**10.48**	**5.24E-03**
HEXYTHIAZOX	**0.422988241**	**LB**	**LB**	**Hexythiazox**	**77**	**32.57**	**1.63E-02**
HYDRAMETHYLNON	**0.613627515**	**LB**	**LB**	**Hydramethylnon**	**5**	**3.07**	**1.53E-03**
IMAZAPYR	**0.024746163**	**LB**	**LB**	**Imazapyr**	**408**	**10.10**	**5.05E-03**
IMAZAQUIN	**0.400383954**	**LB**	**LB**	**Imazaquin**	**37**	**14.81**	**7.41E-03**
IMAZETHAPYR	**0.018776758**	**LB**	**LB**	**Imazethapyr**	**1644**	**30.87**	**1.54E-02**
IMIDACLOPRID	**0.30515662**	**LB**	**LB**	**Imidacloprid**	**231323**	**70,589.74**	**3.53E+01**
IPRODIONE	**0.202777271**	**LB**	**LB**	**Iprodione**	**4118**	**835.04**	**4.18E-01**
ISOXABEN	**0.102701053**	**LB**	**LB**	**Isoxaben**	**662**	**67.99**	**3.40E-02**
KINOPRENE	**0.466385911**	**LB**	**LB**	**Kinoprene**	**11**	**5.13**	**2.57E-03**
KRESOXIM-METHYL	**0.0338**	**LB**	**LB**	**Kresoxim-methyl**	**108**	**3.65**	**1.83E-03**
LACTOFEN	**0.400383954**	**LB**	**LB**	**Lactofen**	**4**	**1.60**	**8.01E-04**
LINURON	**0.077406043**	**LB**	**LB**	**Linuron**	**1174**	**90.87**	**4.54E-02**
MALATHION	**0.408564945**	**LB**	**LB**	**Malathion**	**691**	**282.32**	**1.41E-01**
MALEIC HYDRAZIDE	**0.015361446**	**LB**	**LB**	**Maleic Hydrazide**	**80**	**1.23**	**6.14E-04**
MANCOZEB	**0.04714311**	**LB**	**LB**	**Mancozeb**	**30280**	**1,427.49**	**7.14E-01**
MANEB	**0.070666852**	**LB**	**LB**	**Maneb**	**5753**	**406.55**	**2.03E-01**
MCPA	**0.470093248**	**LB**	**LB**	**MCPA dimethylamine salt**	**5354**	**2,516.88**	**1.26E+00**
MEFENOXAM	**0.58651298**	**LB**	**LB**	**Mefenoxam**	**828**	**485.63**	**2.43E-01**
METALAXYL	**0.505514399**	**LB**	**LB**	**Metalaxyl-M**	**803**	**405.93**	**2.03E-01**
METAM	**0.566**	**LB**	**LB**	**Metam-Sodium**	**8010**	**4,533.66**	**2.27E+00**
METHOMYL	**0.114625109**	**LB**	**LB**	**Methomyl**	**2759**	**316.25**	**1.58E-01**
METHYL BROMIDE	**1.158524567**	**LB**	**LB**	**Methyl Bromide**	**296**	**342.92**	**1.71E-01**
METIRAM	**0.110225**	**LB**	**LB**	**Metiram**	**5**	**0.55**	**2.76E-04**
METOLACHLOR-S	**0.197923197**	**LB**	**LB**	**S-Metolachlor**	**555807**	**110,007.10**	**5.50E+01**
METRIBUZIN	**0.087090886**	**LB**	**LB**	**Metribuzin**	**1566**	**136.38**	**6.82E-02**
METSULFURON	**0.037222222**	**LB**	**LB**	**Metsulfuron Methyl**	**205**	**7.63**	**3.82E-03**
MYCLOBUTANIL	**0.450942607**	**LB**	**LB**	**Myclobutanil**	**1261**	**568.64**	**2.84E-01**
NAPROPAMIDE	**0.384546781**	**LB**	**LB**	**Napropamide**	**411**	**158.05**	**7.90E-02**

NAPTALAM	**0.587980352**	**LB**	**LB**	**Naptalam**	**4**	**2.35**	**1.18E-03**
NEEM OIL	**0.400383954**	**LB**	**LB**	**Neem Oil**	**3**	**1.20**	**6.01E-04**
NICOSULFURON	**0.03690208**	**LB**	**LB**	**Nicosulfuron**	**4805**	**177.31**	**8.87E-02**
NORFLURAZON	**0.030828153**	**LB**	**LB**	**Norflurazon**	**76**	**2.34**	**1.17E-03**
ORYZALIN	**0.212227173**	**LB**	**LB**	**Oryzalin**	**6543**	**1,388.60**	**6.94E-01**
OXADIAZON	**0.181725116**	**LB**	**LB**	**Oxadiazon**	**238**	**43.25**	**2.16E-02**
OXAMYL	**0.72078125**	**LB**	**LB**	**Oxamyl**	**457**	**329.40**	**1.65E-01**
OXYFLUORFEN	**1.012338009**	**LB**	**LB**	**Oxyfluorfen**	**242**	**244.99**	**1.22E-01**
PACLOBUTRAZOL	**0.982514667**	**LB**	**LB**	**Paclobutrazol**	**4027**	**3,956.59**	**1.98E+00**
PARAQUAT	**0.310577425**	**LB**	**LB**	**Paraquat dicholride**	**137874**	**42,820.55**	**2.14E+01**
PELARGONIC ACID	**0.400383954**	**LB**	**LB**	**Pelargonic Acid**	**416**	**166.56**	**8.33E-02**
PENDIMETHALIN	**0.558789524**	**LB**	**LB**	**Pendimethalin**	**30957**	**17,298.45**	**8.65E+00**
PERMETHRIN	**3.34487239**	**LB**	**LB**	**Permethrin**	**53361**	**178,485.74**	**8.92E+01**
PETROLEUM DISTILLATE	**1.14200855**	**LB**	**LB**	**Petroleum Distillate**	**5152**	**5,883.63**	**2.94E+00**
PETROLEUM OIL	**0.884364955**	**LB**	**LB**	**Petroleum Oils**	**10247**	**9,062.09**	**4.53E+00**
PIPERONYL BUTOXIDE	**4.504163141**	**LB**	**LB**	**Piperonyl Butoxide**	**32422**	**146,033.98**	**7.30E+01**
PRODIAMINE	**0.125840336**	**LB**	**LB**	**Prodiamine**	**145979**	**18,370.05**	**9.19E+00**
PROPAMOCARB HCL	**0.179701585**	**LB**	**LB**	**Propamocarb Hydrochloride**	**3415**	**613.68**	**3.07E-01**
PROPICONAZOLE	**1.052037715**	**LB**	**LB**	**Propiconazole**	**7071**	**7,438.96**	**3.72E+00**
PROSULFURON	**0.400383954**	**LB**	**LB**	**Prosulfuron**	**203**	**81.28**	**4.06E-02**
PYRETHRINS	**6.73713926**	**LB**	**LB**	**Pyrethrins**	**249**	**1,677.55**	**8.39E-01**
PYRIDABEN	**0.018712121**	**LB**	**LB**	**Pyridaben**	**1**	**0.02**	**9.36E-06**
QUINCLORAC	**0.121314591**	**LB**	**LB**	**Quinclorac**	**6859**	**832.10**	**4.16E-01**
QUIZALOFOP	**4.121052632**	**LB**	**LB**	**Quizalofop-ethyl**	**16**	**65.94**	**3.30E-02**
RIMSULFURON	**0.0704**	**LB**	**LB**	**Rimsulfuron**	**5313**	**374.04**	**1.87E-01**
SETHOXYDIM	**3.751133787**	**LB**	**LB**	**Sethoxydim**	**315**	**1,181.61**	**5.91E-01**
SIMAZINE	**0.08875528**	**LB**	**LB**	**Simazine**	**200734**	**17,816.20**	**8.91E+00**
SODIUM CHLORATE	**0.024940212**	**LB**	**LB**	**Sodium Chlorate (Bleach)**	**84**	**2.09**	**1.05E-03**
STREPTOMYCIN	**0.132760814**	**LB**	**LB**	**Streptomycin**	**13**	**1.73**	**8.63E-04**
SULFENTRAZONE	**0.127556818**	**LB**	**LB**	**Sulfentrazone**	**3407**	**434.59**	**2.17E-01**
SULFOMETURON	**0.075515924**	**LB**	**LB**	**Sulfometuron Methyl**	**6**	**0.45**	**2.27E-04**
SULFUR	**0.013084013**	**LB**	**LB**	**Sulfur**	**38701**	**506.36**	**2.53E-01**
TEBUCONAZOLE	**0.178406772**	**LB**	**LB**	**Tebuconazole**	**1914**	**341.47**	**1.71E-01**
TEBUTHIURON	**0.074551495**	**LB**	**LB**	**Tebuthiuron**	**4**	**0.30**	**1.49E-04**
TEFLUTHRIN	**0.400383954**	**LB**	**LB**	**Tefluthrin**	**901**	**360.75**	**1.80E-01**
TERBACIL	**0.023125**	**LB**	**LB**	**Terbacil**	**38**	**0.88**	**4.39E-04**
TERBUFOS	**0.400383954**	**LB**	**LB**	**Terbufos**	**1520**	**608.58**	**3.04E-01**
THIABENDAZOLE	**0.117210258**	**LB**	**LB**	**Thiabendazole**	**241**	**28.25**	**1.41E-02**
THIFENSULFURON	**0.049333333**	**LB**	**LB**	**Thifensulfuron methyl**	**3502**	**172.77**	**8.64E-02**
THIOPHANATE-METHYL	**0.117956516**	**LB**	**LB**	**Thiophanate-methyl**	**24138**	**2,847.23**	**1.42E+00**

THIRAM	**0.219390616**	**LB**	**LB**	**Thiram**	**695**	**152.48**	**7.62E-02**
TRIADIMEFON	**0.162459575**	**LB**	**LB**	**Triadimefon**	**1840**	**298.93**	**1.49E-01**
TRIBENURON METHYL	**0.030454341**	**LB**	**LB**	**Tribenuron-methyl**	**1594**	**48.54**	**2.43E-02**
TRICLOPYR	**0.433012401**	**LB**	**LB**	**Triclopyr or Triclopy**	**6878**	**2,978.26**	**1.49E+00**
TRIFLOXYSTROBIN	**0.083225592**	**LB**	**LB**	**Trifloxystrobin**	**267**	**22.22**	**1.11E-02**
TRIFLURALIN	**0.736875308**	**LB**	**LB**	**Trifluralin**	**125501**	**92,478.59**	**4.62E+01**
TRINEXAPAC	**2.385644844**	**LB**	**LB**	**Trinexapac-ethyl**	**690**	**1,646.09**	**8.23E-01**
VINCLOZOLIN	**0.055254546**	**LB**	**LB**	**Vinclozolin**	**11**	**0.61**	**3.04E-04**
ZINC	**0.32858394**	**LB**	**LB**	**Zinc**	**18**	**5.91**	**2.96E-03**
ZIRAM	**0.030618627**	**LB**	**LB**	**Ziram**	**1863**	**57.04**	**2.85E-02**
2,4-DP	**0.4**	**LB**	**LB**	**2,4-DP**	**283**	**113.20**	**5.66E-02**
Acetic Acid	**0.4**	**LB**	**LB**	**Acetic Acid**	**16813**	**6,725.20**	**3.36E+00**
Allethrin	**0.4**	**LB**	**LB**	**Allethrin**	**1**	**0.40**	**2.00E-04**
Anthraquinone	**0.4**	**LB**	**LB**	**Anthraquinone**	**15**	**6.00**	**3.00E-03**
Bacillus spahericus	**0.4**	**LB**	**LB**	**Bacillus spahericus**	**174**	**69.60**	**3.48E-02**
Beauveria Bassiana	**0.4**	**LB**	**LB**	**Beauveria Bassiana**	**1**	**0.40**	**2.00E-04**
Boric Acid	**0.4**	**LB**	**LB**	**Boric Acid**	**58573**	**23,429.20**	**1.17E+01**
Bromadiolone	**0.4**	**LB**	**LB**	**Bromadiolone**	**1**	**0.40**	**2.00E-04**
Calcium Hypochlorite	**0.4**	**LB**	**LB**	**Calcium Hypochlorite**	**251**	**100.40**	**5.02E-02**
Carbofuran	**0.4**	**LB**	**LB**	**Carbofuran**	**2**	**0.80**	**4.00E-04**
Chlorimuron Ethyl	**0.4**	**LB**	**LB**	**Chlorimuron Ethyl**	**589**	**235.60**	**1.18E-01**
Cyclohexanecarboxamide	**0.4**	**LB**	**LB**	**Cyclohexanecarboxamide**	**9**	**3.60**	**1.80E-03**
Dichlorvos	**0.4**	**LB**	**LB**	**Dichlorvos**	**13506**	**5,402.40**	**2.70E+00**
Dikegulac Sodium	**0.4**	**LB**	**LB**	**Dikegulac Sodium**	**19**	**7.60**	**3.80E-03**
Diphacinone	**0.4**	**LB**	**LB**	**Diphacinone**	**6**	**2.40**	**1.20E-03**
Dithiocarbamate	**0.4**	**LB**	**LB**	**Dithiocarbamate**	**8798**	**3,519.20**	**1.76E+00**
Ethylene Oxide	**0.4**	**LB**	**LB**	**Ethylene Oxide**	**45376**	**18,150.40**	**9.08E+00**
Flucythrinate	**0.4**	**LB**	**LB**	**Flucythrinate**	**1**	**0.40**	**2.00E-04**
Flurprimidol	**0.4**	**LB**	**LB**	**Flurprimidol**	**794**	**317.60**	**1.59E-01**
Fluvalinate	**0.4**	**LB**	**LB**	**Fluvalinate**	**1**	**0.40**	**2.00E-04**
Fosamine Ammonium	**0.4**	**LB**	**LB**	**Fosamine Ammonium**	**673**	**269.20**	**1.35E-01**
Halofenozide	**0.4**	**LB**	**LB**	**Halofenozide**	**13**	**5.20**	**2.60E-03**
Hydroprene	**0.4**	**LB**	**LB**	**Hydroprene**	**205**	**82.00**	**4.10E-02**
Isoctyl	**0.4**	**LB**	**LB**	**Isoctyl**	**1192**	**476.80**	**2.38E-01**
Lambda-cyhalothrin	**0.4**	**LB**	**LB**	**Lambda-cyhalothrin**	**1375**	**550.00**	**2.75E-01**
Linalool	**0.4**	**LB**	**LB**	**Linalool**	**2**	**0.80**	**4.00E-04**
MCPP	**0.4**	**LB**	**LB**	**MCPP**	**85625**	**34,250.00**	**1.71E+01**
Manganese	**0.4**	**LB**	**LB**	**Manganese**	**146**	**58.40**	**2.92E-02**
Mefluidide	**0.4**	**LB**	**LB**	**Mefluidide**	**138**	**55.20**	**2.76E-02**
Mercurous Chloride	**0.4**	**LB**	**LB**	**Mercurous Chloride**	**2797**	**1,118.80**	**5.59E-01**

Methoprene	**0.4**	**LB**	**LB**	**Methoprene**	**84**	**33.60**	**1.68E-02**
Methoxychlor	**0.4**	**LB**	**LB**	**Methoxychlor**	**124**	**49.60**	**2.48E-02**
Nicotonic Acid	**0.4**	**LB**	**LB**	**Nicotonic Acid**	**1**	**0.40**	**2.00E-04**
Octoborate	**0.4**	**LB**	**LB**	**Octoborate**	**18**	**7.20**	**3.60E-03**
Potassium Salts Fatty Acids	**0.4**	**LB**	**LB**	**Potassium Salts Fatty Acids**	**19141**	**7,656.40**	**3.83E+00**
Primisulfuron-methyl	**0.4**	**LB**	**LB**	**Primisulfuron-methyl**	**4**	**1.60**	**8.00E-04**
Prometon	**0.4**	**LB**	**LB**	**Prometon**	**325**	**130.00**	**6.50E-02**
Propetamphos	**0.4**	**LB**	**LB**	**Propetamphos**	**7374**	**2,949.60**	**1.47E+00**
Propoxur	**0.4**	**LB**	**LB**	**Propoxur**	**5**	**2.00**	**1.00E-03**
Pyrethrum	**0.4**	**LB**	**LB**	**Pyrethrum**	**38**	**15.20**	**7.60E-03**
Siduron	**0.4**	**LB**	**LB**	**Siduron**	**343**	**137.20**	**6.86E-02**
Spinosad	**0.4**	**LB**	**LB**	**Spinosad**	**55**	**22.00**	**1.10E-02**
Sulfuryl Fluride	**0.4**	**LB**	**LB**	**Sulfuryl Fluride**	**183620**	**73,448.00**	**3.67E+01**
Sumithrin	**0.4**	**LB**	**LB**	**Sumithrin**	**8**	**3.20**	**1.60E-03**
Tetrachloroisophthalonitrile	**0.4**	**LB**	**LB**	**Tetrachloroisophthalonitrile**	**6305**	**2,522.00**	**1.26E+00**
Triazin-3-one	**0.4**	**LB**	**LB**	**Triazin-3-one**	**6**	**2.40**	**1.20E-03**
Trichlorfon	**0.4**	**LB**	**LB**	**Trichlorfon**	**1651**	**660.40**	**3.30E-01**
Triisopropanolamine	**0.4**	**LB**	**LB**	**Triisopropanolamine**	**2485**	**994.00**	**4.97E-01**
Vernolate	**0.4**	**LB**	**LB**	**Vernolate**	**461**	**184.40**	**9.22E-02**
Zinc Phosphide	**0.4**	**LB**	**LB**	**Zinc Phosphide**	**27**	**10.80**	**5.40E-03**

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

Harvested Acres by County and Percent of Total Harvested

State and County FIPS Code	Harvested Acres	Percent of Total Acres Harvested
24001	800.00	0.05%
24003	9500.00	0.56%
24005	32100.00	1.90%
24009	6600.00	0.39%
24011	122500.00	7.24%
24013	70100.00	4.14%
24015	46450.00	2.75%
24017	14000.00	0.83%
24019	496000.00	29.31%
24021	88200.00	5.21%
24023	5200.00	0.31%
24025	219750.00	12.99%
24027	5200.00	0.31%
24029	116500.00	6.89%
24031	16100.00	0.95%
24033	6100.00	0.36%
24035	141650.00	8.37%
24037	22800.00	1.35%
24039	45900.00	2.71%
24041	74600.00	4.41%
24043	32600.00	1.93%
24045	48600.00	2.87%
24047	70800.00	4.18%
24510	0.00	0.00%
STATE TOTAL	**1692050.00**	**100.00%**

Emissions Calculation

Equations:

$$E_{pest} = \frac{(AI \times EF_{pest})}{2000}$$

where:

AI = Active Ingredient (lb. / yr.)

EF_{pest} = Emission Factor for particular pesticide (lb. VOC / lb. AI)

Sample Calculations:

Pesticide – Acephate with 6302 pounds of active ingredient used in Maryland.

EPA's EF for Acephate is 0.2750 (lb. VOC / lb. AI)

$$E_{Acephate} = \frac{(6302 \times 0.2750)}{2000} = 0.87 \text{ tons of Voc year}$$

After calculating VOCs for each pesticide a portion was distributed across counties that harvested crops using the table above containing percentages for total harvested acres. Then VOCs were summed in each county. The types of crops were summed in each county by application a percentage was derived and assigned the appropriate SCC code for soil or surface.

2014 Pesticide Percentage Application Table of Maryland

State and County FIPS Code	SOIL CORN/SOYBEAN	SURFACE WHEAT/BARLEY	2461800001 % SOIL	2461800002 % SURFACE
24001	4,000	0	100%	0%
24003	19,400	0	100%	0%
24005	66,600	0	100%	0%
24009	13,800	0	100%	0%
24011	172,500	84,700	67%	33%
24013	120,600	36,100	77%	23%
24015	86,800	10,850	89%	11%
24017	28,500	0	100%	0%
24019	142,400	76,000	65%	35%
24021	151,400	65,550	70%	30%
24023	14,000	0	100%	0%
24025	71,300	4,950	94%	6%
24027	11,200	0	100%	0%
24029	176,600	116,700	60%	40%
24031	41,300	18,000	70%	30%
24033	13,000	0	100%	0%
24035	220,400	141,150	61%	39%
24037	47,300	0	100%	0%
24039	70,400	56,500	55%	45%
24041	147,700	7,900	95%	5%
24043	84,600	23,000	79%	21%
24045	97,400	12400	89%	11%
24047	143,800	0	100%	0%
24510	0	0	0	0

Total VOCs from Soil applied pesticides for Harford County were estimated to be:
$E_{HarfordSoil}$ = 2.12 tons per year
Pesticides-Soil for Harford County was found to have a
SAF = seasonal adjustment factor of 0.25
POS = peak ozone period of 0.25
Days of the Period 312
Daily adjusted $E_{HarfordSoil\mathbf{da}}$ = ($E_{HarfordSoil}$ / 312)*(SAF / POS)
$E_{HarfordSoil\mathbf{da}}$ = (2.12 / 312)*(0.25 / 0.25) = **6.78E-03 VOC tons/day**

4.1.2.13 **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 [33, 34]		
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:

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

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:

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

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

Emissions Calculation

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

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

Where:

E_{CC} = VOC emissions in tons per day from commercial and consumer solvents
POP_i = 2014 population of county i
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%)

2014 Sample Calculation Personal Care Products Consumer Solvent Use (Anne Arundel County)
VOC Emission Factors after OCT Phase 2

$$E_{PersonalCare} = \frac{[(560{,}133^{35}) \times (1.7529695)]}{2000}$$

$E_{PersonalCare}$ = **490.95 tons $_{VOC}$ per year for Anne Arundel County**

Personal Care Products for Anne Arundel County was found to have a
SAF = seasonal adjustment factor of 0.25
POS = peak ozone period of 0.25
Days of the Period 365
Daily adjusted $E_{PersonalCare\mathbf{da}} = (E_{PersonalCare} / 365)*(SAF / POS)$

$E_{PersonalCare\mathbf{da}}$ = (**490.95** / 365)*(0.25 / 0.25) = **1.35E+00 VOC tons/day**

4.1.2.14 **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.

[35] 2014 Population data from U.S. Bureau of Census, Population Estimates Branch

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/ARA registration files have been subtracted from the emissions calculated by employee.

Activity
Employee numbers were taken from County Business Patterns 2013 - 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

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

Emissions Calculation

The equation used to estimate emissions from bakeries is:

Equation:

$E_{BAK} = EF_{BAK} \mathbf{x}\ EMPj$

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

$E_{BAK\text{-}ADJ} = EF_{BAK} \mathbf{x}\ EMPj_{Pt.\ Sources}$

Where:

$E_{BAK\text{-}ADJ}$ = Point source adjusted bakery emissions
EF_{BAK} = per employee emission factor for bakeries
$EMPj_{Pt.\ SourcesAd}$[36] = Point Source Adjustment was done by subtracting employment for Baltimore City related sources before calculating emissions.

2014 Sample Calculation for Bakery VOC Emissions (Baltimore City):

Employees in NAICS 311811 and 311812 in Baltimore City:
$EMP_{Pt.BCity}$ = 1,160 emp

Employees in Baltimore City Bakeries:
EMP_{BCity} = 951.22

[36] Point Source Reduction from MDE ARA registration files

$EMP_{BC\ Pt.\ SourcesAd}$ = 1,160 - 951.22 = 208.78 emp

E_{BAK} = EF_{BAK} **x** $EMPj_{Pt.\ SourcesAd}$

E_{BAK} = 0.11 **x** 208.78

E_{BAK} = 22.97 tons $_{VOC}$ per year

Bakeries for Baltimore City was found to have a
SAF = seasonal adjustment factor of 0.25
POS = peak ozone period of 0.25
Days of the Period 260
Daily adjusted $E_{BAK\mathbf{da}}$ = (**E_{BAK}** / 260)*(SAF / POS)

$E_{BAK\mathbf{da}}$ = (**22.97** / 260)*(0.25 / 0.25) = **8.83E-02 VOC tons/day**

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/ARA staff surveyed small brewpubs and microbreweries in Maryland.

Activity
The survey questionnaire asked the brewing facilities to provide MDE/ARA with the amount of barrels brewed per month for the calendar year 2014. 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

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

Emissions Calculation

The equation used to estimate emissions from bakeries is:

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

Where:

E_{BREW} = VOC emissions from small bakeries in tons per year
EF_{BREW} = emission factor for small breweries
BPj = 2014 beer production in barrels

<u>2014 Sample Calculation for Small Brewery VOC Emissions (Howard County)</u>:

Number barrels produced by microbreweries in Howard County = 109,255 barrels

$$E_{BREW} = \frac{0.05674 \mathbf{x}\ 109{,}255}{2000}$$

E_{BREW} = 3.10 tons $_{VOC}$ per year

Breweries for Howard County was found to have a
SAF = seasonal adjustment factor of 0.25
POS = peak ozone period of 0.25
Days of the Period 260
Daily adjusted E_{BREWda} = (**E_{BREW}** / 260)*(SAF / POS)

E_{BREWda} = (**3.10** / 260)*(0.25 / 0.25) = **1.19E-02 VOC tons/day**

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[37], 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 Comptroller's Office, and direct survey of most of Maryland's wineries revealed that approximately 430,792 gallons of wine was produced in 2014. The survey suggests that 215,703 gallons of white and 215,836 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.

[37] 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

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

Emissions Calculation State Total

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

White wine EMtotal = (215,703 gal x **0.0018 lb voc per gal) / 2000**
White wine EMtotal = 0.194 tons $_{VOC}$ per year

Red wine EMtotal = (215,836 gal x **0.0046 lb voc per gal) / 2000**
Red wine EMtotal = 0.496 tons $_{VOC}$ per year

Using the above figures, the production of wine by all Maryland wineries in 2014 resulted in the production **of 0.691 tons $_{VOC}$ per year**

Daily calculation can be made for each county (see example below)
Anne Arundel County Winery VOC total was:
$EM_{Anne\ Arundel}$ = 1.82E-02 tons $_{VOC}$ per year

Wineries for Anne Arundel County was found to have a
SAF = seasonal adjustment factor of 0.25
POS = peak ozone period of 0.25
Days of the Period 260
Daily adjusted $EM_{Anne\ Arundel\,da}$ = ($EM_{Anne\ Arundel}$ / 260)*(SAF / POS)

$EM_{Anne\ Arundel\,da}$ = (**1.82E-02** / 260)*(0.25 / 0.25) = **7.01E-05 VOC tons/day**

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 2014. 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’s Emergency Response Program. They provided MDE/ARA staff a yearly report of all oil spills that occurred in Maryland during 2014. Spills around Maryland totaled to about 129,286 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

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

Emissions Calculation

The equation used to estimate emissions from oil spills:

$$E_{\text{Oil Spills}} = EF_{\text{Oil Spills}} \times GOSi$$

Where:

$E_{\text{Oil Spills}}$ = VOC emissions from oil spills in tons $_{\text{VOC}}$ per year

$EF_{Oil\ Spills}$ = tons of pollutant per gallon of oil spilled
GOSi = gallons of oil spilled in county i

2014 Sample Calculation for Oil Spill VOC Emissions (Baltimore County):

Annual Emissions:
Number gallons oil spilled Baltimore County 2014: **14,270** gallons

$E_{Oil\ Spills}$ = (0.0000925) **x** (14,270)

$E_{Oil\ Spills}$ = 1.32 tons $_{VOC}$ per year

Oil Spills for Baltimore County was found to have a
SAF = seasonal adjustment factor of 0.25
POS = peak ozone period of 0.25
Days of the Period 312
Daily adjusted $E_{Oil\ Spills\mathbf{da}}$ = ($E_{Oil\ Spills}$ / 312)*(SAF / POS)

$E_{Oil\ Spills\mathbf{da}}$ = (**1.32** / 312)*(0.25 / 0.25) = **4.23E-03 VOC tons/day**

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

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

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>2014 Sample Calculation for Leaking Underground Storage Tanks (Anne Arundel County)</u>

No seasonal variation assumed

$$E_{LUST-AA} = \frac{52 \textbf{ x } 28_{VOC} \text{ lbs./day} \textbf{ x } 30 \text{ day}}{2000 \text{ lb./ton}}$$

$E_{LUST-AA}$ = 21.84 tons $_{VOC}$ per year

Leaking Underground Storage Tanks for Anne Arundel was found to have a
SAF = seasonal adjustment factor of 0.25
POS = peak ozone period of 0.25
Days of the Period 365
Daily adjusted $E_{LUST-AA\mathbf{da}}$ = ($E_{LUST-AA}$ / 365)*(SAF / POS)

$E_{LUST-AA\mathbf{da}}$ = (**21.84** / 365)*(0.25 / 0.25) = **5.98E-02 VOC tons/day**

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/ARA 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.

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

No point source adjustments were made

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

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

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}[38]	=	VOC emission factor for POTWs
SAF_{POTW}[39]	=	Seasonal adjustment factor for peak ozone season which is 1.4
		Plant operation is 365 days a year

<u>2014 Sample Calculation for POTW VOC Emissions (Howard County)</u>:

Howard County has only one POTW,
Little Patuxent Treatment Plant statistics[40]**:**
Actual daily flow (MGD)[41]: 20.233

$$E_{POTWY} = \frac{(20.233) \textbf{ x } (0.44 \text{ lbs.}_{VOC} / \text{gal}) \textbf{ x } 365 \text{ days}}{2000}$$

$$\mathbf{E_{POTWY} = 1.625 \textbf{ tons}_{VOC} / \textbf{year}}$$

POTW for Howard County was found to have a
SAF = seasonal adjustment factor of 0.35
POS = peak ozone period of 0.25
Days of the Period 365
Daily adjusted $E_{POTWY\mathbf{da}} = (E_{POTWY} / 365)*(SAF / POS)$

$E_{POTWY\mathbf{da}}$ = (**1.625** / 365)*(0.35 / 0.25) = **6.23E-03 VOC tons/day**

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[38] Emission factor taken from Procedures, Section 3.5.1
[39] Seasonal adjustment factor taken from Procedures, Table 5.8.1
[40] Supplied by the Maryland Water Management Administration (see Appendices)
[41] 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 in Maryland 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[42], 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

[42] 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	66	99
Softwood	37.5	56.25 rounded by EPA to 57
Grass	4.5	4.5

Average fuel loading factors were calculated as follows:

$$LF_{OB-LCD-COi} \quad \frac{(Acres_{HW-COi} \times LF_{Adj-HW}) + (Acres_{SW-COi} \times LF_{Adj-SW}) + (Acres_{GR-COi} \times LF_{Adj-GR})}{Acres_{TOT-COi}}$$

$LF_{OB-LCD-COi}$	=	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 [43]

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. $_{NOx}$/ 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.

[43] 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

Emissions are temporally allocated to months or seasons by the number of permits issued per month per county.

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 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."[44]

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 2014, 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 performed to estimate controlled emissions for areas that prohibit open burning. 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

[44] 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.

respondents, while RE 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 as provided by the 2000 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[45] 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:

$E_c = E_{uc} * [(1-(CE)(RP)(RE)]$

[45] 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 the survey.

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 survey responses were obtained for those areas. Pechan did not develop state specific RE values since we had no reason to believe that local jurisdictions in individual states implemented their rules differently than local jurisdictions in the rest of 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 or 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 effect 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).

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)

SCC	Weekday Hour											
	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

SCC	Weekday Hour											
	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)

SCC	Weekend Day Hour											
	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

SCC	Weekend Day Hour											
	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:

$$Wt_{MSW} = HH * Bt * M$$

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."[46]

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 2014, 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 performed to estimate controlled emissions for areas that prohibit open burning. 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

[46] 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.

respondents, while RE 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 as provided by the 2000 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[47] 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:

$E_c = E_{uc} * [(1-(CE)(RP)(RE)]$

[47] 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 the survey.

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 survey responses were obtained for those areas. Pechan did not develop state specific RE values since we had no reason to believe that local jurisdictions in individual states implemented their rules differently than local jurisdictions in the rest of 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 or 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 effect 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).

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)

SCC	Weekday Hour											
	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

SCC	Weekday Hour											
	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)

SCC	Weekend Day Hour											
	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

SCC	Weekend Day Hour											
	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 supplied by sources)

**Method and
Data Sources**

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/ARA 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.

**Point Source
Adjustments**

No subtraction of emissions from point sources is necessary.

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 landfill 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[48], 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:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} k L_o \left(\frac{M_i}{10} \right) e^{-k t_{ij}}$$

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)

48 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
SAF was applied to emissions and were averaged according to period of operation to a daily estimate. See section 2.2.1.1

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, 2013, published by Energy Information Administration, U.S. Department of Energy[49].

Emission Factors

Uncontrolled Emission Factors – AP-42 Tables 1.3-1 and 1.3-3 (hand-fed units)

Pollutant	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

[49] Total residential distillate oil use in the State of Maryland in 2013 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, 2013".

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[50] in an Area Source Method Abstract for Residential and Commercial/Institutional Fuel Oil and Kerosene combustion.

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).[51]

$$SAF_{InventoryCounty} = \frac{HDD_{InventoryCounty} * POP_{InventoryCounty}}{\sum_{AllCountiesInState}(HDD_{County} * POP_{County})}$$

Where:

$SAF_{InventoryCounty}$	=	Spatial apportioning factor for inventory county
$HDD_{InventoryCounty}$	=	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

50 Emissions Inventory Improvement Program (EIIP) Area Source Method Abstract – Residential and Commercial/Institutional Fuel Oil and Kerosene Combustion, dated April 2011.

51 http://www.noaa.gov (home page) or http://www.ncdc.noaa.gov/ol/climate/climateproducts.html#PUBS (for a list of available data)

The spatial apportioning factor is used to allocate the state fuel total to the county level using the following equation:

$$\text{Fuel}_{\text{INVENTORY COUNTY}} = \text{SAF}_{\text{INVENTORY COUNTY}} \times \text{Fuel}_{\text{TOTAL STATE}}$$

Where:

$\text{Fuel}_{\text{INVENTORY COUNTY}}$ = Total Fuel consumed annually in the inventory county
$\text{Fuel}_{\text{TOTAL STATE}}$ = Total Fuel consumed annually in the state

Temporal

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:

$\text{Fuel}_{\text{InventroyCountyAnnual}}$ = Total Fuel consumed annually in the inventory county
$\text{Fuel}_{\text{TotalState}}$ = 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

$$SAF_{InventoryCounty} = \frac{HDD_{InventoryCounty} * POP_{InventoryCounty}}{\sum_{AllCountiesInState}(HDD_{County} * POP_{County})}$$

Apportion State Fuel Consumption to the County Level

$F_{I-CTY} = SAF_{CTY} \times F_{ST}$

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.

$EM_R = (F_{I-CTY} \mathbf{x}\ EF_R) / 2000$

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

$EM_C = (F_{I-CTY} \mathbf{x}\ EF_C) / 2000$

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 County)</u>

Residential Distillate Oil Consumed State of Maryland = **2,768**[52] kbarrels (Thousand Barrels)

Spatial apportioning factor for Baltimore City:

$$SAF_{\text{Baltimore Co}} = \frac{HDD_{\text{Baltimore Co}} \times POP_{\text{Units Heating Baltimore Co}}{}^{53}}{\sum_{\text{ALL COUNTIES IN STATE}} (HDD_{\text{COUNTY}} \times POP_{\text{Units Heating State}})}$$

$SAF_{\text{Baltimore Co}}$ = **0.1257813**

To calculate the total annual kilo gallons of distillate oil used in city of Baltimore for residential space heating:

$Fuel_{\text{Baltimore Co}} = SAF_{\text{Baltimore City}} \times Fuel_{\text{TOTAL STATE}}$

$Fuel_{\text{Baltimore Co}}$ = **0.1257813** x 2**,768,000**

$Fuel_{\text{Baltimore Co}}$ = **348.16** kbarrels 42 gallons per barrel

$Fuel_{\text{Baltimore Co}}$ = 348.16 kbarrels x 42 Kgal per kbarrels

$Fuel_{\text{Baltimore Co}}$ = 14,622.83 Kgal

---

[52] From EIA: Adjusted Sales for Residential End Use: Distillate Fuel Oil and Kerosene, 2013 (Thousand Barrels)

[53] Population data from the U.S. Bureau of the Census, The Maryland Department of Planning

Annual Emissions Calculation

$E_{\text{Baltimore Co– Res - VOC}}$ = Fuel $_{\text{Baltimore County}}$ x EF $_{\text{VOC}}$

$E_{\text{Baltimore Co– Res - VOC}}$ = 14,622.83 Kgal x 0.713 lbs $_{\text{VOC PER}}$ Kgal

$E_{\text{Baltimore Co– Res - VOC}}$ 10,426.08 lbs $_{\text{VOC}}$ / year

$E_{\text{Baltimore Co– Res - VOC}}$ = 5.21 tons $_{\text{VOC}}$ / year

Daily Emissions Calculation

Distillate Oil for Baltimore County was found to have a

SAF = seasonal adjustment factor of 0.002765272

POS = peak ozone period of 1

Days of the Period 31 (average days in summer month)

Daily adjusted $E_{\text{Baltimore Co– Res - VOC}\mathbf{da}}$ = ($E_{\text{Baltimore Co– Res - VOC}}$ / 31)*(SAF / POS)

$E_{\text{Baltimore Co– Res - VOC}\mathbf{da}}$ = (**5.21**/ 31)*(0.002765272 / 1) = **4.65E-04 VOC tons/day**

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 2014 was obtained from 2013 U. S. Census Profile on economic characteristics and the Maryland Office of Planning. MDE estimated that no new housing units would be equipped to burn coal as a home heating fuel.

(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 2013. 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[54] 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).[55]

$$SAF_{InventoryCounty} = \frac{HDD_{InventoryCounty} * CHU_{InventoryCounty}}{\sum_{AllCountiesInState}(HDD_{County} * CHU_{County})}$$

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.

$$Residential\ Fuel_{MONTH} = Residential\ Fuel_{ANNUAL} \times \frac{HDD_{MONTH}}{HDD_{ANNUAL}}$$

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

[55] 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

Annual Emissions Calculation
Residential Coal Combustion Sample Calculation (Harford County) (tons / year)

Total Residential Coal Consumption – State of Maryland 2,000 tons (Bituminous Coal)

To calculate spatial apportioning factor for Harford County:

$$SAF_{HARFORD\ COUNTY} = \frac{HDD_{INVENTORY\ COUNTY} \times CHU_{INVENTORY\ COUNTY}}{\sum_{ALL\ COUNTIES\ IN\ STATE} (HDD_{COUNTY} \times CHU_{COUNTY})}$$

$SAF_{HARFORD\ COUNTY}$ = **0.07254565**

To calculate tons of coal used in Harford County:

$Residential\ Coal_{HARFORD\ COUNTY}$ = $SAF_{HARFORD\ COUNTY} \times Coal_{TOTAL\ STATE}$
$Residential\ Coal_{HARFORD\ COUNTY}$ = 0.07254565 x 2,000
$Residential\ Coal_{HARFORD\ COUNTY}$ = 145.09 tons

Equation:

Residential Coal SO2 Emission Calculation for Harford County

$$E_{COALR} = \frac{(EF_{COAL\ VOC} \times Coal_{HARFORD\ COUNTY})}{2000}$$

$$E_{COALR} = \frac{(10.0 \times 145.09)}{2000}$$

E_{COALR} = 0.73 $tons_{VOC}$ year

Daily Emissions Calculation
Residential Coal Combustion for Harford County was found to have a
SAF = seasonal adjustment factor of 0.002765272
POS = peak ozone period of 1
Days of the Period 31 (average days in summer month)
Daily adjusted $E_{COALR\mathbf{da}}$ = (E_{COALR} / 31)*(SAF / POS)

$E_{COALR\mathbf{da}}$ = (**0.73** / 31)*(0.002765272 / 1) = **6.47E-05 VOC tons/day**

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 9,000 tons/year of total coal was used commercially by Maryland in 2013.

(ii) Number of Dwelling Units using Coal
The number of businesses using coal for space heating for 2014 was obtained from 2013 U. S. Census Profile on economic characteristics. MDE estimated that no businesses would be equipped to burn coal for 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

Annual Emissions Calculation

Commercial Coal Combustion Sample Calculation (Allegany County) (tons / year)

Total Commercial Coal Consumption – State of Maryland 9,000 tons

To calculate spatial apportioning factor for Allegany County:

$$SAF_{\text{ALLEGANY COUNTY}} = \frac{HDD_{\text{INVENTORY COUNTY}} \times CHU_{\text{INVENTORY COUNTY}}}{\sum_{\text{ALL COUNTIES IN STATE}} (HDD_{\text{COUNTY}} \times CHU_{\text{COUNTY}})}$$

$$SAF_{\text{ALLEGANY COUNTY}} = \mathbf{0.371317}$$

To calculate tons of coal used in Allegany County:

$$\text{Commercial Coal}_{\text{ALLEGANY COUNTY}} = SAF_{\text{ALLEGANY COUNTY}} \times \text{Coal}_{\text{TOTAL STATE}}$$

$$\text{Commercial Coal}_{\text{ALLEGANY COUNTY}} = 0.371317 \times 9{,}000$$

$$\text{Commercial Coal}_{\text{ALLEGANY COUNTY}} = 3{,}341.85 \text{ tons}$$

Equation:

Commercial Coal VOC Emission Calculation for Allegany County

$$E_{COALC} = \frac{(EF_{COAL\ VOC} \times Coal_{ALLEGANY\ COUNTY})}{2000}$$

$$E_{COALC} = \frac{(0.675 \times 3{,}341.85)}{2000}$$

E_{COALC} = 1.13 tons $_{VOC}$ year

Daily Emissions Calculation
Commercial Coal Combustion for Allegany County was found to have a
SAF = seasonal adjustment factor of 0.002765272
POS = peak ozone period of 1
Days of the Period 31 (average days in summer month)
Daily adjusted $E_{COALC\mathbf{da}} = (E_{COALC} / 31)*(SAF / POS)$

$E_{COALC\mathbf{da}}$ = (**1.13** / 31)*(0.002765272 / 1) = **1.01E-04 VOC tons/day**

4.1.6.5 **Natural Gas Combustion**

SCC: 21 04 006 000 (Residential Natural Gas)
SCC: 21 03 006 000 (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 2014 was obtained from 2013 U. S. Census Profile on economic characteristics and the Maryland Office of Planning.

(ii) Residential and Commercial/Institutional Natural Gas Consumption Data

Total residential and commercial/institutional natural gas consumption data in the State of Maryland for 2014 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 2014 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.

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, 1998-2013. 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.

$$\text{Space Heat Fuel}_{\text{MONTH}} = \text{Space Heat Fuel}_{\text{ANNUAL}} \times \frac{\text{HDD}_{\text{MONTH}}}{\text{HDD}_{\text{ANNUAL}}}$$

Where:

$\text{Space Heat Fuel}_{\text{MONTH}}$ = Space heating fuel use for inventory month
$\text{Space Heat Fuel}_{\text{ANNUAL}}$ = Space heating fuel use for inventory year
$\text{HDD}_{\text{MONTH}}$ = Heating degree days for inventory month
$\text{HDD}_{\text{ANNUAL}}$ = 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 County[56] 14,597.42 M ft^3

	Total Natural Gas Delivered (M ft^3)	
	Residential	**Commercial**
State of Maryland	**88,823.81**	**83,000.00**

$$E_{NatGas} = \frac{(EF_{NatGas\text{-}voc} \times NG_{Bato.County})}{2000}$$

$$E_{NatGas} = \frac{(5.5 \times 14{,}597.42)}{2000}$$

E_{NatGas} 40.14 tons $_{VOC}$ year

The same equation and methodology can be used to estimate emission of various pollutants.

Daily Emissions Calculation
Residential Natural Gas Consumption for Baltimore County was found to have a
SAF = seasonal adjustment factor of 0.06283113
POS = peak ozone period of 1
Days of the Period 31 (average days in summer month)
Daily adjusted $E_{NatGas\mathbf{da}}$ = (E_{NatGas} / 31)*(SAF / POS)

$E_{NatGas\mathbf{da}}$ = (**40.14** / 31)*(0.06283113 / 1) = **8.14E-02 VOC tons/day**

[56] 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 2014 was obtained from 2013 U. S. Census Profile on economic characteristics and the Maryland Office of Planning.

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 2013 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 an allocation factor from local and state totals of annual heating degree days and housing units heating with liquid propane gas to spatially allocated liquid propane gas consumption. The method is documented and recommended by EIIP[57] 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).

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).[58]

$$SAF_{\text{INVENTORY COUNTY}} = \frac{HDD_{\text{INVENTORY COUNTY}} \times \text{LP-HU}_{\text{INVENTORY COUNTY}}}{\sum_{\text{ALL COUNTIES IN STATE}} (HDD_{\text{COUNTY}} \times \text{LP-HU}_{\text{COUNTY}})}$$

[57] Emissions Inventory Improvement Program (EIIP) Area Source Method Abstract – Natural Gas and LPG Combustion, dated 2011

[58] http://www.noaa.gov (home page) or http://www.ncdc.noaa.gov/ol/climate/climateproducts.html#PUBS (for a list of available data)

Where:

$SAF_{INVENTORY\ COUNTY}$ = Spatial apportioning factor for inventory county
$HDD_{INVENTORY\ COUNTY}$ = Annual heating degree days for inventory county
$LP\text{-}HU_{INVENTORY\ COUNTY}$ = Housing units using LP gas for inventory county
HDD_{COUNTY} = Annual heating degree days for each county in the state
$LP\text{-}HU_{COUNTY}$ = 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:

$$LPG_{INVENTORY\ COUNTY} = SAF_{INVENTORY\ COUNTY} \times LPG_{TOTAL\ STATE}$$

Where:

$LPG_{INVENTORY\ COUNTY}$ = Total LPG fuel consumed in the inventory county
$LPG_{TOTAL\ STATE}$ = 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.

Emissions Calculation

Emission Calculation

$$E_{LPGi} = \frac{(EF_{LPG\ p} \times LPG_{County\ i})}{2000}$$

E_{LPGi} = Yearly emissions from liquid propane gas combustion in county i
$EF_{LPG\ p}$ = Emission factor for LPG combustion for pollutant p
$LPG_{County\ i}$ = LPG consumed for space heating in county i

2014 Residential LPG Combustion Sample Calculation (Baltimore City) (tons/year)

Total Residential LPG Consumption – State of Maryland 1,761 thousand barrels (kbbl)
To calculate spatial apportioning factor for Baltimore City:

$$SAF_{BALTIMORE\ CITY} = \frac{HDD_{INVENTORY\ COUNTY} \times LP\text{-}HU_{INVENTORY\ COUNTY}}{\sum_{ALL\ COUNTIES\ IN\ STATE} (HDD_{COUNTY} \times LP\text{-}HU_{COUNTY})}$$

$$SAF_{BALTIMORE\ CITY} = \frac{4{,}419 \times 2{,}055}{324{,}050{,}721}$$

$$SAF_{BALTIMORE\ CITY} = 0.0280235$$

To calculate thousand barrels of liquefied petroleum gas (LPG) used in Baltimore City:

$$\text{Residential LPG}_{\text{BALTIMORE CITY}} = \text{SAF}_{\text{BALTIMORE CITY}} \times \text{LPG}_{\text{TOTAL STATE}}$$
$$\text{Residential LPG}_{\text{BALTIMORE CITY}} = 0.0280235 \times 1{,}761$$
$$\text{Residential LPG}_{\text{BALTIMORE CITY}} = \mathbf{49.35}\ \text{kbbl}$$

Equation:

$$E_{LPGi} = \frac{(EF_{LPG\ voc} \times LPG_{County\ i})}{2000}$$

$$E_{LPGi} = \frac{(21.91 \times \mathbf{49.35})}{2000}$$

E_{LPGi} = 0.54 tons $_{VOC}$ per year

Daily Emissions Calculation
Residential LPG Consumption for Baltimore City was found to have a
SAF = seasonal adjustment factor of 0.06283113
POS = peak ozone period of 1
Days of the Period 31 (average days in summer month)
Daily adjusted $E_{LPGi\mathbf{da}} = (E_{LPGi} / 31)*(SAF / POS)$

E_{LPGida} = (**0.54** / 31)*(0.06283113 / 1) = **1.10E-03 VOC tons/day**

4.1.6.7 **Wood Combustion**

SCC: 21 04 008 000 (Residential Wood Combustion)

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 downloaded along with the RWC TOOL at EPA's FTP site. 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.

Emissions Calculation

MDE ran EPA's RWC TOOL and accepted the emissions generated by the tool as the best estimates of Maryland's residential wood combustion at the present time.

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"[59]. 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 was collected from County Business Patterns 2011 - Maryland, NAICS: 7221, Full-Service Restaurants and 72213, Limited Service Restaurants. Year 2011 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 - 4.1.6.8-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 4.1.6.8-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[60].

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[59] Source: Adapted from PECHAN December 2003 Commercial Cooking Processes Technical Memorandum.
[60] Source: Adapted from County Business Patterns (CBP) and U.S. Census Bureau 2013 reports. Total may not be multiplier and divisional because of rounding.

Table 4.1.6.8-c gives average number of equipment pieces by restaurant type. Table 4.1.6.8-d shows average pounds of meat cooked on each type of equipment per week (lbs/week). And Table 4.1.6.8-e gives emission factors (lb/ton meat).

Table 4.1.6.8-a 2013 CBPs' Total Number of County Restaurants

County Name	NAICS Code 7221 & 72213
Allegany	55
Anne Arundel	444
Baltimore County	521
Calvert	56
Caroline	19
Carroll	114
Cecil	65
Charles	85
Dorchester	24
Frederick	173
Garrett	27
Harford	151
Howard	205
Kent	33
Montgomery	762
Prince George's	333
Queen Anne's	38
St Mary's	70
Somerset	11
Talbot	59
Washington	108
Wicomico	80
Worcester	191
Baltimore City	412

Table 4.1.6.8-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

Table 4.1.6.8-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

Note: Divide decimal numbers in Table 4.1.6.8-b by 100 to change % into fraction values.

Table 4.1.6.8-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 4.1.6.8-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 4.1.6.8-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
Under fired-charbroiler (natural gas) (ufc) Rest.	2302002200	Hamburger (25%fat)	65.4	65.4	63.8	27.44	0	7.88
		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
Deep fat fryer (natural gas) (dff) Rest.	2302003000	Shoestring potatoes	0	0	0	0	0	0.42
		Breaded chicken	0	0	0	0	0	0.24
		Breaded fish	0	0	0	0	0	0.28
Griddle (electric) (fg) Rest.	2302003100	Hamburger (24% fat)	10	10	7.6	0.76	0	0.14
		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 and Temporal Allocations

Spatial

Data for spatial allocation is the number of restaurant per county from CBPs'.

Temporal

Emissions were averaged according to period of operation to a daily estimate. See section 2.2.1.

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 4.1.6.8-a, and Table 4.1.6.8-b.
ii. Multiply county-level facility counts by the fraction (i.e. percent) of restaurants with each type of cooking equipment (Table 4.1.6.8-c).
iii. Multiply number of restaurants with each type of cooking equipment by number of pieces of equipment (Table 4.1.6.8-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 4.1.6.8-e).
vi. Finally, multiply results from v by emission factor (lb/ton meat) (Table 4.1.6.8-f) and divided emission values by 2000 by 365 for daily lbs/ton unit.

$$\overbrace{\hphantom{(N*(Frac_n/100))}}^{B_{poe}}$$

$$E_{CC} = (N*(Frac_n/100))* D_{tn} * Sum_{all} * Meat_{type} * EF_{meat\ type}/2000$$

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
$Frac_n$ = 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.

$E^{3}_{BC,cdc,FFood} = (N*(Frac_n/100)) = 521 * (47.98/100) = 250.00$

Total number of businesses in Baltimore County times % of FF restaurant by CBP
Number of fast food (FF) restaurants in Baltimore County is 250.00

Step ii.

$E^{3}_{BC,cdc,FFood}$ = 250.00*(18.6/100) = 46.5

The number of FF restaurants times % of restaurants with cdc equipment
The number of cdc restaurants in Baltimore County is 46.5

Step iii.

$E^{3}_{BC,cdc,Fast\ food}$ = 46.5 * 1.07 = 49.76

The number of cdc restaurants times average cdc pieces of equipment for that restaurant type

Step iv.

$Sum_{all,} E^{3}_{BC,cdc,Fast\ food}$ = 49.76

Total pieces of cdc equipment for fast food restaurants in Baltimore County.

Step v.

Do steps 1 thru 4 again for the following restaurants: Ethnic, Family, Seafood, and Steak and Barbecue.
The total pieces of cdc equipment for each restaurant type will be 8.73, 10.54, 0, and 0 respectively. (Plus 49.76 for fast food)

Sum_{all} = 69.02 Total number of summed of pieces of cdc equipment across restaurants
Average amount of meats cooked on cdc equipment each week
Steak 236 lbs
Hamburger 798 lbs
Poultry, with skin 147 lbs
Poultry, skinless 266 lbs
Pork 57.6 lbs
Seafood 119 lbs

Calculating PM10-PRI for Chain-Driven Charbroilers (cdc) restaurant in Baltimore County

Step vi.

$Meat_{steack}$ = 69.02 x 236 = 16,288.72 lbs
$Meat_{Hamburger}$ = 69.02 x 798 = 55,077.96 lbs
$Meat_{Poultryskin}$ = 69.02 x 147 = 10,145.94 lbs
$Meat_{Poultryskinless}$ = 69.02 x 266 = 18,359.32 lbs
$Meat_{Pork}$ = 69.02 x 57.6 = 3,975.55 lbs
$Meat_{Seafood}$ = 69.02 x 119 = 8,213.38 lbs

$E_{CCSteackCDC}$ = (16,288.72 x 14.8) / 2000 / 39 = 3.09 tons PM10-PRI

$E_{CCHamburgerCDC}$ = (55,077.96 x 14.8) / 2000 / 39 = 10.45 tons PM10-PRI

$E_{CCPoultryskin}$ = (10,145.94 x 21) / 2000 / 39 = 2.73 tons PM10-PRI

$E_{CCPoultryskinlessCDC}$ = (18,359.32 x 21) / 2000 / 39 = 4.94 tons PM10-PRI

$E_{CCPorkCDC}$ = (3,975.5 x 2) / 2000 / 39 = 1.07 tons PM10-PRI

$E_{CCSeafoodCDC}$ = (8,213.38 x 6.6) / 2000 / 39 = 0.69 tons PM10-PRI

Total Baltimore County Ecc for CDC Conveyorzed (sum all emissions)

$E_{CCBaltoCOCDC}$ = 22.98 tons PM10-PRI per year

Daily Emissions Calculation
Chain-Driven Charbroilers for Baltimore County was found to have a
SAF = seasonal adjustment factor of 0.333333333
POS = peak ozone period of 0.25
Days of the Period 365
Daily adjusted **$E_{CCBaltoCOCDCda}$** = (**$E_{CCBaltoCOCDC}$** / 365)*(SAF / POS)

$E_{CCBaltoCOCDCda}$ = (**22.98** / 365)*(0.333333333 / 0.25) = **8.40E-02 PM10-PRI tons/day**

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.

Table 4.1.7.1-a *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

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

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

$$E_{RC-SFH,\,w/o\,BM} = \frac{HS_{SFH} \text{ x } (1 - HS_{SFH,w\,BM}) \text{ x } (AD_{RC-SFH}) \text{ x } (PD_{RC-SFH}) \text{ x } EF_{RC-SFH}}{2000}$$

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

$$E_{RC-SFH,\,w\,BM} = \frac{[HS_{SFH} \text{ x } HS_{SFH,w\,BM} \text{ x } (AD_{RC-SFH}) \text{ x } (PD_{RC-SFH}) \text{ x } EF_{RC-SFH}] + [HS_{SFH} \text{ x } HS_{SFH,w\,BM} \text{ x } AHS_{RC-SFH} \text{ x } ABD_{RC-SFH} \text{ x } PDE_{RC-SFH} \text{ x } EF_{Acres\text{-}Disturb}]}{2000}$$

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[61]. 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[62]. 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

ARA 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 2013 County Business Patterns.

A conversion factor of 2.2902276 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 - 2014 constant dollars using The Bureau of Labor Statistics *Producer Price Index*[63] for Construction. The duration of construction activity for nonresidential construction is estimated to be 11 months.

Employee numbers were taken from County Business Patterns 2013 - 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 NAIC. 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.

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[61] Bureau of Census, Annual Value of Construction Put in Place - Not Seasonally Adjusted in the United States: 2013

[62] U.S. Census Bureau, County Business Patterns, NAIC Code 2362, Industry Nonresidential Building Construction 2013

[63] U.S. Census Bureau, County Business Patterns, 2013

Table 4.1.7.2-a *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
SAF was applied to emissions and were averaged according to period of operation to a daily estimate. See section 2.2.1.1

Emissions Calculation

Value of Construction Work in the U.S. - HC_J	$**347,666,000,000**
Number of Employees within NAIC 2362 in the U.S. - EMPus	562,270
Number of Employees within NAIC 2362 in Maryland	12967

$E_{HC\,i}$ = $HC_j \times (EMP_j / EMP_{us}) \times CF_{HC} \times AEF_{HC\,i} \times DC_{HC}$

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 2014
EMPus = Employment NAICS 2362 US in 2013
EMPj = Employment NAICS 2362 County j in 2013
CF_{HC} = Conversion factor (acres/million dollars) for heavy construction (2.29)
$AEF_{HC\,i}$ = Adjusted Emissions factor in tons per acre per month for pollutant i
DC_{HC} = Duration of construction activity (11 months)

<u>2014 Sample Calculation Heavy Construction (Baltimore City)</u>

Number of Employees within NAIC 2362 in Baltimore City	470

PE = precipitation-evaporation value for each State,
S = % dry silt content in soil for area being inventoried

$AEF_{HC\,PM10}$ = Initial $EF_{HC\,I} \times (24/PE) \times (S/9\%)$

$AEF_{HC\,PM10}$ = 0.19(PM $_{10)}$ x (24/114.1) x (52/9%)

$AEF_{HC\,PM10}$ = 0.2309

$E_{HC\,PM10}$ = HC_j **x** (EMPj / EMPus) x CF_{HC} **x** $EF_{HC\,i}$ **x** DC_{HC}

$E_{HC\,PM10}$ = **347,666 x** (470 / 562,270) x 2.2902276 **x** 0.2309 **x** 11

$E_{HC\,PM10}$ = 1690.54 tons/year PM_{10}

Daily Emissions Calculation
Heavy Construction for Baltimore City was found to have a
SAF = seasonal adjustment factor of 0.260459225
POS = peak ozone period of 0.25
Days of the Period 365
Daily adjusted $E_{HC\,PM10da}$ = ($E_{HC\,PM10}$ / 365)*(SAF / POS)

$E_{HC\,PM10da}$ = (**1690.54** / 365)*(0.260459225 / 0.25) = **4.83E+00 PM_{10} tons/day**

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 2013 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.

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. It is assumed that water techniques used statewide, reduce emissions by 50%.

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

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

Emissions Calculation

$$E_{RC,\,i} \quad = \quad \frac{Exp \times MC_i \times AD_i \times EF_{RC\,i} \times DUR}{2000}$$

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 United States Department of Agriculture and the National Agricultural Statistics Service. A summary of crop acreage harvested in 2014 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 harvesting 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[64]. 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 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

[64] U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, AP-42, Section 11.2.2, Fourth Edition September 1985.

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
Data for temporal allocation is not available for this source in Maryland.

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

$$E_{ALP\ i} = \frac{EF_{ALP\ i}\ \mathbf{x}\ A_I\ \mathbf{x}\ AP_I}{2000}$$

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 2014

AP_i = Acre-passes per acres for crop i

2014 Sample Calculation Agricultural Land Preparation (Baltimore County)

$$E_{ALP\ PM2.5} = \frac{EF_{ALP\ PM2.5}\ \mathbf{x}\ [(A_{wheat}\ \mathbf{x}\ AP_{wheat}) + (A_{corn\text{-}gr}\ \mathbf{x}\ AP_{corn\text{-}gr}) + (A_{hay}\ \mathbf{x}\ AP_{hay}) + (A_{soy}\ \mathbf{x}\ AP_{soy}) + (A_{barley}\ \mathbf{x}\ AP_{barley})}{2000}$$

$E_{ALP\ PM2.5}$ = (1.141968254 x [(0 x 1) + (17,700 x 4) + (0 x 1) + (14,400 x 6) + (0 x 1)) / 2000

$E_{ALPPM2.5}$ = (1.141968254 x 157,200)/2000

$E_{ALPPM2.5}$ = 89.76 tons per year of $PM_{2.5}$

Daily Emissions Calculation
Agricultural Land Preparation for Baltimore County was found to have a
SAF = seasonal adjustment factor of 0.25
POS = peak ozone period of 0.25
Days of the Period 365
Daily adjusted $E_{ALPPM2.5\mathbf{da}}$ = ($E_{ALPPM2.5}$ / 365)*(SAF / POS)

$E_{ALPPM2.5\mathbf{da}}$ = (**89.76** / 365)*(0.25 / 0.25) = **2.46E-01 $PM_{2.5}$ tons/day**

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 CALCULATED 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 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

$EF_N = [(k) \times (sL)^{0.91} \times (W)^{1.0\,2}] \times (1\text{-}P/4N)$
EF_N = A calculated emission factor for a given road type in a month having *N* days

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 EPA AP-42 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 days in a month with greater than or equal to 0.1 inch of precipitation, BUT > 0.01 inches

N = number of days in the averaging period (e.g., 365 for annual, 91 for seasonal, 30 for monthly).

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).

Table 4.1.7.5-a

Look-Up	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.
Allegany County Rural Interstate emissions example calculation:
$EF_N = [(k) \times (sL)^{0.91} \times (W)^{1.02}] \times (1\text{-}P/4N)$
$EF_N = [(0.0022) \times (0.015)^{0.91} \times (6360/2000)^{1.02}] \times (1\text{-}5/4(31))]$
EF_N = 0.000150407 lb/mile

Table 4.1.7.5-b **2014 Annual Rural Traffic VMT (millions of miles)**

FUNCTIONAL CLASS	Inter-State	Other Principal Arterial	Minor Arterial	Major Collector	Minor Collector	Local	TOTAL RURAL
ALLEGANY	167	18	25	17	15	49	**291**
ANNE ARUNDEL	104	27	145	36	26	67	**405**
BALTIMORE	288	29	76	178	35	123	**729**
CALVERT	0	23	0	24	26	10	**83**
CAROLINE	0	117	110	72	38	64	**401**
CARROLL	0	41	188	91	58	69	**447**
CECIL	218	34	109	38	40	86	**525**
CHARLES	0	114	70	72	55	55	**366**
DORCHESTER	0	92	77	31	29	43	**272**
FREDERICK	248	206	90	162	84	152	**942**
GARRETT	175	68	65	71	45	81	**505**
HARFORD	67	71	133	89	54	77	**491**
HOWARD	275	67	74	69	31	104	**620**
KENT	0	32	45	51	26	28	**182**
MONTGOMERY	74	0	72	80	30	48	**304**
PRINCE GEORGE'S	0	32	27	63	35	26	**183**
QUEEN ANNE'S	0	309	75	76	46	99	**605**
ST. MARY'S	0	174	167	86	68	92	**587**
SOMERSET	0	88	35	25	23	32	**203**
TALBOT	0	206	95	33	26	72	**432**
WASHINGTON	505	23	91	82	51	151	**903**
WICOMICO	0	146	11	47	39	44	**287**
WORCESTER	0	220	31	59	26	67	**403**
BALTIMORE CITY	0	0	0	0	0	0	**0**
GRAND TOTALS	**2121**	**2137**	**1811**	**1552**	**906**	**1639**	**10166**

Table 4.1.7.5-c **2014 Annual Urban Traffic VMT (millions of miles)**

FUNCTIONAL CLASS	Inter-state	Freeways & Express-ways	Other Principal Arterial	Minor Arterial	Collector	Local	TOTAL URBAN
ALLEGANY	158	0	176	92	37	33	**496**
ANNE ARUNDEL	1186	1618	969	792	483	358	**5406**
BALTIMORE	3612	465	1148	1260	582	502	**7569**
CALVERT	0	32	440	52	94	44	**662**
CAROLINE	0	0	0	0	0	0	**0**
CARROLL	37	0	467	136	126	54	**820**
CECIL	329	13	184	143	62	52	**783**
CHARLES	0	0	534	176	118	59	**887**
DORCHESTER	0	0	62	11	12	6	**91**
FREDERICK	802	319	301	211	288	136	**2057**
GARRETT	0	0	1	0	0	0	**1**
HARFORD	704	136	441	310	222	129	**1942**
HOWARD	1074	1065	247	448	316	224	**3374**
KENT	0	0	12	10	5	2	**29**
MONTGOMERY	2475	434	2085	1057	561	469	**7081**
PRINCE GEORGE'S	2994	1534	1826	996	713	572	**8635**
QUEEN ANNE'S	0	47	240	3	22	22	**334**
ST. MARY'S	0	9	180	52	45	20	**306**
SOMERSET	0	45	10	7	5	5	**72**
TALBOT	0	0	150	11	15	12	**188**
WASHINGTON	504	0	200	204	109	72	**1089**
WICOMICO	0	188	215	127	106	45	**681**
WORCESTER	0	26	209	42	38	22	**337**
BALTIMORE CITY	1061	136	1128	629	215	225	**3394**
GRAND TOTALS	**14936**	**6067**	**11225**	**6769**	**4174**	**3063**	**46234**

VMT should be converted into monthly totals by county by road type using seasonal fraction factors.

Ert = $\boldsymbol{EF_N}$ x *VMT* x ***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

$E_{PM10Allegany}$ = $\boldsymbol{EF_N}$ x (*VMT* x *VMTFRACwinter)* x ***TF***

$E_{PM10Allegany}$ = 0.000150407 x (167 x 0.2199*)* x ***1***

$E_{PM10Allegany}$ = 0.9408 tons per winter of PM_{10} Inter-State Rural traffic emissions

The previous calculations must now be repeated for each of 12 months using seasonal *VMTFRAC* for 13 different road types in Allegany and then summed to obtain the total emission for the county. The same process must be repeated for all counties to get a state total.

Daily Emissions Calculation

Paved Road for each Maryland County was found to have a

SAF = seasonal adjustment factor of 0.28

POS = peak ozone period of 0.25
Days of the Period 365

Daily adjusted $\mathbf{E}_{\boldsymbol{PM10\text{-}PRIannual\ ad}}$ = ($E_{PM10\text{-}PRIannual}$ / 365)*(SAF / POS)
You can total emissions for a given county and apply the daily parameters in the adjusted emissions equation above to obtain its daily emissions. The same method is used to calculate $PM_{2.5}$.

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

Same method used in 2011 was used in 2014 to calculate unpaved road emissions. The following examples were used in 2011. 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 4.1.7.6-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 4.1.7.6-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 4.1.7.6-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 4.1.7.6-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[1]:

$$EF = \frac{\left[k * \left(s/12\right)^a * \left(SPD/30\right)^b\right]}{\left(M/0.5\right)^c} - C$$

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 4.1.7.6-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
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[2]. 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

[1] 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.

[2] G. Stensland, Illinois State Water Survey, personal communication with W. Barnard of E.H. PECHAN & Associates, Inc., Durham, NC. 1989.

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 4.1.7.6-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 4.1.7.6-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.

Table 4.1.7.6-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[3]. 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 4.1.7.6-h. 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 4.1.7.6-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

[3] 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

State	County	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
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.

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 [4] temporal allocation factors. SAF was applied to emissions and were averaged according to period of operation to a daily estimate. See section 2.2.1.1

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)

[4] 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.

Calculate Local Unpaved Roads Emission Factors
Example: Anne Arundel County - Local Rural Unpaved Roads – PM_{25}

$$EF_{PM25} = \frac{\left[k * \left(s/12\right)^{a} * \left(SPD/30\right)^{b}\right]}{\left(M/0.5\right)^{c}} - C$$

$$EF_{PM25} = \frac{\left[0.27 * \left(3.9/12\right)^{1} * \left(30/30\right)^{0.5}\right]}{\left(0.5/0.5\right)^{0.2}} - 0.00036$$

$$EF_{PM25} = 0.08739$$

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})

$$EF_{PM25-CORR} = EF_{PM25} * \left[\frac{(D-p)}{D}\right]$$

$$EF_{PM25-CORR} = 0.08739 * \left[\frac{(31-8)}{31}\right]$$

$$EF_{PM25-CORR} = 0.064838$$

Emission Equation:

$$EM_{PM25} = \frac{EF_{PM25-CORR} * VMT * VMTFRAC}{2000} * \left[1 - \left(CE * RE * RP\right)\right]$$

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

Sample Calculation Unpaved Roads (Anne Arundel County - July)

$$EM_{PM25} = \frac{EF_{PM25-CORR} * VMT * VMTFRAC}{2000} * [1 - (CE * RE * RP)]$$

$$EM_{PM25} = \frac{0.0648377 * 0.0001533 * 0.09586}{2000} * [1 - (0 * 100 * 100)]$$

***EM** $_{PM25}$* **= 4.764E-10 tons PM_{25} for July in Ann Arundel County Rural traffic emissions**

Daily Emissions Calculation
Paved Road for each Maryland County was found to have a
SAF = seasonal adjustment factor of 0.28
POS = peak ozone period of 0.25
Days of the Period 365

Daily adjusted $\mathbf{E}_{\boldsymbol{PM25annual\ ad}}$ = ($E_{PM25annual}$ / 365)*(SAF / POS)
You can total emissions for a given county and apply the daily parameters in the adjusted emissions equation above to obtain its daily emissions.

4.1.8 **FIRE SOURCES**

Some fires are produced from sources such as forest fires, slash and prescribed burning, agricultural burning, structure fires, and vehicle fires.

EPA has developed new tools by which they use to estimate fire emissions for each state from a verity of sources. Using data collected from national fire database and activity on fire incidents and events around the county; with climate data and grid mapping EPA has estimated emissions for counties in each state. The emissions data are posted as csv files for every state on their FTP site. The methods used by EPA reflect use of the SMARTFIRE2 (SF2) framework. For the 2014 PEI MDE reviewed the data and estimations by EPA and decided to accept and use EPA's emissions:

Wild Fires / Forest Fires -- SCC: 2810001000
Prescribed Burns -- SCC: 2810015000
Slash Burns -- SCC: 2810005000

4.1.8.1 **Vehicle Fires**

SCC: 28 10 050 000

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)[5]. 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)[6]. 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, we used EIIP Vehicle Fires – January 1999 and 2000 guidance.

Pollutant	Lbs/ton burned
VOC	32
NOx	4
CO	125
PM10-PRI	100
PM2.5-PRI	100

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

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[5] 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

[6] CARB 1995. Emission Inventory Procedural Manual, Vol. III: Methods for Assessing Area Source Emissions. California Environmental Protection Agency: Air Resources Board.

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

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

Emissions Calculation

$$E_{VF,\,i} = \frac{VB_j \mathbf{\ x\ } FLF_{VF} \mathbf{\ x\ } EF_{VF\ i}}{2000}$$

where:

$E_{VF,i}$	=	Emissions of pollutant i in tons per year from vehicle fires
VB_J	=	Vehicles burned in county j in 2014
FLF_{VF}	=	Fuel loading factor 0.25 tons/vehicle burned
$EF_{VF\ i}$	=	Emissions factor in pounds per ton burned for pollutant i

<u>2014 Example Calculation Vehicle Fires (Anne Arundel County)</u>

$$E_{VF,\,Ann} \quad \frac{VB_j \mathbf{\ x\ } FLF_{VF} \mathbf{\ x\ } EF_{VOC}}{2000}$$

$$E_{VF,\,Ann} \quad \frac{(227 \mathbf{\ x\ } (0.25) \mathbf{\ x\ } 32)}{2000}$$

$E_{VF,\,Ann}$ 0.91 tons VOC per year emitted from vehicle fires in Anne Arundel County in 2014

Daily Emissions Calculation
Vehicle Fires for Anne Arundel County was found to have a
SAF = seasonal adjustment factor of 0.25
POS = peak ozone period of 0.25
Days of the Period 365
Daily adjusted $E_{VF,\,Ann\mathbf{da}}$ = ($E_{VF,\,Ann}$ / 365)*(SAF / POS)

$E_{VF,\,Annda}$ = (**0.91** / 365)*(0.25 / 0.25) = **2.49E-03 VOC tons/day**

4.1.8.2 **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 2014 did not require information distinguishing the amount of agricultural waste to be burned versus other materials.

4.1.8.3 **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[7], Structure Fires, dated July 1999.

Activity

The Maryland State Fire Marshal's office provided the number of structure fires by county.

4.1.8.3-a ***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		

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

[7] Emission Inventory Improvement Program

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

Because structure fires occur at different times of the year, ARA used no seasonal adjustment factor. The activity level is seven days per week.

Emissions Calculation

$$E_{SF\ i} = \frac{SF_k \mathbf{\ x\ } EF_{SF\ i} \mathbf{\ x\ } FLF_{SF}}{2000}$$

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 2014

$EF_{SF,i}$ = Emission factor for pollutant i in pounds per ton

ARA used an activity level of 7 days a week with no seasonal variation as given in Table 5.8-1 in the EIIP document.

2014 Example Calculation Structure Fires (Baltimore County)

Equation:

$$E_{SF\ BCo} = \frac{SF_k \mathbf{\ x\ } EF_{SF\ i} \mathbf{\ x\ } FLF_{SF}}{2000}$$

$$E_{SF\ BCo} = \frac{286 \mathbf{\ x\ } 11 \mathbf{\ x\ } 1.15}{2000}$$

$$\mathbf{E_{SF\ BCo} = 1.81\ tons_{VOC}\ /\ year}$$

Daily Emissions Calculation

Structure Fires for Baltimore County was found to have a

SAF = seasonal adjustment factor of 0.2

POS = peak ozone period of 0.25

Days of the Period 365

Daily adjusted $E_{SF\ BCo\mathbf{da}} = (E_{SF\ BCo} / 365)*(SAF / POS)$

$E_{SF\ BCo\mathbf{da}}$ = (**1.81** / 365)*(0.2 / 0.25) = **3.96E-03 VOC tons/day**

4.1.8.4 **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 uses the Carnegie Mellon University Ammonia Model (CMU-Ammonia Model version 3.6) [8] computer program to develop an ammonia emissions inventory. However, for the 2014 NEI emissions inventory cycle, MDE has accepted EPA's 2014 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 **Ammonia SOURCE EMISSION CATEGORIES**

4.1.9.4 **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, 2012), 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. 2014 activity data were used from the USDA Census of Agriculture data to develop the 2014 ammonia emission inventory.

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[8] 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

4.1.9.5 Beef and Dairy cattle (cows)

SCC: 2805002000 (Beef Cattle)
2805018000 (Dairy Cows)

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, 2014 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). Emissions were averaged according to period of operation to a daily estimate. See section 2.2.1.1

Emissions Calculation

Equation:

2014 TPY ammonia emissions for cows in an individual county

$$EM_{COWS\text{-}2014\ Total} = 2014EM_{BC} + 2014\ EM_{MC} + 2014\ EM_{HF} + 2014\ EM_{ST}$$

Where:

$EM_{COWS\text{-}2014\ Total}$ = Total NH3 emissions from cows, all categories

EM_{BC} = 2014 Uncontrolled emissions from beef cows

EM_{DC} = 2014 Uncontrolled emissions from dairy cows

Where:

$EM_{BC} = AC_{BC} * EF_{BC}$

$EM_{DC} = AC_{BC} * EF_{DC}$

Where:

AC_{BC} = Activity level (number) of beef cows

AC_{DC} = Activity level (number) of dairy cows

EF_{BC} = Emission factor for beef cows

EF_{DC} = Emission factor for dairy cows

4.1.9.6 **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, 2014 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). Emissions were averaged according to period of operation to a daily estimate. See section 2.2.1.1

Emissions Calculation

Equation:

2014 TPY ammonia emissions for swine in an individual county

$$EM_{SWINE\text{-}2014\ Total} = 2014\ EM_{HOGS} + 2014\ EM_{PIGS}$$

Where:

$EM_{SWINE\text{-}2014\ Total}$ = Total NH3 emissions from swine, all categories

EM_{HOGS} = 2014Uncontrolled emissions from hogs

EM_{PIGS} = 2014 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

4.1.9.7 Chickens (Layers and Broilers)

SCC: 28 05 007 100 (Chickens Layers)
28 05 030 004 (Broilers, 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, 2014 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). Emissions were averaged according to period of operation to a daily estimate. See section 2.2.1.1

Emissions Calculation

Equation:

2014 TPY ammonia emissions for chickens in an individual county

$$EM_{CHICKENS\text{-}2014\ Total} = 2014\ EM_{LAYER} + 2014\ EM_{BROILER}$$

Where:

$EM_{CHICKENS\text{-}2014\ Total}$ = Total NH3 emissions from chickens, all categories

EM_{LAYER} = 2014 Uncontrolled emissions from layers

$EM_{BROILER}$ = 2014 Uncontrolled emissions from broilers

Where:

$EM_{LAYER} = AC_{LAYER} * EF_{LAYER}$

$EM_{BROILER} = AC_{BROILER} * EF_{BROILER}$

Where:

AC_{LAYER} = Activity level (number) of layer chickens

$AC_{BROILER}$ = Activity level (number) of broiler chickens

EF_{LAYER} = Emission factor for layer chickens

$EF_{BROILER}$ = Emission factor for broiler chickens

4.1.9.8 **Agricultural Fertilizer Application**

SCC: 28 01 700 099 (Miscellaneous Fertilizers)

Description:

The following description comes directly from the EPA's agricultural fertilizer application documentation.

"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 approach to estimate 2014 fertilizer emissions consists of these general steps:

- Run the Fertilizer Emissions Scenario Tool for CMAQ (FEST-C[1]) and CMAQ[2] model with bidirectional ("bidi") NH_3 exchange to produce year 2011 nitrate (NO_3) Ammonium (NH_4, including Urea), and organic (manure) nitrogen fertilizer estimates and gaseous ammonia NH_3 emission estimates respectively.
- Run the Environmental Policy Integrated Climate (EPIC[3]) modeling system to produce year 2014 NO_3, Ammonium (including Urea), and organic (manure) nitrogen fertilizer estimates.
- Compute year 2011 emission factors from the FEST-C outputs to use in estimating year 2014 NH_3 emissions.
- All emissions are assigned to one SCC: "…Miscellaneous Fertilizers" (2801700099).

FEST-C reads land use data from the Biogenic Emissions Landuse Dataset (BELD) version 4, meteorological variables from the Weather Research and Forecasting (WRF[4]) model, and nitrogen deposition data from a previous or historical average CMAQ simulation. FEST-C model outputs are discussed in greater detail in the "NH3_Fert_Fact_Sheet_v2.docx" included in the zip file "*2014_Fertilizer_Application_v1.0_22apr2016.zip*" available at:

ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint/ "[9]

Pollutants

NH_3

Emission Factors

The emission factors were derived from the 2011 FEST-C outputs. Total fertilizer emission factors for each month and county were computed by taking the ratio of total fertilizer NH_3 emissions (short tons) to total nitrogen fertilizer application (short tons).

[9] EPA's Agricultural Fertilizer Application Documentation located at ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint/

Sample Calculations

EPA’s modeling system is too large and many spreadsheets would be needed to show chemical make and transport modeling, making it very difficult to show a sample calculation.

5.0 NONROAD SOURCES

5.1 INTRODUCTION NONROAD VEHICLES/ENGINES

This section contains the nonroad source emission inventory for volatile organic compounds (VOCs), nitrogen oxides (NO_x), carbon monoxide (CO), sulfur oxides (SO_X), particulate matter (PM2.5 and PM10), ammonia (NH_3), 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
- Logging equipment
- Recreational marine equipment
- Light commercial equipment
- Industrial equipment
- Construction and Mining equipment
- Agricultural or farm equipment
- Recreational land vehicles or equipment
- Railroads
- Commercial aviation
- Air taxis
- General aviation
- Military aviation
- Commercial marine vessels

The Department used the most current version of EPA's NONROAD2008a model, which is incorporated into MOVES2014a Model to develop the inventory for nonroad mobile sources. The NONROAD2008a 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 allowed the use of the NONROAD Model and associated default inputs in the development of inventories supporting State Implementation Plans (SIPs).

5.2 NONROAD MODEL

NONROAD2008a supersedes all previous versions of NONROAD models. It calculates past, present, and future emission inventories in tons of pollutant for all nonroad equipment categories. It does not calculate commercial marine, aircraft, or rail locomotive emissions. The model estimates exhaust and evaporative hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NOx), particulate matter (PM), sulfur dioxide (SO2), and carbon dioxide (CO2). The user may select a specific geographic area like the nation, a state, or county and time period like annual, monthly, seasonal, or daily for which to generate emissions.

The 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 growth estimates, and geographic and temporal allocation. Default values are provided for all input files. The user can 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 input files are also modifiable to test control strategies.

The NONROAD model consists of three separate components: a graphical user interface written in Visual Basic, the core model written in FORTRAN, and a reporting utility written in Microsoft ACCESS. The install utility supplied with the model easily installs all three components of the model onto a personal computer.

The primary purpose of the user interface is to provide the user with an easy method to specify the options for a model run. With simple Windows-type screens and pull-down menus, the user can quickly set up, execute, and view a modeling scenario. Once the model options are specified, the user can then run the FORTRAN core model from within the interface, and then can move directly to the reporting utility to view and summarize the modeling results.

The core model of NONROAD, written in FORTRAN, contains all of the algorithms used by the model for calculating emissions estimates. The core model can be operated as a stand-alone application; however, as a stand-alone application it requires some basic knowledge of the DOS operating system. Also, note that while the user interface runs the core model for one specified set of conditions, it cannot run multiple runs in batch mode. Multiple runs can be performed by creating and running a batch file in DOS or in a DOS window environment.

The reporting utility, written using Microsoft's ACCESS database software, is used to create standardized reports using output data generated in the core model. Like the graphical user interface, the reporting utility is a fully operational Windows program, with pull-down menus, designed as a separate module in order to take advantage of the many reporting and formatting options available when using a database application. Although the reporting utility is written in ACCESS, it is a stand-alone application, and you do not need to know how to use ACCESS to generate reports.

The NONROAD model estimates emissions for six exhaust pollutants: hydrocarbons (HC), NOx, carbon monoxide (CO), carbon dioxide (CO_2), sulfur oxides (SO_X), and PM. The user selects among five different types for reporting HC — as total hydrocarbons (THC), total organic gases (TOG), non-methane organic gases (NMOG), non-methane hydrocarbons (NMHC), or volatile organic compounds (VOC). Particulate matter can be reported as PM of 10 microns or less (PM_{10}) or PM of 2.5 microns or less ($PM_{2.5}$). The model also estimates emissions of non-exhaust HC for four modes — diurnal, refueling spillage, vapor displacement, and crankcase emissions. All emissions are reported as short tons (i.e., 2000 lbs).

5.2.1 **Emission Calculation Methodologies**

The NONROAD2008a model estimates the amount of pollution emitted by a particular type of equipment during a unit of use. Emission factors activity data are stored in the model defaulted National County Data (NCD) county database input files. Adjustments are defaulted automatically made within the model based on the age of equipment and controls applied for given time frames and inventory year. Emission changes with the age of the engine, often called 'deterioration', are also applied by the model.

NONROAD2008a model estimates the 2014 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 2014 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.

The MOVES2014a Model incorporates the latest version of the NONROAD2008 model to calculate nonroad emissions. The model produces county-level mobile source emissions inventories from a National County Database (NCD), which includes onroad and nonroad data for each state. The NCD uses these nonroad inputs in the model to estimate and process county-level outputs on an annual, monthly, or daily basis in a single model run. The MOVES2014a model automatically applies controls, when applicable, for a given year.

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 NONROAD2008 model software was ran for all twelve months in 2014 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 2014 were added together to develop annual emissions. Model inputs (temperature, fuel, and other parameters) used in this analysis were included in the NCD county database. The NONROAD2008 model is intended for Windows 98 and later. Its primary use is for estimation of air pollution inventories by professional mobile source modelers, such as state air quality officials and consultants. NONROAD2008 updates NONROAD2005 to include new nonroad emission standards promulgated in 2008 related to small gasoline engines and pleasure craft.

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:

(2-Stroke) 2260004***	(4-Stroke) 2265004***		(LPG) 2267004***	(Diesel) 2270004***
2260004015	2265004010	2265004041	2267004066	2270 004000
2260004016	2265004011	2265004046		
2260004020	2265004015	2265004051		
2260004021	2265004016	2265004055		
2260004025	2265004025	2265004056		
2260004026	2265004026	2265004066		
2260004030	2265004030	2265004071		
2260004031	2265004031	2265004075		
2260004035	2265004035	2265004076		
2260004036	2265004036			
2260004071	2265004040			

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

- EPA NONROAD2008a Emissions Model contains an overview of the model, equipment types, pollutants reported, geographic and temporal coverage, the model components, model inputs, and output options. The EPA's NONROAD2005 (202 pp, 1.6MB, EPA420-R-05-013) user guide documents how to install and run the model and the associated reporting utilities. Websites: NONROAD2005 User's Guide (PDF) (202 pp, 1.6MB, EPA420-R-05-013) and NONROAD2008a: https://www.epa.gov/moves/nonroad-model-nonroad-engines-equipment-and-vehicles.

- MOVES2014a Website: https://www.epa.gov/moves/moves2014a-latest-version-motor-vehicle-emission-simulator-moves.

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran the NONROAD2008a model to determine the emission estimate for 2014. MDE-ARA 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 NONROAD2008a model automatically applies controls, when applicable, for a given year.

Spatial and Temporal Allocations

Spatial

The NONROAD2008a 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 NONROAD2008a 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 NONROAD2008a 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 NONROAD2008a's data input files. NONROAD2008a 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

- EPA NONROAD2008a Emissions Model contains an overview of the model, equipment types, pollutants reported, geographic and temporal coverage, the model components, model inputs, and output options. The EPA's NONROAD2005 (202 pp, 1.6MB, EPA420-R-05-013) user guide documents how to install and run the model and the associated reporting utilities. Websites: NONROAD2005 User's Guide (PDF) (202 pp, 1.6MB, EPA420-R-05-013) and NONROAD2008a: https://www.epa.gov/moves/nonroad-model-nonroad-engines-equipment-and-vehicles.

- MOVES2014a Website: https://www.epa.gov/moves/moves2014a-latest-version-motor-vehicle-emission-simulator-moves.

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran NONROAD2008a model to determine the emission estimates for 2014. MDE-ARA opted to choose monthly seasonal (annual and summer) period totals as the output files from the model.

Ground Support Equipment (GSE) emissions were estimated using NONROAD2008a nonroad modeling for all airports except for very large and military airports that were calculated using the EPA EDMS.[1]

[1] Emissions & Dispersion Modeling System (EDMS) Version 4.12 for Windows from CSSI, Inc

Point Source Adjustments

No subtraction of emissions from point sources is necessary.

Adjustments for Controls

The NONROAD2008a 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 NONROAD2008a 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 NONROAD2008a 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 MOVES2014a model estimates the amount of pollution emitted by a particular type of equipment during a unit of use. Emission factors activity data are stored in MOVES2014a's data input files. Adjustments are made within the model based on the age of equipment and controls applied for given time frames. Emission changes with the age of the engine, often called 'deterioration', are also applied by the model.

[86] Emissions & Dispersion Modeling System (EDMS) Version 5.1 for Windows from CSSI, Inc

5.3.3 Recreational Land Vehicles

SCC:

2260001010	2-Stroke	motorcycles
2260001020	2-Stroke	snowblowers
2260001030	2-Stroke	ATVs
2260001060	2-Stroke	Specialty vehicles - carts
2265001010	4-Stroke	motorcycles
2265001030	4-Stroke	ATVs
2265001050	4-Stroke	golf carts
2265001060	4-Stroke	Specialty vehicles - carts
2267001060	LPG	Specialty vehicles - carts

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

- EPA NONROAD2008a Emissions Model contains an overview of the model, equipment types, pollutants reported, geographic and temporal coverage, the model components, model inputs, and output options. The EPA's NONROAD2005 (202 pp, 1.6MB, EPA420-R-05-013) user guide documents how to install and run the model and the associated reporting utilities. Websites: NONROAD2005 User's Guide (PDF) (202 pp, 1.6MB, EPA420-R-05-013) and NONROAD2008a: https://www.epa.gov/moves/nonroad-model-nonroad-engines-equipment-and-vehicles.

- MOVES2014a Website: https://www.epa.gov/moves/moves2014a-latest-version-motor-vehicle-emission-simulator-moves.

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran NONROAD2008a model to determine the emission estimates for 2014. MDE-ARA 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 NONROAD2008a model automatically applies controls, when applicable, for a given year.

Spatial and Temporal Allocations

Spatial

The NONROAD2008a 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 NONROAD2008a model allocates activity and emissions. The emissions for the month of July was chosen and then divided by 31 (days) to get an average day for that month.

Emissions Calculation

The NONROAD2008a 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 NONROAD2008a's data input files. NONROAD2008a 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:

2282005010	2-Stroke	Outboard
2282005015	2-Stroke	Personal Water Craft
2282010005	4-Stroke	Inboard/Sterndrive

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

- EPA NONROAD2008a Emissions Model contains an overview of the model, equipment types, pollutants reported, geographic and temporal coverage, the model components, model inputs, and output options. The EPA's NONROAD2005 (202 pp, 1.6MB, EPA420-R-05-013) user guide documents how to install and run the model and the associated reporting utilities. Websites: NONROAD2005 User's Guide (PDF) (202 pp, 1.6MB, EPA420-R-05-013) and NONROAD2008a: https://www.epa.gov/moves/nonroad-model-nonroad-engines-equipment-and-vehicles.

- MOVES2014a Website: https://www.epa.gov/moves/moves2014a-latest-version-motor-vehicle-emission-simulator-moves.

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran NONROAD2008a model to determine the emission estimates for 2014. MDE-ARA 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 NONROAD2008a model automatically applies controls, when applicable, for a given year.

Spatial and Temporal Allocations

Spatial

The NONROAD2008a 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 NONROAD2008a model allocates activity and emissions. The emissions for the month of July was chosen and then divided by 31 (days) to get an average day for that month.

Emissions Calculation

The NONROAD2008a 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 NONROAD2008a's data input files. NONROAD2008a 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:

2260006005	2-Stroke	generator set
2260006010	2-Stroke	pump
2260006015	2-Stroke	air compressors
2260006035	2-Stroke	hydro-power units
2265006005	4-Stroke	generator set
2265006010	4-Stroke	pump
2265006015	4-Stroke	air compressors
2265006025	4-Stroke	welders
2265006030	4-Stroke	pressure washers
2265006035	4-Stroke	hydro-power units
2267006005	LPG	generator set
2267006010	LPG	pump
2267006015	LPG	air compressors
2267006025	LPG	welders
2267006030	LPG	pressure washers
2267006035	LPG	hydro-power units
2268006005	CNG	generator set
2268006010	CNG	pump
2268006015	CNG	air compressors
2268006020	CNG	gas compressors

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

- EPA NONROAD2008a Emissions Model contains an overview of the model, equipment types, pollutants reported, geographic and temporal coverage, the model components, model inputs, and output options. The EPA's NONROAD2005 (202 pp, 1.6MB, EPA420-

R-05-013) user guide documents how to install and run the model and the associated reporting utilities. Websites: NONROAD2005 User's Guide (PDF) (202 pp, 1.6MB, EPA420-R-05-013) and NONROAD2008a: https://www.epa.gov/moves/nonroad-model-nonroad-engines-equipment-and-vehicles.

- MOVES2014a Website: https://www.epa.gov/moves/moves2014a-latest-version-motor-vehicle-emission-simulator-moves.

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran NONROAD2008a model to determine the emission estimates for 2014. MDE-ARA 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 NONROAD2008a model automatically applies controls, when applicable, for a given year.

Spatial and Temporal Allocations

Spatial

The NONROAD2008a 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 NONROAD2008a model allocates activity and emissions. The emissions for the month of July was chosen and then divided by 31 (days) to get an average day for that month.

Emissions Calculation

The NONROAD2008a 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 NONROAD2008a's data input files. NONROAD2008a 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:

2260003030	2-Stroke	sweepers/scrubbers
2260003040	2-Stroke	other general industrial equipment
2265003010	4-Stroke	aerial Lifts
2265003020	4-Stroke	forklifts
2265003030	4-Stroke	sweepers/scrubbers
2265003040	4-Stroke	other general industrial equipment
2265003050	4-Stroke	other material handling equipment
2265003060	4-Stroke	ac\refrigeration
2265003070	4-Stroke	terminal tractors
2265010010	4-Stroke	other oil field equipment
2267003010	LPG	aerial Lifts
2267003020	LPG	forklifts
2267003030	LPG	sweepers/scrubbers
2267003040	LPG	other general industrial equipment
2267003050	LPG	other material handling equipment
2267003070	LPG	terminal tractors

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. 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

- EPA NONROAD2008a Emissions Model contains an overview of the model, equipment types, pollutants reported, geographic and temporal coverage, the model components, model inputs, and output options. The EPA's NONROAD2005 (202 pp, 1.6MB, EPA420-R-05-013) user guide documents how to install and run the model and the associated reporting utilities. Websites: NONROAD2005 User's Guide (PDF) (202 pp, 1.6MB, EPA420-R-05-013) and NONROAD2008a: https://www.epa.gov/moves/nonroad-model-nonroad-engines-equipment-and-vehicles.

- MOVES2014a Website: https://www.epa.gov/moves/moves2014a-latest-version-motor-vehicle-emission-simulator-moves.

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran NONROAD2008a model to determine the emission estimates for 2014. MDE-ARA 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 NONROAD2008a model automatically applies controls, when applicable, for a given year.

Spatial and Temporal Allocations

Spatial

The NONROAD2008a 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 NONROAD2008a model allocates activity and emissions. The emissions for the month of July was chosen and then divided by 31 (days) to get an average day for that month.

Emissions Calculation

The NONROAD2008a 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 NONROAD2008a's data input files. NONROAD2008a 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 and mining Equipment

SCC:

2260002006	2265002021	2265002060	2267002033
2260002009	2265002024	2265002066	2267002039
2260002021	2265002027	2265002072	2267002045
2260002027	2265002030	2265002078	2267002054
2260002039	2265002033	2265002081	2267002057
2260002054	2265002039	2267002003	2267002060
2265002003	2265002042	2267002015	2267002066
2265002006	2265002045	2267002021	2267002072
2265002009	2265002054	2267002024	2267002081
2265002015	2265002057	2267002030	2268002081

2-Stroke, 4-Stroke, CNG, and LPG equipment

Description

Construction and mining equipment includes a variety of types and sizes of machinery used in the construction of roadways, buildings, digging, and tunneling. 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

- EPA NONROAD2008a Emissions Model contains an overview of the model, equipment types, pollutants reported, geographic and temporal coverage, the model components, model inputs, and output options. The EPA's NONROAD2005 (202 pp, 1.6MB, EPA420-R-05-013) user guide documents how to install and run the model and the associated reporting utilities. Websites: NONROAD2005 User's Guide (PDF) (202 pp, 1.6MB, EPA420-R-05-013) and NONROAD2008a: https://www.epa.gov/moves/nonroad-model-nonroad-engines-equipment-and-vehicles.

- MOVES2014a Website: https://www.epa.gov/moves/moves2014a-latest-version-motor-vehicle-emission-simulator-moves.

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran NONROAD2008a model to determine the emission estimates for 2014. MDE-ARA 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 NONROAD2008a model automatically applies controls, when applicable, for a given year.

Spatial and Temporal Allocations

Spatial

The NONROAD2008a 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 NONROAD2008a model allocates activity and emissions. The emissions for the month of July was chosen and then divided by 31 (days) to get an average day for that month.

Emissions Calculation

The NONROAD2008a 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 NONROAD2008a's data input files. NONROAD2008a 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

- EPA NONROAD2008a Emissions Model contains an overview of the model, equipment types, pollutants reported, geographic and temporal coverage, the model components, model inputs, and output options. The EPA's NONROAD2005 (202 pp, 1.6MB, EPA420-R-05-013) user guide documents how to install and run the model and the associated reporting utilities. Websites: NONROAD2005 User's Guide (PDF) (202 pp, 1.6MB, EPA420-R-05-013) and NONROAD2008a: https://www.epa.gov/moves/nonroad-model-nonroad-engines-equipment-and-vehicles.

- MOVES2014a Website: https://www.epa.gov/moves/moves2014a-latest-version-motor-vehicle-emission-simulator-moves.

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran NONROAD2008a model to determine the emission estimates for 2014. MDE-ARA 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 NONROAD2008a model automatically applies controls, when applicable, for a given year.

Spatial and Temporal Allocations

Spatial

The NONROAD2008a 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 NONROAD2008a model allocates activity and emissions. The emissions for the month of July was chosen and then divided by 31 (days) to get an average day for that month.

Emissions Calculation

The NONROAD2008a 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 NONROAD2008a's data input files. NONROAD2008a 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

- EPA NONROAD2008a Emissions Model contains an overview of the model, equipment types, pollutants reported, geographic and temporal coverage, the model components, model inputs, and output options. The EPA's NONROAD2005 (202 pp, 1.6MB, EPA420-R-05-013) user guide documents how to install and run the model and the associated reporting utilities. Websites: NONROAD2005 User's Guide (PDF) (202 pp, 1.6MB, EPA420-R-05-013) and NONROAD2008a: https://www.epa.gov/moves/nonroad-model-nonroad-engines-equipment-and-vehicles.

- MOVES2014a Website: https://www.epa.gov/moves/moves2014a-latest-version-motor-vehicle-emission-simulator-moves.

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran NONROAD2008a model to determine the emission estimates for 2014. MDE-ARA 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 NONROAD2008a model automatically applies controls, when applicable, for a given year.

Spatial and Temporal Allocations

Spatial

The NONROAD2008a 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 NONROAD2008a model allocates activity and emissions. The emissions for the month of July was chosen and then divided by 31 (days) to get an average day for that month.

Emissions Calculation

The NONROAD2008a 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 NONROAD2008a's data input files. NONROAD2008a 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.

5.3.10 **Railway Maintenance**

SCC: 22 85 002 015 (4-Stroke) Gasoline
22 85 004 015 (Diesel)
22 85 006 015 (LPG)

Description

Railway maintenance equipment is equipment specifically used for repair, maintenance, and construction of rail lines. Examples of some rail equipment are ballast handlers, rail and tie handlers, and rail straightening equipment.

Pollutants

$PM_{2.5}$ -PRI, SOx, NOx, CO, NH3, and HAPs

Method and Data Sources

Data sources

- EPA NONROAD2008a Emissions Model contains an overview of the model, equipment types, pollutants reported, geographic and temporal coverage, the model components, model inputs, and output options. The EPA's NONROAD2005 (202 pp, 1.6MB, EPA420-R-05-013) user guide documents how to install and run the model and the associated reporting utilities. Websites: NONROAD2005 User's Guide (PDF) (202 pp, 1.6MB, EPA420-R-05-013) and NONROAD2008a: https://www.epa.gov/moves/nonroad-model-nonroad-engines-equipment-and-vehicles.

- MOVES2014a Website: https://www.epa.gov/moves/moves2014a-latest-version-motor-vehicle-emission-simulator-moves.

Methods sources

Based upon EPA's requirements for determining nonroad emissions, the Department ran NONROAD2008a model to determine the emission estimates for 2014. MDE-ARA 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 NONROAD2008a model automatically applies controls, when applicable, for a given year.

Spatial and Temporal Allocations

Spatial

The NONROAD2008a 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 NONROAD2008a model allocates activity and emissions. The emissions for the month of July was chosen and then divided by 31 (days) to get an average day for that month.

Emissions Calculation

The NONROAD2008a 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 NONROAD2008a's data input files. NONROAD2008a 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 –

1. 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 railroad: 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. Class III railroad: 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: 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: called **suburban rail**, transport passengers, but only between a city and outer suburbs or nearby 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 eleven railroad companies operated in Maryland and were asked to provide the amount of fuel used in 2014, 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 **- Only Yard Railroad**
3. CSX Transportation, Incorporated	Class I – Plus Yard Railroad
4. Bay Coast Railroad	Class II Railroad
5. Maryland & Delaware Railroad Company	Yard Railroad in MD
6. Maryland Midland Railway, Incorporated	Class II
7. Norfolk and Southern Railway Company	Class I – Plus Yard Railroad
8. Western Maryland Scenic Railroad	Passenger Railroad
9. Winchester and Western Railroad Company	Class III Railroad
10. MARC	Commuter Railroad
11. Walkersville Southern Railroad	Passenger Railroad

Class 1 railroads CSX and Norfolk operating statistics contained in R-1 reports were 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 US EPA's and OTAC's Emissions Factors for Locomotives, Technical Highlights document, EPA-420-F-09-025 April 2009. The factors were in grams per gallon, but were converted to pounds per gallon for easier conversion of pollutant totals to tons later.

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

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:

Allegany County Passenger Rail Emissions (only part of emissions table)

Line Haul Emission Estimate

AMTRAK and Western Maryland Scenic Railroad operated line haul locomotives in the county.

Amount of fuel used in gallons provided by railroads:

$G_{ctyAMTRAK}$ = 20,075 gallons used in Allegany Co. per year by AMTRAK

$G_{ctyWMDSENIC}$ = 10,555 gallons used in Allegany Co. per year by Western Maryland Scenic

EPA Tier controlled VOC emission factor for 2014 is 0.0142 lbs. $_{VOC}$/gal
VOC Emissions from line haul locomotives in Allegany County:

$$EM_{AlleganyPassVOC} = \frac{(20{,}075 \text{ gal / yr} + 10{,}555 \text{ gal / yr}) * 0.0142 \text{ lbs. }_{VOC}\text{/gal}}{(2000 \text{ lbs. per ton})}$$

$EM_{AlleganyPassVOC}$ = **0.22 tons $_{VOC}$ / year**

EPA Tier controlled NOX emission factor for 2014 is 0.2976 lbs. $_{NOX}$/gal
NOx Emissions from line haul locomotives in Allegany County:

$$EM_{AlleganyPassNOX} = \frac{(20{,}075 \text{ gal / yr} + 10{,}555 \text{ gal / yr}) * 0.2976 \text{ lbs. }_{NOX}\text{/gal}}{(2000 \text{ lbs. per ton})}$$

$EM_{AlleganyPassNOX}$ = **4.56 tons $_{NOX}$ / year**

EPA Tier controlled CO emission factor for 2014 is 0.0587 lbs. $_{CO}$/gal
CO Emissions from line haul locomotives in Allegany County:

$$EM_{AlleganyPassCO} = \frac{(20{,}075 \text{ gal / yr} + 10{,}555 \text{ gal / yr}) * 0.0587 \text{ lbs. }_{CO}\text{/gal}}{(2000 \text{ lbs. per ton})}$$

$EM_{AlleganyPassCO}$ = **0.90 tons $_{CO}$ / year**

Yard Locomotives Emission Estimate
CSX reportedly operated 4 yard locomotives in Anne Arundel County at 304 cumulative duty hours for the year at a rate of 247.18 gallons of fuel per hour.

CSX_{FUEL} = (304 x 247.18) = 75,143 gallons

VOC Emissions from *yard* locomotives in Anne Arundel County:
EPA Tier controlled VOC emission factor for 2014 is 0.0295 lbs. $_{VOC}$/gal

$$EM_{CSXVOC} = \frac{(75{,}143 \text{ gal / yr}) \times (0.0295 \text{ lbs. }_{VOC}\text{/gal})}{(2000 \text{ lbs. per ton})}$$

EM_{CSXVOC} = 1.11 tons $_{VOC}$ / year

NOx Emissions from *yard* locomotives in Anne Arundel County:
EPA Tier controlled NOX emission factor for 2014 is 0.4784 lbs. $_{NOX}$ /gal

$$EM_{CSXNOX} = \frac{(75{,}143 \text{ gal / yr}) \times (0.4784 \text{ lbs. }_{NOX}\text{/gal})}{(2000 \text{ lbs. per ton})}$$

EM_{CSXNOX} = 17.97 tons $_{VOC}$ / year

CO Emissions from *yard* locomotives in Anne Arundel County:
EPA Tier controlled CO emission factor for 2014 is 0.0587 lbs. $_{CO}$ /gal

$$EM_{CSXCO} = \frac{(75{,}143 \text{ gal / yr}) \times (0.0587 \text{ lbs. }_{CO}\text{/gal})}{(2000 \text{ lbs. per ton})}$$

EM_{CSXCO} = 2.21 tons $_{CO}$ / year

Daily emissions for rail were calculated by taking the annual emissions and dividing them by 365 (days).

EM_{CSXCO} = 6.05E-03 tons $_{CO}$ / day

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

ARA 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 ARA 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 ARA 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 ARA to collect LTO data rather than specific aircraft data. For the 2014 inventory ARA requested operation data for military aircraft from Maryland Army, Navy, and Air Force base environmental support offices.

3) For commercial aviation ARA used FAA's EDMS[1] 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 MOBILE 6.2, 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, ARA 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, ARA 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

In EDMS actual weather (annual average values or hourly values) are in used for both modeling. **Daily emissions for rail were calculated by taking the annual emissions and dividing them by 365 (days).**

[1] 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), Climbout 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 5.5.1-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 5.5.1-a EDMS Aircraft & Engine Estimated Averages and Defaults Data

Aircraft Name	Aircraft Type	Engine Assigned	Approach Time (min)	Climbout 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

Aircraft Name	Aircraft Type	Engine Assigned	Approach Time (min)	Climbout Time (min)	Takeoff Time (min)	Annual LTO	Taxi Time (min)	Queue Time (min)
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

Aircraft Name	Aircraft Type	Engine Assigned	Approach Time (min)	Climbout Time (min)	Takeoff Time (min)	Annual LTO	Taxi Time (min)	Queue Time (min)
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. **Defaults data is updated as new revisions of the model are posted**. For the latest 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 5.5.1-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	924.84	184.05	831.54	94.25	23.40	23.40
General Aviation	71.47	14.22	64.26	7.28	1.81	1.81
Air Taxi	112.10	22.31	100.79	11.42	2.84	2.84
Military Aviation	19.66	3.91	17.68	2.00	0.50	0.50
Total	**1,128.07**	**224.50**	**1,014.27**	**114.96**	**28.54**	**28.54**

The model was run for all aircraft at BWI, Martin State, Hagerstown Regional, Ocean City Municipal, Frederick County, Phillips Air Field, Weide Army Air Field and Andrews Air Force

5.5.2 General Aviation

SCC: 22 75 050 000

Emission Calculation

An estimate of emissions was calculated after information on the LTO operations of aircraft operation type was 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 5.5.2-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 Calvert County. The combined airports had 1,400 General Aviation LTOs over a twelve month period.

$Emiss_{VOC}$ = [LTO (GA) * EF $(GA)_{HC}$] * CF (VOC/HC)
$Emiss_{VOC}$ = [(1,400 LTOs / Year * 0.394 (lbs. HC / LTO)] * 0.9708 (lbs. VOC / lbs. HC))]
$Emiss_{VOC}$ = 535.49 lbs. VOC / Year
$Emiss_{VOC}$ = 0.27 Tons VOC / Year

$Emiss_{CO}$ = [1,400 LTOs / Year * 12.014 (lbs. CO / LTO)]
$Emiss_{CO}$ = 16,819.60 lbs. of CO / Year
$Emiss_{CO}$ = 8.41 Tons CO / Year

$Emiss_{NOx}$ = [1,400 LTOs / Year * 0.065 (lbs. NOx / LTO)]
$Emiss_{NOx}$ = 91.00 lbs. of NOx / Year
$Emiss_{NOx}$ = 0.05 Tons NOx / Year

$Emiss_{SO2}$ = [1,400 LTOs / Year * 0.100 (lbs. SO2 / LTO)]
$Emiss_{SO2}$ = 140 lbs. of SO2 / Year
$Emiss_{SO2}$ = 0.07 Tons SO2 / Year

$Emiss_{PM2.5\text{-}PRI}$ = [1,400 LTOs / Year * 0.020 (lbs. PM2.5-PRI / LTO)]
$Emiss_{PM2.5\text{-}PRI}$ = 28.00 lbs. of PM $_{PM2.5\text{-}PRI}$ / Year
$Emiss_{PM2.5\text{-}PRI}$ = 0.01 Tons PM $_{PM2.5\text{-}PRI}$ / Year

Daily calculation can be made for each county (see example below)
Calvert County General Aviation CO total was:
$Emiss_{CO}$ = 8.41 Tons CO / Year

$Emiss_{CO}$ = 8.41/365 Tons CO / Day

$Emiss_{CO}$ = 2.30E-02 Tons CO / Day

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. ARA 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 ARA asked for and received LTO information by aircraft operation type, ARA used composite emission factors from Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources, 1988 and the EDMS model (version 5.1).

TABLE 5.5.3-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

Sometime military bases use commercial or other local fields. It was reported the military made 45 LTOs at Carroll County Regional Airport and 100 at Reservoir Airport in Carroll County.
Total 145 Military LTOs in Carroll County.

$Emiss_{VOC}$ = [L(AT) * $EF(MA)_{HC}$]
$Emiss_{VOC}$ = [(145 LTOs / Year * 27.10 (lbs. VOC / LTO)]
$Emiss_{VOC}$ = 3,929.5 lbs. VOC / Year
$Emiss_{VOC}$ = 1.96 Tons VOC / Year

$Emiss_{CO}$ = [145 LTOs / Year * 48.80 (lbs. CO / LTO)]
$Emiss_{CO}$ = 7,076 lbs. of CO / Year
$Emiss_{CO}$ = 3.54 Tons CO / Year

$Emiss_{NOx}$ = [145 LTOs / Year * 9.160 (lbs. NOx / LTO)]
$Emiss_{NOx}$ = 1,328.20 lbs. of NOx / Year
$Emiss_{NOx}$ = 0.66 Tons NOx / Year

$Emiss_{SO2}$ = [145 LTOs / Year * 1.43 (lbs. SO2 / LTO)]
$Emiss_{SO2}$ = 207.35 lbs. of SO2 / Year
$Emiss_{SO2}$ = 0.10 Tons SO2 / Year

$Emiss_{PM2.5-PRI}$ = [145 LTOs / Year * 15.23 (lbs. PM / LTO)]
$Emiss_{PM2.5-PRI}$ = 2,208.35 lbs. of PM $_{PM2.5-PRI}$ / Year
$Emiss_{PM2.5-PRI}$ = 1.10 Tons PM $_{PM2.5-PRI}$ / Year

Daily calculation can be made for each county (see example below)
Military emissions in Carroll County CO total were:
$Emiss_{CO}$ = 3.54 Tons CO / Year

$Emiss_{CO}$ = 3.54/365 Tons CO / Day

$Emiss_{CO}$ = 9.70E-03 Tons CO / Day

5.6 MARINE VESSELS

SCC: 2280002100 (Diesel Oil – Port)
2280002200 (Diesel Oil – Underway)
2280003100 (Residual Oil – Port)
2280003200 (Residual Oil – Underway)

Description

Commercial Marine Vessels (CMV) includes 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. "The CMV source category does not include recreational marine vessels, which are generally less than 100 feet in length, most being less than 30 feet, and powered by either inboard or outboard. These emissions are included in those calculated by the NONROAD model."

Pollutants

PM2.5-PRI, PM10-PRI, SO_2, NOx, CO, CO_2, VOC, NH3, and 22 HAPS

Method and Data Sources

Historically, MDE used marine vessels data prepared by the Baltimore Maritime Exchange (BME) to develop and calculated commercial marine vessels emissions inventory and referred to 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. However, EPA offers the most recent descriptions and current methodologies used for the calculations for CMV inventory. MDE performed analysis comparison between MDE and EPA's 2014 CMV emissions estimates. After these analysis comparisons, MDE decided to adopt EPA's emissions estimates and methodology for Maryland's 2014 CMV inventory cycle.

To calculate the 2014 CMV emission inventory estimates, the EPA used a bottom up methodology approach. The EPA's bottom up methodology approach was base on EPA collecting 1) national activity data (kilowatt hours or kW) of CMV, 2) engine operating load factors, and 3) emission factors and HAPs speciation profiles.

EPA then incorporated informational data sets on vessels movement/waterway-route segments and speeds were used to estimate emissions by ship types for a given port.

The data sets on vessels movement/waterway-route segments and speeds by ship types then were intersected with EPA's NEI shapefiles of ports and shipping lanes. Shipping lanes associated with RSZs were coded to allow for adjustment in vessel speed, time spent transiting the RSZ, and engine operating load.

EPA also used Emissions Modeling Platform Criteria pollutant estimates to allocated and determine shapeID files ratio for underway and port county combinations. In cases where model files had emissions in counties with shape IDs, emissions were allocated to shapes in those counties proportionately to shape area. However, in cases where model files had emissions in counties for which EPA had no shapeIDs, the model file emissions were dropped. In all these cases, emissions were very small and considered to be negligible.

To derived HAP estimates, the EPA applied toxic fractions to VOC or PM estimates. HAP speciation fractions based on VOC and PM were employed to calculate HAPs.

For each of the commercial marine vessels SCCs, an appropriate emissions type (M=maneuvering, H=hotelling, C=cruise, Z=reduced speed zone) was applied because emission factors vary by emission type. Each SCC and emissions type combination was allocated to a shape file identifier in the nonpoint inventory. The allowed combinations are shown in Table 4.6.1. The default values are those assumed when the actual emission type may be unknown; for example, emissions that occur in shipping lanes are assumed to be 'cruising' and cannot be 'hotelling', which only occurs at ports. See Table 4.6.1. Also see Table 4.6.2 for CMV Vessel Types, Table 4.6.3 for Vessel Speed Data, and Table 4.6.4 for Vessel Power Attributes by Vessel Type.

TABLE 5.6.1-a Commercial Marine Vessel SCCs and emission types

SCC	SCC Description	Allowed	Default
2280002100	Marine Vessels, Commercial Diesel Port	M	M
2280002200	Marine Vessels, Commercial Diesel Underway	C	C
2280003100	Marine Vessels, Commercial Residual Port	H	H
2280003100	Marine Vessels, Commercial Residual Port	M	H
2280003200	Marine Vessels, Commercial Residual Underway	C	C
2280003200	Marine Vessels, Commercial Residual Underway	Z	C

TABLE 5.6.1-b Marine Vessel Ship Types

Ship Types	
Bulk Carrier (Laker)	Bouy Tender
Barge	Ferries
Coast Guard	Fishing
Container	FPSO
Dredger	Passenger
Drilling	Pipelaying
General Cargo	Refrigerated Cargo (Reefer)
Icebreaker	Research
Roll On-Roll Off (RORO)	Tug
Tanker (Oil/LNG/LPG)	Vehicle Carrier
Miscellaneous	Supply
Well Stimulation	Support

TABLE 5.6.1-c Vessel Speed Data

Ship Type	Size Category	Size Units	Ratio of average at-sea speed to design speed	Percent of total population	Weight amount	Weighted Cruising Speed Factor
Bulk Carrier	0-9999	dwt	0.84	0.9%	0.007403	0.822751023
	10000-34999		0.82	25.1%	0.20571	
	35000-59999		0.82	36.0%	0.295272	
	60000-99999		0.83	31.7%	0.26308	
	100000-199999		0.81	6.2%	0.050227	
	200000+		0.84	0.1%	0.001058	
Container	0-999	TEU	0.77	4.9%	0.038087	0.681508656
	1000-1999		0.73	11.8%	0.086059	
	2000-2999		0.7	12.5%	0.087716	
	3000-4999		0.68	32.8%	0.223116	
	5000-7999		0.65	28.6%	0.185944	
	8000-11999		0.65	9.0%	0.058409	
	12000-14500		0.66	0.3%	0.002176	
	14500+		0.6	0.0%	0	
Oil Tanker	0-4999	dwt	0.8	0.1%	0.001094	0.782982216
	5000-9999		0.75	0.3%	0.002052	
	10000-19999		0.76	0.0%	0.0	
	20000-59999		0.8	3.6%	0.028454	
	60000-79999		0.81	15.6%	0.12632	
	80000-11999		0.78	43.4%	0.338249	
	120000-199999		0.77	32.6%	0.250698	
	200000+		0.8	4.5%	0.036115	

dwt = dead weight tonnage; TEU = twenty foot equivalent units

Note: For RSZs, a vessel's speed was assumed to be the zone's speed unless the vessel's cruising speed was lower. For example, a vessel with a cruising speed of 12 knots traveling through a waterway segment with a reduced speed of 14 knots was assumed to be operating at 12 knots.

The hours of operation were applied to the vessel's power, which was adjusted for typical engine operating loads to get kilowatt hours. In turn, the kilowatt hours were applied to the appropriate EPA emission factor based on the vessel engine's category to estimate criteria pollutant emissions.

TABLE 5.6.1-d Vessel Power Attributes by Vessel Type

Standard Type	Count	Avg Main hrs	Avg Aux kW	Avg Max Speed	Default Vessel Category
Bulk Carrier	3,177	8,990	1,935	14.3	3
Bulk Carrier, Laker	80	7,069	2,216	13.7	3
Buoy Tender	4	4,266		12.6	2
Container	1,218	39,284	7,851	23.2	3
Crude Oil Tanker	731	15,070	2,888	15.1	3
Drilling	7	15,806	12,840	11.7	2
Fishing	123	1,262	272	2.3	1
FPSO	2	18,123		11.5	3
General Cargo	1,020	6,130	1,619	14.6	3
Icebreaker	2	21,844		12.0	2
Jackup	4	1,643	270	3.5	1
LNG Tanker	44	29,607	8,129	19.2	3
LPG Tanker	151	8,557	3,021	15.8	3
Misc.	35	2,805	631	10.0	1
Passenger	168	45,760	4,477	20.4	3
Pipelaying	14	11,355	5,037	12.6	2
Reefer	182	8,930	3,328	18.9	3
Research	55	5,395	1,905	11.2	2
RORO	72	9,479	4,006	16.7	3
Supply	255	3,201	662	10.1	1
Support	73	6,590	2,305	9.7	2
Tanker	1,423	8,474	2,730	14.5	3
Tug	396	3,440	348	7.7	2
Vehicle Carrier	441	13,829	3,729	19.8	3
Well Stimulation	3	7,697	340	8.2	3

Activity

- National activity data (kilowatt hours or kW) of CMV.
- Vessel characteristics data.
- The time spent, by ship type, in each of four operating modes defines as: normal cruise, slow cruise, maneuvering, and hostelling.
- The engine operating load factors.
- The engine power of each vessel types.

Note all activity data were adjusted for typical engine loads for the modes of operation (i.e., cruising, reduced speed zone (RSZ), maneuvering, and hoteling).

Vessel characteristics data were compiled and linked to the vessel types. The vessel characteristics included the following data:

- Vessel identification codes
- Vessel name
- Country of registry
- Call sign
- Vessel type
- Gross/net tonnage
- Vessel power
- Auxiliary engine power
- Piston stroke length/cylinder diameter (to calculate vessel category)
- Maximum vessel speed.

EPA's Emission Factors:

Note: The hours of operation were applied to the vessel's power, which was adjusted for typical engine operating loads to get kilowatt hours. In turn, the kilowatt hours were applied to the appropriate EPA emission factor based on the vessel engine's category to estimate criteria pollutant emissions.

Below are defaulted emission rates per pollutant per engine per fuel per vessel type per mode of operation.

Vessels equipped with Category 3 propulsion engines:

As the dominant propulsion engine configuration for large Category 3 vessels is the slow speed diesel (SSD) engine, the following SSD emission factors were used for Category 3 propulsion engines. Medium speed diesel (MSD) emission factors were used for auxiliary engines associated with these larger vessels. For the 2014 inventory, it was assumed that Emission Control Area (ECA) compliant fuels were used while transiting U.S. waters. Emission factors for vessels equipped with Category 3 propulsion engines are presented in Table 4.6.5.

TABLE 5.6.1-e Category 3 Emission Factors (g/kW-hrs)

Type	Engine	Fuel	NOX	VOC	HC	CO	SO 2	CO 2	PM10	PM25
SSD	Main	1% Sulfur	14.7	0.6318	0.6	1.4	3.62	588.86	0.45	0.42
MSD	Aux	1% Sulfur	12.1	0.4212	0.4	1.1	3.91	636.6	0.47	0.43

From: U.S. EPA/OTAQ, Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder, March 2008.
[a] Hydrocarbon (HC) was converted to VOC using a conversion factor of 1.053 as provided in the above reference
[b] $PM_{2.5}$ was assumed to be 97 percent of PM_{10} using the above reference

Vessels equipped with Category 1 or 2 propulsion engines and Tier types:

TABLE 5.6.1-f Tier Emission Factors for Vessels Equipped With Category 1 / Category 2 Propulsion Engines (g/kW-hrs)

Tier	PM10	NOx	HC	CO	VOC	PM25 b	SO 2	CO 2
0	0.32	13.36	0.134	2.48	0.141102	0.3104	0.006	648.16
1	0.32	10.55	0.134	2.48	0.141102	0.3104	0.006	648.16
2	0.32	8.33	0.134	2.00	0.141102	0.3104	0.006	648.16
3	0.11	5.97	0.07	2.00	0.073710	0.1067	0.006	648.16

Engines and Marine Compression Ignition Engines Less than 30 Liters per Cylinder, March 2008.

[a] HC was converted to VOC using a conversion factor of 1.053 as provided in the above reference.

[b] $PM_{2.5}$ was assumed to be 97 percent of PM_{10} using the above reference.

Emissions Calculation

The general equation for estimating CMV emissions is:

$$\text{Emissions} = Vp_i\,(\text{kW}) \times LF \times \frac{D\,(\text{NM})}{Vs\,(\text{NM/hr})} \times EF\,\frac{(\text{g})}{(\text{kWh})}$$

Where:

a. D_i = Distance along Segment, NM / C or RSZ Knots by vessel (i) and engine type (h)
b. Vp_i = rated power of propulsion engine by vessel (i) and engine type (h)
c. $LF_{i\,g}$ = Load factor (fraction less than 1) in mode g (cruise, slow cruise or maneuvering)
d. Vs_{ig} = 0.94 x maximum vessel speed = cruising speed or RSZ speed (i) and mode (g) (hours)
e. $EF_{i\,h}$ = Emission factor in mode (i) and by engine type (h)

Note: D/Vs are used to estimate operating hours and 0.94 is Cruising Speed (knots), 94% of the max rated speed. Also, if vessel speed is unknown, typical speed by vessel type was used (nautical miles/hr or knots).

Mode Equations Calculation:

RSZ Mode:

RSZ Criteria

- E&C RSZName <> "Cruising"
- EF Mode = “Cruising”
- EF Engine Type = “Main”
- IF (CruiseSpeed(94%Max)Revised < RSZ_Speed_kn, o then CruiseSpeed(94%Max)Revised otherwise RSZ_Speed_kn

RSZ Linkage

• ShipType
• CatLookup
• RSZ

RSZ Emission Equation

EM = SumofLength_nm / IF(CruiseSpeed(94%Max)Revised < RSZ_Speed_kn, then CruiseSpeed(94%Max)Revised, otherwise RSZ_Speed_kn)* MainkW * EF-g/kWhr

Maneuvering Mode:

Maneuvering Criteria

• EF Mode = “Man”
• EF Engine Type = IF(Engine Type = “Main” o Then, kW-hrs = MainkW* Maneuvering Time, Otherwise, kW-hrs = AuxKW*Maneuvering Time (where Engine Type = “Aux”)

Maneuvering Linkage

• ShipType
• CatLookup
• Engine Type

Maneuvering Emission Equation

EM = If Engine Type = “Main”

• Then, MainkW-hrs* EF-g/kWhr,
• Otherwise AuxkW-hrs * EF-g/kWhr (where Engine Tytpe = “Aux”)

Hoteling Mode:

Hoteling Emission Equation

EM = AuxkW-hrs * EF-g/kWwhr

Crusing Mode:

Cruising Emission Equation

EM = TRIP_MILES/ Speed(knots)* SUMorTRIPS* Percent* HORSEPOWER* HP to kW conversion factor * EF-g/kWhr.

Adjustment for Controls

Controls were applied when applicable to a particular source category.

Spatial and Temporal Allocations

Spatial

National level CMV information was broken down to shapeID# using spatial allocation documented and assigned by EPA.

Temporal

Data for temporal allocation was base on EPA’s annual emissions and were divided by 312 to estimate daily emissions.

6.0 ONROAD MOBILE SOURCES

6.0 INTRODUCTION

This document detailed the methodology, assumptions and results of work performed by MSCP, ARA of MDE to generate the 2014 ozone and the greenhouse gases (GHG) precursor emissions inventories for highway vehicles using the MOVES2014 modeling tools. As detailed in the following sections, the 2014 inventories of highway vehicles had been developed based on daily and annual Highway Performance Monitoring System (HPMS) inventories.

The official 2014 ozone and GHG precursor inventory of highway vehicles for the Baltimore Ozone Nonattainment Area, which comprises Baltimore City, and the counties of Anne Arundel, Baltimore, Carroll, Harford and Howard were the daily and annual HPMS-based inventories. The official 2014 ozone and GHG precursor inventory of highway vehicles for the Maryland portion of the Metropolitan Washington Council of Governments (MWCOG) Nonattainment Area, which comprises the counties of Calvert, Charles, Frederick, Montgomery and Prince George's, were also the daily and annual HPMS-based inventories.

The official 2014 ozone and GHG precursor inventories of highway vehicles for the Maryland portion of the Philadelphia, Pennsylvania Ozone Nonattainment Area, which comprises Cecil County, and the counties of Kent and Queen Anne's Nonattainment Area were also the daily and annual HPMS-based inventories.

The official 2014 ozone and GHG precursor inventory for the remaining portion of the State, which comprises the counties of Allegany, Caroline, Dorchester, Garrett, Saint Mary's, Somerset, Talbot, Washington, Wicomico and Worcester, were also the daily and annual HPMS-based inventories.

6.0.1 Highway Vehicle Emissions Inventory

This inventory documented herein described specifically how United States Environmental Protection Agency's (USEPA's) MOVES2014 (MOVES) was used to estimate the 2014 annual criteria pollutants' and GHG's emissions as well as 2014 daily criteria pollutants from on-road vehicles and total energy consumption in the State. MOVES is the best tool used in developing these criteria pollutants and GHG emission estimates. Moreover, MOVES was used at the County scale to estimate the emissions of carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) as these pollutants basically make up the GHG pollutants.

Emissions were estimated based on emission factors and vehicle activity. Consequently, emission factors for vehicles were based on vehicle type such as passenger cars, passenger trucks, vehicle age and the vehicle's operating modes. Operating modes for running, start, and idle emissions are included in MOVES. It should be noted that operating modes for running emissions were based on vehicle speed as well as whether the vehicle was accelerating, decelerating or cruising. In addition, the emission factors from all vehicles varied over the entire range of conditions these vehicles operate such as the ambient air temperature, speed, traffic conditions, road types, road topography, etc.

Furthermore, these generated emission factors were then multiplied by the appropriate VMT to estimate the criteria pollutants' and GHG's emissions and energy consumption. Moreover, the inventory must also account for non-exhaust or evaporative emissions. It is also important to look at the fleet, which is composed of several generations, types of vehicles and their emission control technologies, each of which performs differently.

In order to estimate both the rate at which emissions are being generated and to calculate VMT, MDE examined its road network and fleet to estimate vehicle activity. For the annual inventories, this was done for each of the twelve months in 2014 and aggregated for the entire year. The entire process was extremely complex and involved large amounts of various data sets.
Computer models were developed to perform these calculations by simulating the travel of vehicles on the State's roadway system.

These models then generated emission factors for different vehicle types for area-specific conditions and then combined them in summary form. The "area-specific conditions" included fleet characteristics such as vehicle population and vehicle age distribution, roadway and travel characteristics, meteorology, control programs in place, mandated fuel requirements, etc.

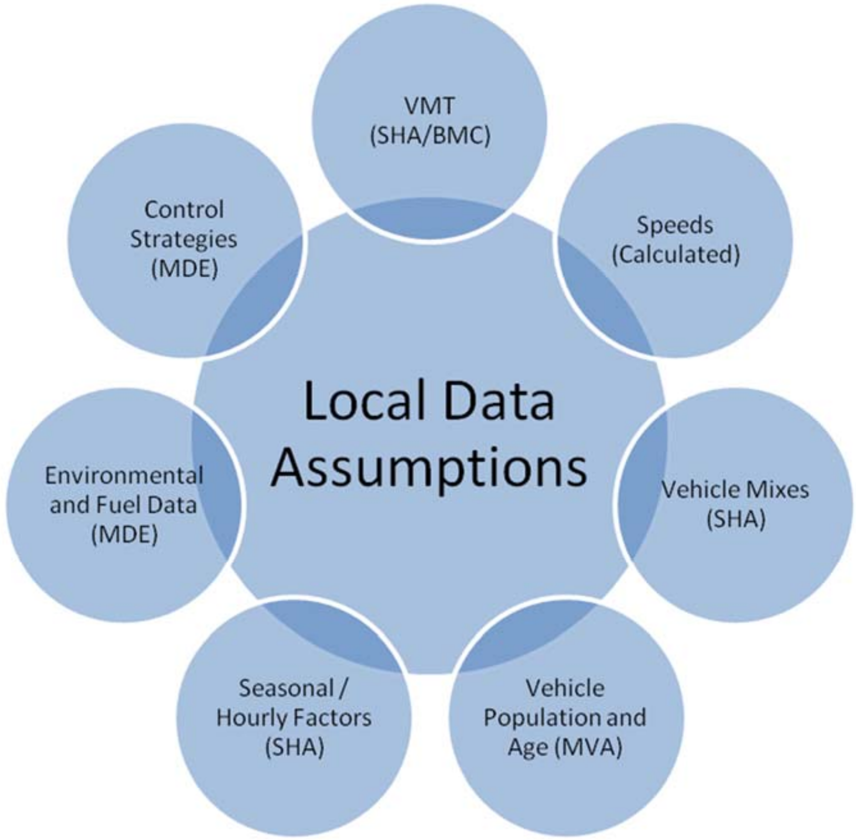
6.1.1 Periodic Inventory Methodology

MSCP used USEPA's Guidance documents to develop the 2014 highway emissions inventory. These documents include inter-alia the following:

Using MOVES for Estimating State and Local Inventories of On-Road Greenhouse Gas Emissions and Energy Consumption, EPA-420-B-12-068, November 2012. *Motor Vehicle Emission Simulator, User Guide for MOVES2014,* EPA-420-B-14-055, July 2014

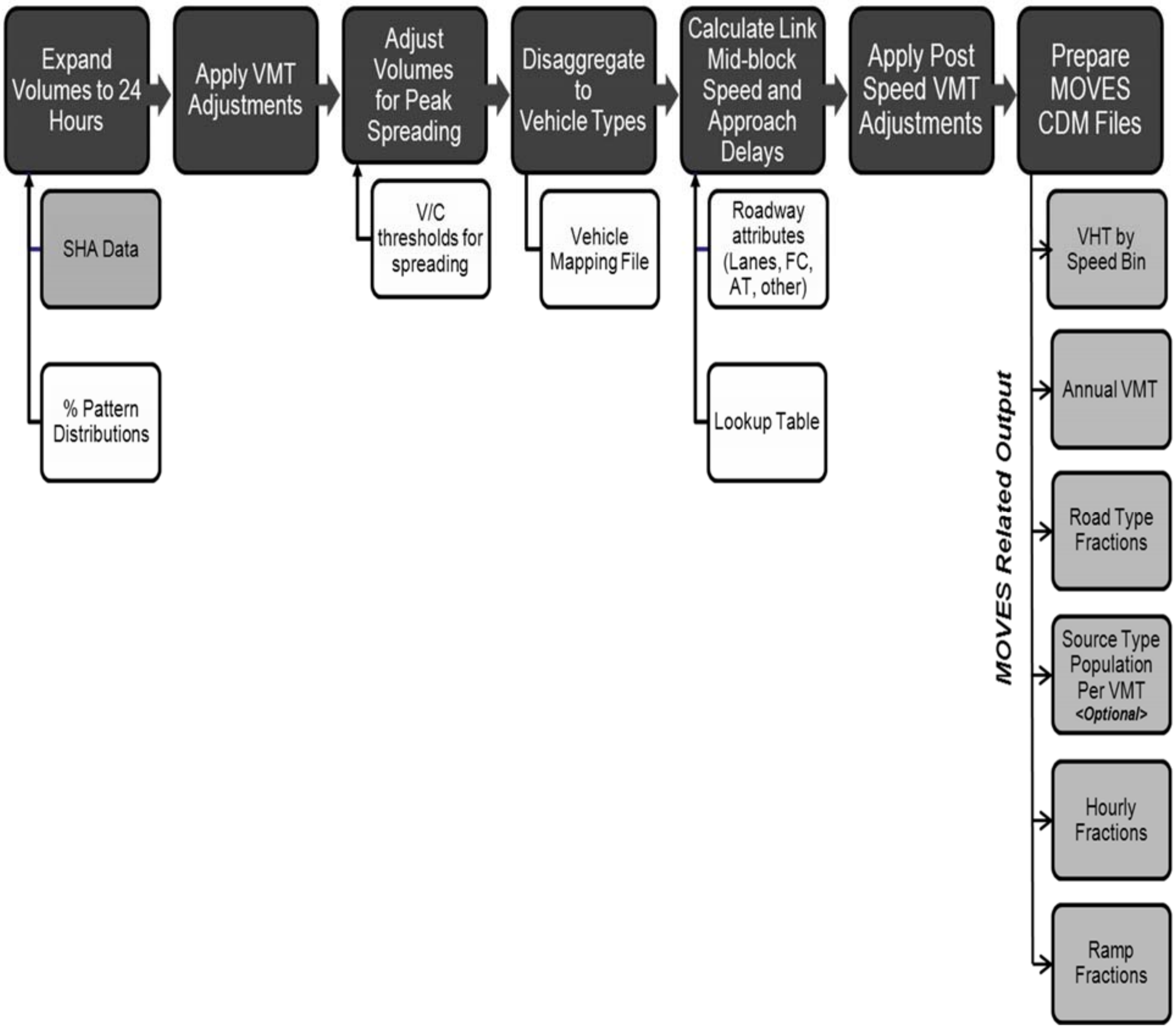
The methodologies used to produce the emission data conform to the recommendations provided in USEPA's Technical Guidance as well as in other documents enumerated above. A mix of local data and national default (internal to MOVES2014) data had been used for the inventory documented herein. As illustrated in Figure 6.1, local data had been used for the primary data items, which had a significant impact on emissions. Local data inputs to the inventory process reflected the latest available planning assumptions using data obtained from MDE, MVA, SHA, BMC, MWCOG and other local/national sources. This inventory document herein reflected the 2014 PEI for the Baltimore Ozone Non-Attainment Area and the rest of Maryland using USEPA's latest MOVES2014 emission model.

Figure 6-1: Local Data Inputs Used for Emissions' Inventory



PPSUITE is a post-processor modeling tool used for estimating speeds and processing emission rates. Section 6.7 describes in detail this modeling tool known as PPSUITE. Figure 6.2 summarizes the key functions of PPSUITE and the traffic-related input files prepared for MOVES.

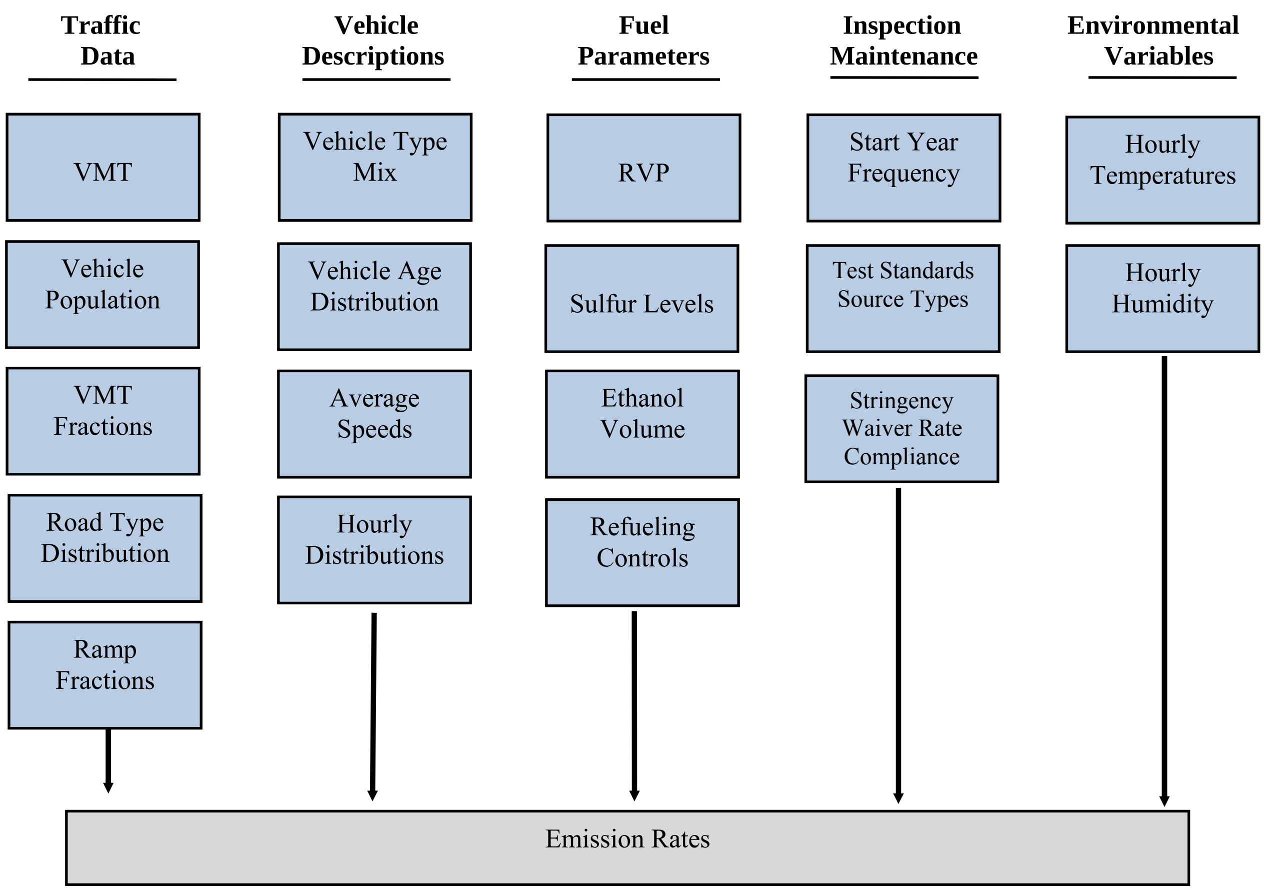
Figure 6-2: Emission Calculation Process



6.1.2 Data Sources

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 (I/M) Program parameters, and environmental variables as shown in Figure 6.3.

Figure 6-3: Examples of Key MOVES Input Data



MOVES2014 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 of this, EPA recommended the use of local data for inventory's preparation and SIPs analyses. These data items are discussed in the following sections.

6.2 DESCRIPTION OF INPUT DATA

This section described the data inputs to the emission calculation process. 15 or 14 MOVES data files were required for input to MOVES Graphical User Interface (GUI) through the MOVES' County Data Manager (CDM). These data files were either created by the staff of MSCP or generated by PPSUITE software. These data files were:

- Roadway Data and VMT
- Month VMT Fractions
- Day VMT Fractions
- Hour VMT Fractions
- Average Speed Distribution
- Road Type Distribution
- Ramp Fraction
- Source Types Population
- Source Types Age Distribution
- Fuel Formulation
- Fuel Supply
- Fuel Usage Fraction
- I/M Programs
- Meteorology Data
- Alternate Vehicle Fuel Technology (AVFT)

6.2.1 **Roadway Data and VMT**

The roadway data input to emissions calculations for this inventory was based on information from the "universal" highway database maintained by the Maryland's State Highway Administration (SHA). SHA obtained this information from periodic visual and electronic traffic counts. The SHA's data is dynamic, since it is continually reviewed and updated from new traffic counts. Information on roadways included in the National Highway System (NHS) 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's database was taken and downloaded to provide an up-to-date record of the State's highway system for estimating emissions. This emissions inventory was based on 2014 data, which is the most current "snapshot" of the SHA's data.
The following information was 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 PPSUITE software used the traffic data to prepare key inputs to the MOVES emission model. This software used roadway segment distances and traffic volumes to prepare estimates of VMT that is the primary traffic input that affects emission results. Before the SHA's data could be used by PPSUITE for speed and emission calculations, several adjustments and additions should be made to the roadway data.

The lane values, area type, and functional class were important inputs for determining the congestion and speeds for individual highway segments. Truck percentages were used in the speed determination process and were used to split volumes to individual vehicle types used by the MOVES2014 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 Figure 6.4. The urban/rural (UR) and functional classes (FC) are important indicators of the type and function of each roadway segment. These values were also used to determine the MOVES Road Type classification, which had an important impact on the emission factors for each roadway segment. Equivalencies between the SHA's and MOVES' indices were discussed in later sections.

Figure 6-4: 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 uses other additional variables other than those available in the SHA's 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 could affect a roadway's calculated congested speed.

This data could 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 (HCM).

6.2.2 Other Supporting Traffic Data

Other traffic data were used to adjust and disaggregate traffic volumes. Key sources used in these processes include the following:

6.2.3 HPMS VMT Adjustments

According to EPA's guidance, baseline inventory VMT computed from the SHA's 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 Federal Highway Administration's (FHWA's) direction. These adjustments were obtained by dividing the HPMS VMT by the analysis run's VMT for each county functional class grouping. These calculated VMT adjustment factors were provided as ASCII input files to PPSUITE, and were applied to each of the roadway segment volumes.

These factors could be applied to any future year runs. The VMT added or subtracted to the SHA's database assumed the speeds calculated using the original volumes for each roadway segment for each hour of the day.

6.2.4 Seasonal Adjustments

The seasonal factors were used to adjust the average annual day traffic (AADT) to represent an average July weekday, an average January weekday, or an average day of any month. Both the seasonal and monthly VMT adjustment factors were developed from the traffic flow data available by day and month from Automatic Traffic Recording (ATR) Station Reports in the Traffic Trends System Report Module, which was obtained from the SHA's website. The report entitled, *Traffic Flow by Day by Month by Group* was used to obtain the monthly variation of traffic flow.

The 4 functional classes for which the seasonal factors were available are: Rural Interstate, Rural other, Urban Interstate and Urban other. This report also contained the AADT's percentage, which was available for the 7 days of the week as well as for the 12 months of the year. An average summer seasonal factor was obtained from the average July weekdays' calculations. In addition, an average winter seasonal factor was obtained from the average January weekdays' calculations. These seasonal factors' calculations were repeated for all the 4 functional classes.

6.2.5 Hourly Patterns

Speeds and emissions vary considerably depending on the time of day as a result of temperature variations and congestion. 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. In addition, the hourly pattern distributions were a key input file to PPSUITE for hourly congested speeds' estimation. Hourly mixes of vehicles for each area and facility type combination were also input to PPSUITE. These hourly mixes were used to determine the proportion of the daily volume in each hour of the day, so separate hourly speeds could be prepared as input to PPSUITE process.

Consequently, hourly pattern data was obtained from a report entitled, *Traffic Trends System Report Module* from the SHA's website. However, the hourly distribution data could be obtained from the report entitled, *Hour Percent of Traffic by Month-Weekday*. The factors for the 4 functional classes (Rural Interstate, Rural other, Urban Interstate and Urban other) could also be obtained from the aforementioned report. Furthermore, the hourly pattern data for the 4 primary functional classes were used to create the PPSUITE input files that were needed in the emission calculation process. For instance, to obtain an hourly percentage of vehicles for a summer weekday, an average hourly factor was calculated for the months of June, July and August.

6.2.6 Vehicle Mix Inputs

The vehicle distribution file was a key input file that could have a significant impact on emissions. Moreover, the vehicle mixes were input to PPSUITE as hourly distributions of vehicles by vehicle type. These mixes were developed by using the 2014 data, which were available from the SHA's website.

6.2.7 Vehicle Type Processing

Emission rates within MOVES vary significantly by the type of vehicle. The MOVES2014 model produces emissions and rates by thirteen MOVES source types. However, VMT is input to MOVES by 5 HPMS vehicle groups. Figure 6.5 below summarizes the distinction between each classification scheme.

Figure 6-5: MOVES Source Types and HPMS Vehicle Groups

SOURCE TYPES		HPMS Class Groups	
11	Motorcycle	10	Motorcycle
21	Passenger Car	25	Light Duty Vehicles
31	Passenger Truck	40	Buses
32	Light Commercial Truck	50	Single Unit Trucks
41	Intercity Bus	60	Combination Trucks
42	Transit Bus		
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		

The PPSUITE process included a method to disaggregate the SHA's traffic volumes to the MOVES2014 thirteen source types and then recombined the estimates to the 5 HPMS vehicle classes. This was done to support the alternative MOVES2014 "rate-based" application method, which could also be handled by the PPSUITE's software. Under the "rate-based" application method, VMT should be estimated for each of the MOVES2014 thirteen source types. PPSUITE used the vehicle type pattern data to divide the hourly roadway segment volumes to the MOVES2014 thirteen source types. This data contained the percentage splits to each source type for every hour of the day, which was similar to the 24-hour pattern data.

6.2.8 VMT Fractions

Month, day and hour VMT fractions were required as inputs to MOVES. Month and day VMT fractions were calculated based on seasonal adjustment factors. It should be noted that the month VMT fractions were used to disaggregate the annual VMT into monthly VMT, while day VMT fractions were used to disaggregate monthly VMT to daily weekdays or weekends VMT. PPSUITE was used to calculate hour VMT fractions, which were based on hourly pattern inputs. These hourly VMT fractions were inputs to MOVES and were responsible to distribute the daily VMT into 24-hourly pattern.

6.2.9 Month VMT Fractions

These are the fractions of annual VMT per source type occurring per month. These fractions must sum to 1 within each source type over a 12-month period. In addition, these fractions were used in MOVES input to disaggregate annual VMT to monthly VMT as stated in the previous section.

6.2.10 Day VMT Fractions

These fractions are the fractions of annual VMT per source type, which occur on either the weekday or weekend. These fractions were also used in MOVES input to disaggregate the monthly VMT to daily VMT per weekdays and weekends as stated in the previous section. These fractions must sum to 1 within each source type, month and road type.

6.2.11 Hour VMT Fractions

These fractions are the fractions of annual VMT per source type, which occur per hour. These fractions were used in MOVES input to distribute the daily VMT by weekdays and weekends into a 24-hourly pattern. These fractions must sum to 1 within each source type, road type and type of day combination. These fractions were applied to all months.

6.2.12 Average Speed Distribution

Emissions for many pollutants such as VOC and NO_x vary significantly with travel speed. Generally, VOC's emissions decrease as speed increases, while NO_x emissions decrease at low speed and increase at higher speeds. The emission process uses the PPSUITE set of programs to obtain the best estimate of vehicle speeds. These PPSUITE sets' primary function was to organize and simplify the handling of large amounts of data, which were needed for the calculations of speeds and preparation of MOVES input files. Furthermore, the PPSUITE's software prepares the MOVES vehicle hours of travel (VHT) by speed bin and summarizes the distribution of speeds across all links into each of 16 MOVES speed bins for each hour of the day.

6.2.13 **Road Type Distribution**

Typical drive cycles and associated operating conditions vary by the type of roadway in MOVES. MOVES define the following road types:

1. Off-Network,
2. Rural Restricted Access,
3. Rural Unrestricted Access,
4. Urban Restricted Access, and
5. Urban Unrestricted Access.

The off-network road type includes emissions from vehicle starts, extended idle activity and evaporative emissions. Off-network activity is primarily determined by the source type population input. The remaining distribution among road types is determined by associating the Maryland Department of Transportation's (MDOT's) functional class with each MOVES road type:

- MOVES Road Type (2) = MDOT Functional Class (1),
- MOVES Road Type (3) = MDOT functional Class (2, 6, 7, 8, 9),
- MOVES Road Type (4) = MDOT Functional Class (11, 12), and
- MOVES Road Type (5) = MDOT Functional Class (14, 16, 17, 19).

6.2.14 **Ramp Fractions**

Since ramps are not directly represented within the SHA's database, it is assumed that 8% of the Freeway VHT is Ramp's VHT. This assumption is consistent with the recommendations given in EPA's Technical Guidance. This ramp fractions file was also input to MOVES. 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.

6.2.15 **Source Type Age Distribution**

Age distribution could be described as mix of vehicles of different ages. MOVES covers a 31-year range of vehicle ages, while vehicles 30 years and older were grouped together. In MOVES, user could specify the fraction of vehicles in each of the 30 vehicle ages for each 13 source types. It is also known that the age distribution of vehicle fleets could vary extensively from area to area and could affect emissions. As a result of older vehicles to have been driven more miles and experiencing more deterioration in their emission control systems, such vehicles tend to have higher emissions. Therefore, fleets with a higher percentage of older vehicles would have higher emissions. In addition, a higher percentage of older vehicles in the fleet indicate that these vehicles would not be able to meet newer and more stringent emission standards or CAFE standards.

It should be noted that if the user wants to apply rates to multiple counties, the user should use a single age distribution that is appropriate for all those counties. However, if the multiple counties that need to be modeled have different age distributions, it is advisable that the user should model each county separately.

MSCP was able to develop the 2014 source type age distribution from the MVA's motor vehicle registration database. MSCP obtained this MVA’s registration database, which was then VIN-decoded, thereby, making it possible to obtain the 13 MOVES source types by model year. However, same age distribution was used for source types 31 and 32 because of the difficulty to split the data into source types 31and 32. The same age distribution was also used for refuse trucks, single unit short-/long-haul trucks. Furthermore, the same age distribution was also used for combination short-/long-haul trucks. However, for source types 52, 53, 61 and 62, the default age distribution was superimposed on the local age distribution that was obtained from the MVA's processed data.

6.2.16 **Source Type Population**

MOVES uses source types’ population to calculate evaporative, start and hotelling emissions. It should be noted that start and hotelling emissions depend on how many vehicles are parked and started than on how many miles of these vehicles are driven. As a result of this, source types’ population played a significant role in calculating the aforementioned emissions. If in the absence of any other source of population data, users could still base population estimates on the VMT estimates for a particular source type. This VMT estimates was based on running MOVES at the national scale for a county of interest, but including VMT and population in the output.

Then, the local VMT would be multiplied by the ratio of default population to default VMT by source type to produce an estimate of the local population. This option was used to obtain the source type population for source types 52, 53, 61 and 62.

6.3 METEOROLOGY

In MOVES, ambient temperature and relative humidity data are essential inputs for estimating the on-road criteria and GHG pollutants' emissions. The temperature and relative humidity are significant factors in modeling emissions from motor vehicles as they affect air conditioner use. MOVES need a 24-hour temperature and humidity profile in order to model a full day of emissions based on every hour of the day. It should be noted that the temperature has to be in degrees Fahrenheit, while the relative humidity must be in percentage.

Moreover, EPA urges users to use the average daily temperature and relative humidity profile for each month in case modeling is to be performed for all the 12 months. Latest available information on temperature and relative humidity should also be used for criteria and GHG pollutants emissions' estimates.

MSCP obtained the 2014 local weather data from Air Monitoring Program from all the airports in Maryland. These weather data were then processed to produce the 24-hourly data for each month. For instance, the Thurgood Marshall-Baltimore Washington (BWI) airport data was used for the Baltimore area, which comprises the Baltimore City and the counties of Anne Arundel, Baltimore, Carroll, Harford and Howard. MSCP also used the same procedure to process the weather data for the remaining counties in Maryland. Based on the airport mapping that MSCP developed, the appropriate airport data were allocated to these counties.

6.4 I/M PROGRAM

In Maryland, I/M Program, also known as Vehicle Emissions Inspection Program (VEIP), tests model year 1977 and newer gasoline powered vehicles weighing up to 26,000 pounds. This test is done biennially, or on a change of ownership. There is a two year grace period for new vehicles. However, model year 1996 and newer light-duty vehicles, and model year 2014 and newer vehicles weighing up to 14,000 pounds get the onboard diagnostics' (OBD's) 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 fields in a typical I/M program are polProcessID, stateID, countyID, yearID, sourceTypeID, fuelTypeID, IMProgramID, inspectFreq, testStandardsID, begModelYearID, endModelYearID, useIMyn and complianceFactor. The field useIMyn allows the user to turn off ("N") or on ("Y").

6.4.1 Pollutant Process ID

MOVES estimate emission reductions from VEIP for CO, hydrocarbons and NO_X. For exhaust emissions, I/M programs affect both running and start emissions. In addition, for evaporative emissions, I/M programs affect hydrocarbon emissions from fuel vapor venting and fuel leaks.

6.4.2 **Source Type and Fuel Type IDs**

These fields are used to describe the source (vehicle) and fuel types included in I/M program. The staff of the VEIP Division in MSCP when preparing I/M file, made sure that the source and fuel types match I/M programs' parameters for the source types included in the VEIP. It should be noted that MOVES currently calculates I/M program's benefits only for gasoline source types or vehicles.

Furthermore, I/M programs have historically applied to vehicles by regulatory weight class; however, MOVES applies I/M program's benefits by source type. This idea could lead to discrepancies between the number of vehicles covered in the actual I/M program and the number of vehicles that MOVES assumes is covered. For instance, I/M program, which targets trucks less than 8,501 pounds Gross Vehicle Weight Rating (GVWR) such as regulatory classes LDT1, LDT2, LDT3 and LDT4 would include parts of two MOVES source types 31 (passenger trucks) and 32 (light commercial trucks).

Moreover, these source types enumerated in this section also include vehicles with GVWR greater than 8,501 pounds. Whenever I/M program is applied to source types 31 and 32 in MOVES, the benefits of I/M program would be applied to all the vehicles in these source types. Hence, there is a need to adjust the compliance factor to account for the fraction of vehicles within a source type that is actually covered by I/M program.

6.4.3 **Inspection Frequency**

MOVES allow users to enter either annual or biennial test frequency. In accordance with Maryland's VEIP design, the MSCP utilized the input indicative of a biennial test frequency for all the inventory work that is documented herein.

6.4.4 **Test Standards and I/M Program ID**

There are 13 exhaust and 7 evaporative emissions tests that MOVES allows users to choose from. In Maryland, MSCP chose for its VEIP four test standards, which are identified by I/M program IDs. The test standards are:

- 11 – This is an Unloaded Idle Test, which is a test performed while vehicle idles in park or neutral.
- 41 – This is an Evaporative Gas Cap Check, which is a test conducted by pressurizing the gas gap so as to identify any leaks in the gas cap.
- 43 – This is an Evaporative System OBD check, which is the test of the evaporative emission related systems and components performed by visual check of the Malfunction Indicator Light (MIL) as well as scan of the OBD computer.
- 51 – This is an Exhaust OBD Check, which is the test of exhaust-related systems and components performed by visual check of MIL and scan of OBD computer for system

readiness, MIL status, and troubled codes are then stored. This test covers 1996 and newer OBD-equipped vehicles only.

It should be noted that in MOVES, I/M programs that have both exhaust and evaporative inspection components including OBD programs should be modeled as 2 separate and simultaneous programs. In addition, I/M Program ID numbers are used to identify these programs. MSCP followed this guideline in its VEIP's setup.

6.4.5 Beginning and End Model Years

In I/M Program, MOVES uses these two columns to specify the beginning and ending model years of vehicles covered. In Maryland, there is a grace period of 2 years before new vehicles are tested. The ending model year depends on the year of evaluation and the grace period for vehicles as enumerated above. However, the beginning model year is 1977 for 3 of the 4 test standards, except OBD test that has the beginning model year as 1996.

6.4.6 Compliance Factor

MOVES uses the compliance factor input to account for I/M program compliance rates, waiver rates, and the adjustments needed to account for the fraction of vehicles within a source type that are covered by the I/M program. These adjustments would be referred to as 'regulatory class coverage adjustment'. The compliance factor ranges from 0 to 100, and the number that would be entered in this column depends on the calculation based on the compliance rate, waiver rate and the regulatory class coverage adjustment as illustrated below:

Compliance Factor = (percent compliance rate) * (100-percent waiver rate)* percent regulatory class coverage adjustment.

Furthermore, the compliance factor represents the percentage of vehicles within a source type that actually receive I/M program's benefits. In addition, the compliance factor could also be looked at as reflecting the observed fail and waiver rates 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.

6.4.7 Compliance Rate

The compliance rate is the percentage of vehicles in the fleet that are covered by I/M program, and which either receive a certificate of compliance or a waiver after taking the test. Moreover, the higher compliance rate for the gas cap check reflects the much higher retest pass rate for this check.

6.4.8 **Waiver Rate**

The waiver rate is the percentage of vehicles that fail an initial I/M test, as well as retest, but they receive a certificate of compliance. It could also be calculated as follows:

$$\boldsymbol{Waiver\ rate} = \frac{(No.of\ vehicles\ that\ fail\ an\ initial\ test\ and\ do\ not\ pass\ retest)}{(No.of\ vehicles\ that\ fail\ an\ initial\ IM\ test)}$$

6.4.9 **Regulatory Class Coverage Adjustment**

In MOVES, I/M programs are applied to source types. The association of source types and I/M program could be inconsistent with state I/M program regulations that define I/M program by the vehicle weight classes. It should be noted that MOVES source types comprise several vehicle-weight classes, applying I/M's benefits to the entire MOVES' source types could be inappropriate. Table A.1 on page 61 of EPA's document entitled, *MOVES2014 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity* could be used to develop adjustments to the compliance factor to account for this discrepancy.

These adjustments are percentages of VMT by the various regulatory weight classes within a source type. After reviewing the table, users should sum the adjustments for weight classes within the source types, which are covered by I/M program. The sum of these adjustments provide users with a multiplicative factor that could be applied along with compliance and waiver rates as already discussed in Section 6.4.6.

6.5 **FUELS**

The four tables represented under fuel are Fuel Formulation, Fuel Supply, Fuel Usage Fraction and Alternative Vehicle Fuels and Technology (AVFT). These tables interact by defining the fuels used in the area being modeled. In MOVES2014, the tables are accessed through a single tab in the County Data Manager (CDM). The Fuel Usage Fraction is the only new table that was not available in the previous MOVES versions. MOVES defaults for these tables are available and could be accessed using the Export Default Data button in the Fuel Tab of the CDM.

The MSCP developed the Fuel Formulation and Fuel Supply Tables, while it used the appropriate default Fuel Usage Fraction for the criteria and GHGs pollutants emissions' estimates because no local data were available. MSCP also used the modified AVFT file that EPA developed as part of the input file for MOVES. Moreover, the Fuel Supply Table identified the fuel formulations used in a region as well as its particular market share, while the Fuel Formulation Table itself defined the fuel properties such as RVP, sulfur level, ethanol volume, aromatic and olefin contents, etc. On the other hand, the Fuel Usage Fraction Table defined the frequency at which E-85 capable vehicles also known as flex fuel vehicles use E-85 vs.

conventional gasoline. The AVFT Table was used to enumerate the fraction of fuel types capable of being used by model year and source types.

Furthermore, when modeling an area, fuels should correspond to the temperature profile for a given month. For example, a wintertime diurnal temperature profile using the MonthID = 7 should not use July fuels, but rather such wintertime diurnal temperature profile to be used should be January fuels. If in a run, the user does not choose output that does not distinguish rates by fuel type, the mix of gasoline/diesel/CNG would be determined by the default AVFT (i.e. the fuel type and technology allocations). However, if in a run the user selects output that is distinguished by fuel type, the AVFT values would not be applied, instead an appropriate mix of activity by fuel type would be applied during post-processing.

6.5.1 **Regional Fuels**

The main goal in the development of the regional fuels approach was to aggregate fuels into larger and more representative areas. By this methodology, eleven general fuel regions were created for the United States and major territories. These fuel regions were initially based on existing Petroleum Administration for Defense Districts' (PADDS') boundaries. These PADDS' boundaries were based on historic division of fuel supply areas, which were originally developed in the 1950s, and were then adjusted to account for broad fuel distribution corridors and the presence of bulk fuel pipelines and terminals. These PADDs are the geographic aggregations of the 50 states and the District of Columbia, which were divided into five districts as follows:

a). PADD1- East Coast.
b). PADD2 – Midwest.
c). PADD3 – Gulf Coast.
d). PADD4 – Rocky Mountain.
e). PADD5 – West Coast.

The MOVES2014 regional fuel areas are defined by the region County table in the MOVES default database. Table 6-1 below illustrates the MOVES2014 Fuel Regions, while Table 6-2 identifies the regionID in MOVES2014.

TABLE 6.5.1-a MOVES2014 Fuel Regions

Region ID#	Region Name	Description
1	East Coast	East coast states up to Appalachians, Florida, and gulf coast region
2	Midwest	Midwest states up to Appalachians (not including Wisconsin), Tennessee, Kentucky
3	South	Southern states not including gulf coast, Nebraska, Iowa
4	North	North and South Dakota, Minnesota, Wisconsin
5	Rocky Mtns	Pacific northwest, Rocky mountain states, Utah
6	CA/NV/AR	California, Nevada, Arizona, AK, and HI NOT using Reformulated Gasoline (RFG)
11	East Coast RFG	East coast states and regions using RFG fuel or under a controlled fuel program
12	MD/VA	Maryland and Virginia regions using RFG fuel or under a controlled fuel program
13	Texas RFG	Texas regions using RFG fuel or under a controlled fuel program
14	Midwest RFG	Midwest regions using RFG fuel or under a controlled fuel program
15	California	California using California fuel, Nevada and Arizona regions using California Fuel

TABLE 6.5.1-b RegionID in MOVES2014

RegionID	AA, Base Region ID#	Base Region Name	BB, Maximum summer RVP (psi) or 00 for ASTM	CC, E10 RVP Waiver (00=1 psi waiver, 01=no waiver)	DD, Minimum ethanol volume, %	XX (Reserved for future use)
0	1	East Coast	0.0	0	0	0
100000000			0.0	0	0	0
100010000			0.0	1	0	0
170000000			7.0	0	0	0
178000000			7.8	0	0	0
178010000			7.8	1	0	0
200000000	2	Midwest	0.0	0	0	0
270000000			7.0	0	0	0
278000000			7.8	0	0	0
278010000			7.8	1	0	0
300000000	3	South	0.0	0	0	0
370000000			7.0	0	0	0
370010000			7.0	1	0	0
400000000	4	North	0.0	0	0	0
500000000	5	Rocky Mtns	0.0	0	0	0
578000000			7.8	0	0	0
600000000	6	CA/NV/AR/All Others	0.0	0	0	0
678000000			7.8	0	0	0
1170011000	11	East Coast RFG	7.0	1	10	0
1270011000	12	MD/VA RFG	7.0	1	10	0
1370011000	13	Texas RFG	7.0	1	10	0
1470011000	14	Midwest RFG	7.0	1	10	0
1570011000	15	California	7.0	1	10	0

6.5.2 Fuel Supply

The Fuel Supply Table classifies the fuel formulation that is used in an area, and each formulation's respective market share. Once the fuel formulation for the area being modeled had been modified, the Fuel Supply Table could be populated. The populated table is indicated in Table 6-3, and due to its large size, only a portion of the entire table could be shown.

TABLE 6.5.2-a Fuel Supply

fuelRegionID	fuelYearID	monthGroupID	fuelFormulationID	marketShare	marketShareCV
1270011000	2014	1	1401	1	0
1270011000	2014	2	1402	1	0
1270011000	2014	3	1403	1	0
1270011000	2014	4	1404	1	0
1270011000	2014	5	1405	1	0
1270011000	2014	6	1406	1	0
1270011000	2014	7	1407	1	0
1270011000	2014	8	1408	1	0
1270011000	2014	9	1409	1	0
1270011000	2014	10	1410	1	0
1270011000	2014	11	1411	1	0
1270011000	2014	12	1412	1	0
1270011000	2014	1	21501	1	0
1270011000	2014	2	21502	1	0
1270011000	2014	3	21503	1	0
1270011000	2014	4	21504	1	0
1270011000	2014	5	21505	1	0
1270011000	2014	6	21506	1	0
1270011000	2014	7	21507	1	0
1270011000	2014	8	21508	1	0
1270011000	2014	9	21509	1	0
1270011000	2014	10	21510	1	0
1270011000	2014	11	21511	1	0
1270011000	2014	12	21512	1	0
1270011000	2014	1	190	1	0
1270011000	2014	2	190	1	0
1270011000	2014	3	190	1	0
1270011000	2014	4	190	1	0
1270011000	2014	5	190	1	0
1270011000	2014	6	190	1	0
1270011000	2014	7	190	1	0
1270011000	2014	8	190	1	0
1270011000	2014	9	190	1	0
1270011000	2014	10	190	1	0
1270011000	2014	11	190	1	0
1270011000	2014	12	190	1	0

The Fuel Supply Table as shown in Table 6-3 has six fields which are the fuelregionID, the fuelyearID, the monthgroupID, the fuelformulationID, the marketShare and the marketShareCV. These fields are briefly described as follows:

The fuelregionID field was created based on the new analysis of nationwide fuel use, which prompted a change in how fuels are defined at the county level in the default database. Consequently, the default fuel supply is divided into fuel regions instead of each county having a unique fuel supply. The noticeable impact of this change could be seen in the fuel supply table where the column for countyID has been replaced with the RegionID. MSCP had utilized the RegionIDs 1 and 12 for the inventory of the criteria pollutants and GHGs as contained in this document.

The monthgroupID field is the same as the monthID; for the monthgroupID field was built in to permit the possibility of seasonal fuels, but that option is not functional at present.

The fuelformulationID field identifies the fuel used in the area and this is the number that is entered in the fuel supply table.

The Marketshare field represents the fraction of the volume of each fuel's formulation that is consumed in the area. It is significant that the Marketshare should sum to one within each fuel type.

The MarketshareCV field represents the coefficient of variation for the market share. This field could be used when uncertainty calculations were enabled. In Maryland, the value is not required and a zero was entered.

6.5.3 **Fuel Formulation**

The Fuel Formulation Table describes the elements such as RVP, sulfur level, ethanol volume, etc. of each fuel. The MSCP prepared the elements of the 2014 Fuel Formulation Table from the Monthly Retail data obtained from the Fuel Tax Division of the Comptroller's Office. A database each was created to enter the values of the gasoline and diesel fuels from these monthly retail data for all the 12 months of 2014. After this, an access program was written to process the average monthly values for all the elements of the gasoline and diesel fuels. For instance, the gasoline fuel is in 3 grades (regular, mid-grade and premium). The weighted average of the gasoline fuel grade was calculated by using EPA's methodology. The diesel fuel is in one grade and access program was also used to calculate the monthly average for all the 12 months of 2014.

These average values represented the elements of the gasoline and diesel in the Fuel Formulation Table. The default values were used for CNG, E-85 and electricity. As a result of the large size of the formulation table, a portion of the fuel formulation table is shown in Table 6-4 of this documentation.

The key fields in the fuel formulation table as shown in Table 6-4 were briefly described as follows:

Fuel Formulation ID: This field identifies the fuel used in the area and this is the number that is entered in the fuel supply table. In MOVES2014, the existing fuel formulation ID could be modified or a new formulation ID could also be created.

Fuel Subtype ID: This number provided a small level of detail about the type of fuel the formulation was describing, but in some cases, there could be more than one fuel subtype that also described the fuel formulation. For instance, the fuel reformulation could be gasoline blended with 10% ethanol or the one blended with MTBE that was earlier used in the gasoline mixture. Hence, a different fuel subtype ID is assigned to this different gasoline mixture.

RVP means 'Reid Vapor Pressure', which was measured in pounds per square inch (psi). This field was used to define the volatility of gasoline.

Sulfur Level: The sulfur level was measured in parts per million (ppmw) in terms of weight. Sulfur levels should be entered for all gasoline and diesel fuels. It should be noted that the Tier2 gasoline sulfur rule established a national average of 30 ppmw sulfur and a cap of 80 ppmw. As for diesel fuel, the ultra-low sulfur rule requires that at least 80% of the highway diesel fuel sold should meet the 15 ppm, while the remaining 20% should meet the Low Sulfur Diesel Standard of 500 ppm.

Ethanol Volume: This field represents the percent by volume of ethanol in the gasoline/ethanol mixture.

MTBE Volume: This field represents the percent by volume of methyl tertiary butyl ether (MTBE) in the gasoline/MTBE mixture. The gasoline that is being supplied to Maryland does not contain any significant amount of MTBE because of the MTBE concentrations, which were found in water in some areas. So a zero value was entered in the MTBE Volume column.

ETBE Volume: This field represents the percent by volume of ethyl tertiary butyl ether (ETBE) in the gasoline/ETBE mixture. A value of zero was entered in the ETBE Volume column because there was no trace of ETBE concentrations in the gasoline that is being supplied to Maryland.

TAME Volume: This field represents the percent by volume of tertiary amyl methyl ether (TAME) in the gasoline/TAME mixture. A value of zero was entered in the TAME Volume column because there was no trace of TAME concentrations in the gasoline that is being supplied to Maryland.

Aromatic Content: This field represents the percent by volume of aromatic hydrocarbon compounds in gasoline. A value of zero was entered for diesel fuel, CNG, E-85 and electricity.

Olefin Content: This field represents the percent by volume of olefin hydrocarbon compounds in gasoline. A value of zero was entered for diesel fuel, CNG, E-85 and electricity.

Benzene Content: This field represents the percent by volume of benzene in gasoline. A value of zero was entered for diesel fuel, CNG, E-85 and electricity.

E200: This field represents the percent of gasoline that had evaporated at 200 degrees Fahrenheit. A value of zero was entered for diesel fuel, CNG, E-85 and electricity.

E300: This field represents the percent of gasoline that had evaporated at 300 degrees Fahrenheit. A value of zero was entered for diesel fuel, CNG, E-85 and electricity.

T50: This field represents the temperature at which 50 percent of the gasoline had evaporated. A value of zero was entered for diesel fuel, CNG, E-85 and electricity.

T90: This field represents the temperature at which 90 percent of the gasoline had evaporated. A value of zero was entered for diesel fuel, CNG, E-85 and electricity.

As a result of the large size of the formulation table, a portion of the fuel formulation table is illustrated in Table 6-4 of this documentation.

TABLE 6.5.3-a Fuel Formulation

fuelFormulationID	fuelSubtypeID	RVP	sulfurLevel	ETOHVol	MTBEVol	ETBEVol	TAMEVol	aromaticC	olefinC	benzeneC	e200	e300	T50	T90
1401	12	12.9	23	10.9	0	0	0	18.8	10.5	0.3	57.5	87.2	157.0	316.4
1402	12	12.9	22	12.2	0	0	0	18.7	10.4	0.3	57.6	87.2	156.7	315.6
1403	12	12.8	22	10.8	0	0	0	19.7	10.2	0.3	57.5	86.9	157.4	316.4
1404	12	11.7	21	10.7	0	0	0	19.9	10.1	0.4	55.8	87.5	165.7	312.8
1405	12	7.5	17	10.5	0	0	0	18.6	8.2	0.4	48.1	87.1	203.7	316.1
1406	12	6.9	22	10.4	0	0	0	19.9	8.6	0.3	47.0	86.2	209.1	320.5
1407	12	7.0	22	10.5	0	0	0	17.0	8.7	0.3	47.2	85.9	207.8	323.3
1408	12	6.9	22	10.4	0	0	0	16.8	8.5	0.3	46.7	85.6	209.3	324.2
1409	12	7.5	23	10.5	0	0	0	17.6	9.9	0.3	48.8	85.8	200.6	323.0
1410	12	10.7	23	10.6	0	0	0	18.2	10.1	0.4	54.5	86.6	173.1	319.1
1411	12	12.3	22	10.8	0	0	0	19.7	9.9	0.4	55.9	87.2	164.4	315.8
1412	12	12.9	23	10.7	0	0	0	18.9	10.1	0.3	57.2	88.4	160.5	309.4
21501	20	0	8	0	0	0	0	0	0	0	0	0	0	0
21502	20	0	8	0	0	0	0	0	0	0	0	0	0	0
21503	20	0	8	0	0	0	0	0	0	0	0	0	0	0
21504	20	0	8	0	0	0	0	0	0	0	0	0	0	0
21505	20	0	7	0	0	0	0	0	0	0	0	0	0	0
21506	20	0	9	0	0	0	0	0	0	0	0	0	0	0
21507	20	0	8	0	0	0	0	0	0	0	0	0	0	0
21508	20	0	7	0	0	0	0	0	0	0	0	0	0	0
21509	20	0	7	0	0	0	0	0	0	0	0	0	0	0
21510	20	0	7	0	0	0	0	0	0	0	0	0	0	0
21511	20	0	7	0	0	0	0	0	0	0	0	0	0	0
21512	20	0	8	0	0	0	0	0	0	0	0	0	0	0
190	90	0	0	0	0	0	0	0	0	0	0	0	0	0
230	30	0	0	0	0	0	0	0	0	0	0	0	0	0
251	51	7.7	8	74	0	0	0	0	0	0	49.9	89.5	200	300

6.5.4 **Fuel Usage Fraction**

A new table called 'Fuel Usage Fraction' became part of the fuel input files that need to be imported into the MOVES GUI through the CDM. This table contains the countyID, fuelYearID, modelYearGroupID, sourceBinFuelTypeID, fuelSupplyFuelTypeID and usageFraction, and each field is described later in this section. E-85 capable vehicles, which are also known as flex-fuel vehicles, (FFVs) do exist throughout the nation.

These vehicles are capable of using either conventional gasoline or E-85 fuel, which is a blend of 85% ethanol and 15% gasoline by volume. The Fuel Usage table classifies the fraction of E-85 use among E-85 capable vehicles but it is not the fraction of use among all vehicles or the fraction of E-85 capable vehicles in the fleet. It should also be noted that the fuel E-85 should always be selected in the On-road Vehicle Equipment Panel because FFVs are there in the national fleet.

Therefore, the Fuel Usage Fraction inputs turn out to be the appropriate place to account for the amount of actual E-85 usage by the FFVs. Since local data is not available, the MSCP utilized the appropriate default Fuel Usage Fraction Table for the inventory of the 2014 criteria and GHGs pollutants as shown in Table 6-5 of this document.

TABLE 6.5.4-a Fuel Usage Fraction

countyID	fuelYearID	modelYearGroupID	sourceBinFuelTypeID	fuelSupplyFuelTypeID	usageFraction
24003	2014	0	1	1	1
24003	2014	0	2	2	1
24003	2014	0	3	3	1
24003	2014	0	4	4	1
24003	2014	0	5	1	0.982134
24003	2014	0	5	5	0.017866
24003	2014	0	9	9	1

The fuel usage fraction in Table 6-5 of this document contains the following fields:

CountyID: This indentifies the county that is being modeled.

fuelYearID: This indentifies the year of evaluation.

modelYearGroupID: This is sometimes refers to as the engine size. However, a value of zero is entered.

sourceBinFuelTypeID: This indentifies all the available fuels including placeholder’s fuels.

fuelSupplyFuelTypeID: This indentifies the fraction of fuel mixtures. For instance, if the fuel is gasoline only, the fuelSupplyFuelTypeID is equal to 1, which means that the fuel is 100% gasoline.

usageFraction: This identifies the fraction of fuel that is being used in the area that is being modeled by capable E-85 vehicles. For example, if the fuel usage fraction was 1.0 in the fuelSupplyFuelTypeID = 5 column, showed that E-85 capable vehicles (FFVs) were using E-85 100% of the time. On the other hand, if the fuel usage fraction was zero in the fuelSupplyFuelTypeID = 5 column, showed that FFVs were using gasoline 100% of the time. It could also indicate that there was no E-85 available in the local fuel supply.

6.5.5 **Alternate Vehicle Fuel Technology (AVFT)**

This table contains the 13 MOVES source types with the fuel engine fraction of each vehicle using different fuels and technologies in each model year. This table permits the users to modify the fraction of vehicles using different fuels and technologies in each model year. This means that the Fuel Tab allows users to define the split between diesel, gasoline, ethanol, CNG and electricity for each vehicle type and model year. For instance, if in a certain county, it was found that the sales data showed that more diesel vehicles were sold than gasoline vehicles, this tab could be used to make the necessary adjustment to reflect the sales data for this particular county.

The State has adopted both the California Low Emission Vehicle (CALEV) and Zero Emission Vehicle (ZEV) Programs. Moreover, the portion of this table reflects the impact of the modeling of the evaporative portion of the ZEV Program, which affects only source types 21, 31 and 32. It should be noted that each state should make sure that the fuel engine fraction of each fuel should be adjusted in this table according to EPA's Guidance. Based on this information, MSCP appropriately adjusted the AVFT Table for source types 21, 31 and 32 to reflect the implementation of the ZEV Program in the State beginning in model year 2011.

Furthermore, for transit buses, the default table assumed that gasoline, diesel and CNG buses were present in the fleet for most model years. However, if the user has the information about the fuel used by the transit bus fleet in a particular county, the user should make sure that this information is reflected in the AVFT table. For example, if in the modeling area, there are no CNG transit buses, the user needs to allocate zero activity to GNG transit buses in the AVFT Table in order to calculate the correct emission results for transit buses. If this is not done, some VMT would be allocated to CNG transit buses, and the emissions associated with this VMT would not be included in the output, since only gasoline and diesel vehicles were selected in the On-road Vehicle Equipment Panel of the MOVES GUI.

As a result of the enormous size of the AVFT Table, Table 6-6 of this document could only show a portion of the AVFT Table. In addition, Table 6-6 specifically showed the fuel engine fraction for source type 21, which was one of the source types that were affected by the implementation of the CALEV and ZEV Programs that began in the State in calendar year 2011, which also coincided with model year 2011.

Other inputs files that were imported into the MOVES GUI include starts, hotelling and retrofit data. MSCP opted for the default values of these input files because local data were not available.

TABLE 6.5.5-a AVFT

SourceTypeID	modelYearID	fuelTypeID	engTechID	fuelEngFraction
21	2009	1	1	0.948159
21	2009	2	1	0.007368
21	2009	5	1	0.044473
21	2009	9	30	0
21	2010	1	1	0.935791
21	2010	2	1	0.010123
21	2010	5	1	0.054087
21	2010	9	30	0
21	2011	1	1	0.812126
21	2011	2	1	0.011746
21	2011	5	1	0.066128
21	2011	9	30	0.11
21	2012	1	1	0.786923
21	2012	2	1	0.011746
21	2012	5	1	0.081331
21	2012	9	30	0.12
21	2013	1	1	0.823469
21	2013	2	1	0.011746
21	2013	5	1	0.044785
21	2013	9	30	0.12
21	2014	1	1	0.823632
21	2014	2	1	0.011746
21	2014	5	1	0.044622
21	2014	9	30	0.12
21	2015	1	1	0.804509
21	2015	2	1	0.011746
21	2015	5	1	0.043745
21	2015	9	30	0.14

6.5.6 **Fuel Wizard**

This is a new feature in MOVES2014. It is a tool for modifying interrelated properties in a user fuel formulation table when analysis of a change in fuel is desired. For instance, the fuel wizard was used to change the current gasoline sulfur content to 10 ppm to model the effects of gasoline sulfur as required by the Tier3 sulfur content standard, which could also affect other fuel properties. In this case, the Fuel Wizard would appropriately modify related fuel formulation properties, based on refinery modeling, to reflect the change made to sulfur content level.

Once the Wizard is opened, the user could select the desired fuel formulation from the fuelformulation table of the importer database, and from the drop-down field, select the property that needs to be changed, which in this case, is the sulfur content. Then, the Fuel Wizard would automatically adjust related fuel properties in a manner that is consistent with refinery modeling results. As a result of this, the Wizard would display the old and new fuel properties, and the user may accept or reject the change. Furthermore, it is recommended that fuel property changes should be made in ascending order of priority, as the Wizard is only capable of changing one property at a time. In addition, it should be noted that by changing a single fuel property such as sulfur content or RVP, other properties like aromatics or the distillation properties change as well.

Furthermore, the Fuel Wizard contains adjustment factors for three fuel properties (ethanol, sulfur and RVP), which are the most commonly analyzed fuel properties for state and local programs. Moreover, the Fuel Wizard is also currently capable of creating fuels with ethanol variations (E0-E15), sulfur from 5 ppm to 80 ppm and RVP from 5 psi to 14 psi.

6.6 **OTHER VEHICLE TECHNOLOGY AND CONTROL STRATEGY DATA**

6.6.1 **Federal Programs**

Current federal vehicle emissions control and fuel programs had been incorporated into the MOVES2014 software. These include the National Program standards covering model year vehicles through 2016. Modifications of default emission rates were required to reflect the early implementation of the National Low Emission Vehicle (NLEV) Program in Maryland.

6.6.2 **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 (CALEV). CALEV was implemented beginning in 2011. CALEV also required all 2011 model year and newer vehicles gross vehicle weight rating (GVWR) to be up to 14,000 lbs. registered in Maryland to meet California emission standards for both criteria and greenhouse gas pollutants. In addition, CALEV also contains a zero emission vehicles' (ZEVs') component that required the manufacturers to produce a certain percentage of zero emission vehicles such as electric, fuel cell, etc., to be purchased in the State. California had just adopted new amendments to the Low-Emission Vehicle regulations entitled, California Low Emission Vehicle III (CALEVIII), which is known as third generation low emission vehicle standards. These amendments created more stringent emission standards for new motor vehicles. These new standards would be phased-in over the 2015-2025 model years in the State.

The impacts of CALEVIII were modeled for all analysis years using USEPA's Guidance document entitled, *Instructions for Using LEV and NLEV Inputs for MOVES2014,* EPA-420-B-14-060a October 2014. To reflect the impact of both NLEV and CALEVIII programs, USEPA had provided inputs in the form of two databases and one spreadsheet file. The emission rates in these files were to be used only in states other than California, which had adopted the California LEVIII standards, as well as states in the Ozone Transport Commission (OTC), which also received early implementation of NLEV standards. The ZEV file and the CA LEVIII's database were modified according to USEPA's Guidance in the State of Maryland, to reflect the start date that began in 2011.

6.7 POST-PROCESS SUITE (PPSUITE)

PPSUITE is a software tool that is widely used for estimating speeds and processing emission rates. It is a process that is integral to produce key input files to the MOVES emission model. Moreover, PPSUITE utilizes a number of programs and operations, which are assembled into a chain of jobs and steps. Michael Baker Jr. Intl. Inc. has utilized the CENTRAL software to provide MDE with the ability to manage efficiently the emission calculation process.

6.7.1 Other PPSUTE Inputs

The other files required by PPSUITE, which are used for all yearly analysis runs include:

- EQUIV.DBF, which is used for input pattern files and output aggregation.
- NAME.DBF, which is used for the output emission reports. It also relates the coded facility and area type numbers to txt names.
- VEHFC2_14SHA.DAT, which contains the impacts of truck percentages on roadway capacity. Consequently, the amount of trucks could have an impact on calculated congested speeds.
- SPDCAP05.DBF. This file contains the free flow speeds, free flow capacities and BPR parameters , which represents the relationship between speed and congestion for each facility and area types as well as lane combination.

6.7.2 **Speed/Capacity Lookup Information**

The speed-lookup table has a significant impact on calculated speeds and capacities for each roadway link. This file is used to determine free-flow speeds for links without coded speed limits, link "ideal" capacity, signal densities and characteristics and speed/congestion relationships. The speed capacity fields include inter alia AREATYPE, which is used to indicate area type code, FACTYPE, which represents facility code, LANES, which indicates number of directional lanes, etc.

6.7.3 **Running the Air Quality Process in Central**

The statewide emission calculation process had been set up to use CENTRAL to assist the user in running the individual program steps. This CENTRAL Program provides a customized windows user-interface with dialog boxes, edit fields and buttons, which are designed specifically for this process. The CENTRAL software had been licensed to MDE, which is always renewed every year and had been used for past regional air quality and conformity analyses as well as the inventories documented herein. This process also requires the PPSUITE software had to be installed in conjunction with MOVES2014 on the computer hard-drive.

6.7.4 **Directory and File Structure**

The CD-ROM that Michael Baker Jr. Intl. Inc. provided contains the MDMOVES14's directory. This directory contains the input files and program driver files that were needed for producing the emission runs. This directory also contains the following sub-directories:

- ! CENTRAL.
- COMMON.
- DRIVERS.
- MOVESINPUTS.
- OUT.
- OUT_RATETABLE.
- OUT_SUMMARY.
- PROGRAMS.
- TRAFFICINPUTS.

6.7.5 **Zone/Area Equivalency**

The Zone/Area equivalency file is used to provide equivalency between each link and the fields used for hourly and vehicle mix pattern indexing and output emission indexes. The user is not required to make any adjustments to the file, and even updates to the network and pattern data area.

The fields included in the equivalency file are as follows:
The fields that PPSUITE used in the analysis consist of COUNTY, which defines the county number for pattern and VMT area indexing and NAME that provides the county name.

On the other hand, the fields that are not used in the analysis, but kept for reference include the following:

- ZONE represents traffic zone number, which is linked to the network database field with the same name. This field represents a combination of the county number and the urban-rural code value in the RURURB field. This is calculated as (COUNTY*10) + RURURB.

- UR is related to the RURURB field values.

- FLIPS_CO represents county FIPS code.

- DISTRICT defines the district the county falls under.

- CO_CODE represents county code.

6.7.6 **Names Database File**

This file is used in generating output emission reports. It transmits the coded facility and area type numbers to text names. This file should only be updated if the area and facility index numbering scheme had been changed from its present values. The NAMES.DBF file contains the emission county totals generated emission reports.

6.7.7 **Running the CENTRAL Process**

The CENTRAL menu system, which is basically a screen menu system, has been setup to produce emission estimates. This screen menu system comprises the work area directory specified as C:\MDMOVES14, while all output files would be placed in "OUT" subdirectory. It should also be noted that the "Primary Control File" should always be specified as the MDMOVES.CTL file, which could be found in the CENTRAL subdirectory. Furthermore, the user could also select the appropriate directories and files by using the "Select" button on the right side of each input option. After the completion/verification of the "Work Area Directory" and the "Primary Control File", the user could select the "GO" button, which would open other menu screens. This screen allows the user, in this case MSCP to choose between the "Run Emission Process" and the "Run Post Processing Steps". The "Run Post Processing Step" is used to combine emission results for multiple counties.

6.8 ANALYSIS METHODOLOGY

The previous sections summarized the input data used for computing speeds and emission rates for 2014 motor vehicle highway emission estimates' inventories. This section describes how PPSUITE and MOVES used the MOVES input data to produce criteria and GHG emission estimates. Figure 6.6 presents a more detailed overview of the PPSUITE analysis procedure using the available traffic data information described in the previous section.

6.8.1 VMT Preparation

Producing an emissions' inventory with PPSUITE requires a complex process of disaggregation and aggregation of vehicle activities. The data that was available was used on a very small scale -- individual ½ mile roadway segments for each of the 24 hours of the day. This data needed 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. The key steps in the preparation of VMT for a summer daily run include:

- *Application of Seasonal Adjustments* - PPSUITE took the input daily volumes from SHA (which represents AADT traffic) and seasonally adjusted the volumes to an average weekday in July. This adjustment utilized factors developed for each functional class and urban/rural code. VMT could then be calculated for each link using the adjusted weekday volumes.

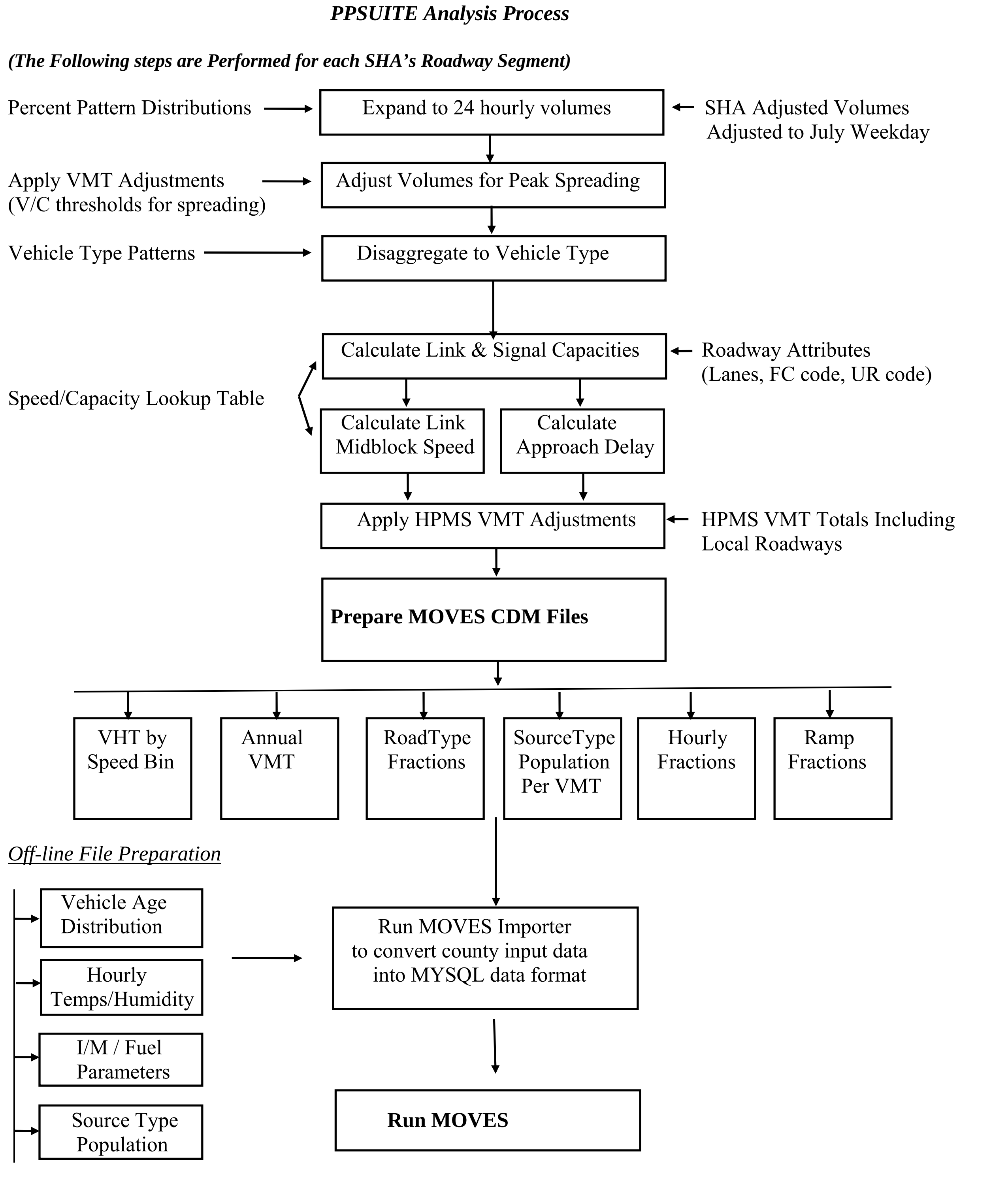
- *Disaggregation to Hours* - After seasonally adjusting the link volumes, the volumes were split to each hour of the day. These seasonal adjustments allowed for more accurate speed calculations factoring in the effects of congested hours, thereby allowing PPSUITE to prepare the hourly VMT and speeds for input to the MOVES model.

- *Peak Spreading* - After dividing the daily volumes to each hour of the day, PPSUITE identified hours that were unreasonably congested. For those hours, PPSUITE then extended a portion of the volume to other hours within the same peak period, thereby approximated the “peak spreading” that normally occurred in such over-capacity conditions.

- *Disaggregation to Vehicle Types* - USEPA requires VMT estimates to be prepared by source types, reflecting specific local characteristics. As a result, for Maryland’s emission inventory runs, the hourly volumes were disaggregated to the five HPMS MOVES vehicle grouping based on count data assembled by SHA in combination with MOVES defaults as described in the previous section.

- *Application of HPMS VMT Adjustments* - Volumes must also be adjusted to account for differences with the HPMS VMT totals, as described previously. VMT adjustment factors were provided as input to PPSUITE, and were 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 that is added or subtracted to the SHA's database assumed the speeds calculated using the original volumes for each roadway segment for each hour of the day.

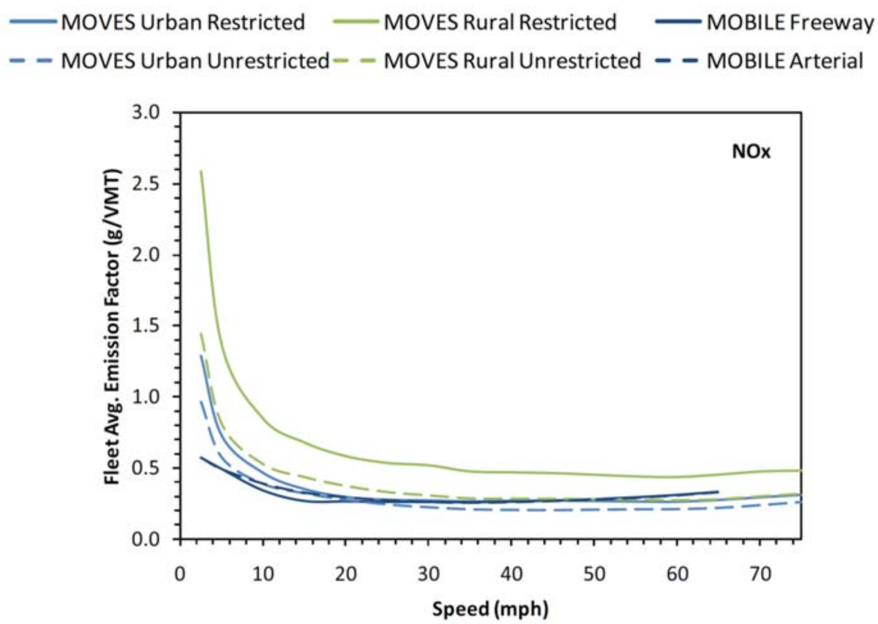
Figure 6-6: PPSUITE Speed/Emission Estimation Procedure



6.8.2 **Speed Estimation**

Emissions for many pollutants (including both VOC and NOx) vary significantly with travel speed. VOCs generally decrease as speed increases, while NOx decreases at the low speed range and increases at higher speeds, as illustrated in Figure 6.7.

Figure 6-7: Emission Factor vs. Speed Variances (NO_X)



Source: Figure 3 from Implications of the MOVES2010 Model on Mobile Source Emission Estimates, Air & Waste Management Association, July 2010.

USEPA recognizes that the estimation of vehicle speeds is a difficult and complex process. Moreover, it recommends that special attention should be given to developing reasonable and consistent speed estimates, knowing that emissions are so sensitive to speeds. Furthermore, 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 met and exceeded that recommendation. Speeds were individually calculated for each roadway segment by hour, and they included 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 was 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 could be represented in the MOVES speed input file. For the motor vehicle highway emissions' inventory, distributions of speeds were input to MOVES by both road type and source type by each hour of the day.

To calculate speeds, PPSUITE first obtained initial capacities (how much volume the roadway could 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 contained default roadway information indexed by the urban/rural code and functional class. For areas with known characteristics, values could be directly coded to the SHA's database, and the speed/capacity data could be overwritten.

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 was an estimated average travel time for each hour of the day for each highway segment. The average time multiplied by the volume produced by VHT.

6.8.3 **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 were provided as inputs to MOVES GUI through the CDM.

VMT Input File: VMT is the primary traffic input that affects emission results. The roadway segment distances and traffic volumes were used to prepare estimates of VMT. PPSUITE performed these calculations and the MOVES annual VMT input file was imported into the MOVES GUI through the 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 were used to the fullest extent and was consistent with the methods and recommendations provided in USEPA's Technical Guidance.

Road Type Distributions**:** In MOVES, typical drive cycles and associated operating conditions vary by the type of roadway.

MOVES define 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 was automatically generated by PPSUITE using defined equivalencies. The off-network road type included 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's 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 USEPA’s Technical Guidance.

6.8.4 MOVES Runs

After computing speeds and aggregating VMT and VHT, PPSUITE prepared traffic-related inputs needed to run USEPA’s MOVES2014 software. Additional required MOVES inputs were prepared external to the processing software, which included temperatures, I/M program parameters, fuel characteristics, vehicle fleet age distributions and source type population.

The MOVES county importer was run in batch mode. This program converted all data files into the MYSQL formats used by the MOVES model. At that point a MOVES run specification file (*.mrs) was created that specified options and key data locations for the run. MOVES was then executed in batch mode.

MOVES could be executed using either the *inventory* or *rate-based* approaches. For this highway emissions inventory, MOVES was applied using the *inventory-based* approach. Under this method, actual VMT and population were provided as inputs to the model, and MOVES was responsible for producing the total emissions for the area being modeled. 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 emissions for the area being modeled.

6.9 FUEL CONSUMPTION ESTIMATES

The MOVES output energy rates could be converted to fuel consumption values using the conversion rates for gasoline and diesel fuel (See equation 1-1 and 4-12 for the conversion of fuel from kilojoules to gallons).

The estimated 2014 fuel consumption values are shown in Table 6-7 below. The 2014 values were compared to the actual statewide fuel sales as illustrated in the last column of Table 6-7.

TABLE 6.9.1-a 2014 Fuel Consumption Estimates

Scenario	Fuel Type	MOVES2014 Output		Actual Statewide Fuel Sales[2] *(Thousand gallons)*
		Energy Consumption *(Trillion KJ)*	Estimated Fuel Consumption[1] *(Thousand Gallons)*	
2014	Gasoline	308.9	**2,605,438**	**2,763,987**
	Diesel	85.8	**619,549**	**479,572**

TABLE 6.9.1-b Fuel Properties

Fuel	Fuel Density	Energy Content
	g/gallon	KJ/g
Gasoline (E10)	**2839**	**41.762**
Conventional Diesel Fuel	**3167**	**43.717**

$$Fuel(gallons) = Energy(KJ) \times \left(\frac{1}{energyContent}\right)\left(\frac{g}{KJ}\right) \times \left(\frac{1}{fuelDensity}\right)\left(\frac{gallons}{g}\right) \quad Equation\ 1-1$$

6.10 RESOURCES

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2. California Environmental Protection Agency, Air Resources Board, *California GHG Emission Inventory, 0F1F California Greenhouse Gas Emissions for 2000 to 2014 – Trends of Emissions and Other Indicators*, June 17, 2016.

3. Michael Baker Jr. Inc., *Maryland Statewide Air Quality Estimation Process Using MOVES-PPSUITE User Guide*, June 2012.

4. Mobile Sources Control Program, *1990 Inventory of Highway Vehicle Emissions for the Baltimore Ozone Nonattainment Area, the Queen Anne's/Kent County Ozone Nonattainment Area, the Cecil County , Maryland portion of the Philadelphia, Pennsylvania Ozone Nonattainment Area, and the remainder of the State of Maryland*, August 23, 1993.

5. Mobile Sources Control Program, *1996 Inventory of Highway Vehicle Emissions for the Baltimore Ozone Nonattainment Area, the Queen Anne's/Kent County Ozone Nonattainment Area, the Cecil County, Maryland portion of the Philadelphia, Pennsylvania Ozone Nonattainment Area, and the remainder of the State of Maryland*, August 9, 1999.

6. Mobile Sources Control Program, *2005 Inventory of Highway Vehicle Emissions for the Baltimore Ozone Non-Attainment Area, the Queen Anne's/Kent County Non-Attainment Area, the Cecil County, Maryland portion of the Philadelphia, Pennsylvania, Non-Attainment Area, and remainder of the State of Maryland*, August 2007.

7. United States Environmental Protection Agency and United States Department of Transportation, *Final Rulemaking to Establish Greenhouse Gas Emission Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles*, August 2011.

8. United States Environmental Protection Agency, *Brake and Tire Wear Emissions f*rom *On-road Vehicles in MOVES2014*, November 2015.

9. United States Environmental Protection Agency, *Emission Adjustments for Temperature, Humidity, Air Conditioning, and Inspection and Maintenance for On-road Vehicles in MOVES2014*, November 2015.

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15. United States Environmental Protection Agency, *Instructions for Using LEV and NLEV Inputs for MOVES2014*, August 2014.

16. United States Environmental Protection Agency, *Motor Vehicle Emission Simulator (MOVES), User Guide for MOVES2014*, July 2014.

17. United States Environmental Protection Agency, *MOVES2014 Software Design Reference Manual*, December 2014.

18. United States Environmental Protection Agency, *MOVES2014 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity*, January 2015.

19. United States Environmental Protection Agency, *Population and Activity of On-road Vehicles in MOVES2014*, March 2016.

20. United States Environmental Protection Agency, *Speciation of Total Organic Gas and Particulate Matter Emissions from On-road Vehicles in MOVES2014*, November 2015.

6.11 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: vehicle types used in MOVES modeling

UR: Urban/rural cod e, 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't 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 (2014). These emissions were computed on an hourly basis with a specially-modified version of BEIS3[76] 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) 2014 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

[76] BEIS 3.142 can be downloaded from an EPA website at: https://www.epa.gov/air-emissions-modeling/biogenic-emission-sources

- ETH: Ethane group from CB-IV chemical mechanism
- 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 A-2

Projection Year State Implementation Plan Emissions Inventory Methodologies

Prepared by:
Maryland Department of the Environment

Maryland Department of the Environment
Projection Year Emissions Inventory Methodologies

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1.0 INTRODUCTION/BACKGROUND

This section describes the proposed approach to estimating future year emissions for the State of Maryland nonattainment areas for the purposes of meeting maintenance plan requirements.

In preparing the projection year inventories, the approach should address two components: (1) estimating expected changes in emissions generating activity between the base year (2014) and the projection year; and (2) accounting for changes in emission rates by source category resulting from air pollution regulations or the replacement of equipment with new, lower emitting technologies. For the first component, the best way for estimating activity changes is to pick an indicator for each source category that has available projections data and provides as direct as possible a link to emissions generating activity.

Possible sources of projections data, in order of preference, are: (1) State of Maryland economic/population projections at the State, sub-State level, or facility level, (2) recent regional economic projections, or (3) Site-specific activity data.

Modeling of control effects will focus on the source categories whose emission rates are expected to change between 2014 and 2025 or 2030. These source categories include on-road mobile sources, nonroad mobile sources, and residential wood combustion.

1.1 ON-ROAD MOBILE SOURCES

On-road mobile source emission projections to 2021 will be made using MOVES emission factors and projections of VMT by vehicle type, roadway functional classification, and associated speed by the BRTB and their staff, BMC and MDE.

BRTB and BMC will supply MDE with input data for projection years. The projection year emission estimates will take into account any fuels strategies that were adopted or planned for the area.

1.2 NONROAD MOBILE SOURCES

The Department used two methodologies approved by the EPA for developing the emissions inventory for nonroad categories. One of the methodologies used consisted of employing EPA's NONROAD[1] MOVES Model. In a memorandum[2], 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 surrogate economic or operational data from federal agencies. The NONROAD MOVES model was used to generate all nonroad mobile emission estimates except for the marine, air and rail source categories.

1 NONROAD2008 Model incorporated into MOVES2014.
2 USEPA Memorandum, dated June 16, 2003, from Gene Tierney or the Air Quality and Modeling Centery and Leila H. Cook of the Transportation and Regional Programs Division; to Regional Mobile Source Program Manages and Staff.

1.2.1 Marine-Air-Rail

The Marine-Air-Rail (M-A-R) source emissions were forecasted to the projection years using surrogate economic or operational data. Aircraft emission projections were grown using Federal Aviation Administration (FAA) Aircraft Operations Forecasts (TAFs or LTOs). Locomotives emission projections were grown using U.S. Energy Information Administration (EIA) Annual Energy Outlook (AEO) Rail data. Marine Vessels emission projections were grown using EIA AEO Marine Shipment data. The growth factors for the M-A-R sources are presented in the table below.

Table 1: Marine-Air-Rail (M-A-R) Growth Factors

M-A-R Source Category	SCC	Surrogate Growth Factor	GF 2021
Aircraft - Military	2275001000	EMP NAICS 481	1.0410
Aircraft - Commercial	2275020000	EMP NAICS 481	1.0410
Aircraft - General Aviation	2275050000	EMP NAICS 481	1.0410
Aircraft - Air Taxi	2275060000	EMP NAICS 481	1.0410
Marine Vessels, Commercial /Diesel /Port emissions	2280002100	EMP NAICS 483	1.1551
Marine Vessels, Commercial /Diesel /Underway emissions	2280002200	EMP NAICS 483	1.1551
Marine Vessels, Commercial /Residual /Port emissions	2280003100	EMP NAICS 483	1.1551
Marine Vessels, Commercial /Residual /Underway emissions	2280003200	EMP NAICS 483	1.1551
Locomotives - Class I Line Haul	2285002006	EMP NAICS 482	1.0000
Locomotives - Class II / III Line Haul	2285002007	EMP NAICS 482	1.0000
Locomotives - Passenger Trains (Amtrak)	2285002008	EMP NAICS 482	1.0000
Locomotives - Commuter Lines	2285002009	EMP NAICS 482	1.0000
Locomotives - Yard Locomotives	2285002010	EMP NAICS 482	1.0000

1.2.1 NONROAD MOVES

Nonroad model source emissions were forecast to the projection years using the NONROAD MOVES Model run for projections year 2021.

For the NONROAD model categories, annual emissions will be estimated by running of the current version of EPA's MOVES-NONROAD model for the projection year with Maryland-specific inputs used in the base year inventory development.

Annual emissions for NONROAD MOVES Model are estimates using the most current version of EPA's NONROAD MOVES Model (NONROAD2008a model version, which is incorporated into MOVES2014a Model). The model includes more than 80 basic and 260 specific types of nonroad equipment sources by horsepower rating, and fuel types (gasoline, diesel, compressed natural gas (CNG), and liquefied petroleum gas (LPG)) to estimates annual emissions. Examples of nonroad equipment sources type's area:

- Residential and commercial lawn and garden equipment, such as leaf and snow blowers.
- 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.

Once the user programs the NONROAD MOVES Model for the specified geographic area and pollutants, the model then estimates and calculates annual emissions for a twelve month period per weekdays per weekends per pollutants. See “EPA’s NONROAD2005 (202 pp, 1.6MB, EPA420-R-05-013) user guide websites: NONROAD2005 User's Guide (PDF) (202 pp, 1.6MB, EPA420-R-05-013) and NONROAD2008a: https://www.epa.gov/moves/nonroad-model-nonroad-engines-equipment-and-vehicles.”

The NONROAD MOVES model further estimates annual emissions for each specific type of nonroad equipment by multiplying the following inputs 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.

These emissions estimates are then temporally allocated for a typical weekday and weekend per month per pollutant to calculate an entire annual or yearly emissions period. In addition, there are several input files that provide necessary information to calculate annual emissions estimates. These input files correspond to the basic data needed to provide the annual calculations: emission factors, base year equipment population, activity, load factor, average lifetime, and geographic allocations. The model automatically applies controls, when applicable, for a given year.

Finally, add the typical weekday and weekend per month per pollutant to calculate annual or yearly emissions estimate.

1.3 POINT SOURCES

Point sources will include those with allowable emissions of 25 or more tons per year of SO_2. In addition to the actual emissions reported for each facility, allowable or potential to emit emissions for point sources will be included. These allowable emissions are important to consider in projected emission inventories, especially where they are much different than actual emissions. Actual emissions will be forecast to the projection years using housing and employment growth surrogates.

For emissions inventory purposes, point sources are defined as stationary, commercial, or industrial operations that emit more than 10 tons per year (tons/year) of VOCs or 25 tons/year or more of NOx or CO. The point source inventory consists of actual emissions for the base-year 2014 and includes sources within the geographical area of the Anne Arundel and Baltimore

Counties, MD SO_2 nonattainment area. Each of Maryland's major source facility is identified by standard NAICS industry codes.

Point source emissions are forecasted using data from the Maryland Department of Labor, Licensing and Regulation (DLLR), Maryland Industry Projections (http://www.dllr.state.md.us/lmi/iandoproj/industry.shtml). The industry projection data from the DLLR was correlated to standard NAICS industry employment codes. The calculated growth per NAICS industry employment code is used as the growth surrogate for each major source. Maryland does not allow for negative NAICS growth surrogates (less than one) for a SIP inventory. Therefore, all growth surrogates calculated to be less than one are defaulted to a growth surrogate of one indicating no growth for the facility. The point source growth factors are presented in the table below.

Table 2: Point Source Growth Factors

Point Source Growth Factors				
SO2 NAA	State Facility ID	Facility Name	NAICS	2021 GF
Wagner	003-0023	Valley Proteins, Inc.	311	1
Wagner	003-0033	Jessup Correctional Institute	922	1.002228
Wagner	003-0043	Reliable Contracting Company, Inc.	324	1
Wagner	003-0056	Erachem Comilog, Inc	325	1
Wagner	003-0060	Reliable Contracting Company, Inc.	324	1
Wagner	003-0118	William T. Burnett and Company	326	1
Wagner	003-0208	Baltimore Washington International Thurgood Marshall Airport	488	1.044717
Wagner	003-0250	Northrop Grumman Systems Corporation	334	1
Wagner	003-0276	Hi Tech Color Inc	325	1
Wagner	003-0310	Naval Support Activity Annapolis	928	1.031862
Wagner	003-0316	US Coast Guard Yard (USCG Yard)	926	1
Wagner	003-0317	National Security Agency	928	1.031862
Wagner	003-0322	Fort George G. Meade, Dept. of the Army	928	1.031862
Wagner	003-0468	Fort Smallwood Road Complex	22	1
Wagner	003-0548	Lafarge Mid-Atlantic, LLC - Jessup Plant	327	1
Wagner	003-0826	Aggregate Industries - Severn Asphalt	324	1
Wagner	003-0886	Millersville Landfill & Resource Recovery Facility	562	1.05988
Wagner	003-0984	National Security Agency Fanx III	928	1.031862
Wagner	003-1460	Allan Myers Materials-Jessup (RAP)	324	1
Wagner	003-1471	Millersville Landfill Gas to Electric Project	562	1.05988
Wagner	005-0002	University Of Maryland - Baltimore County	61	1.160557
Wagner	005-0003	Bluegrass Materials Texas Quarry	212	1
Wagner	005-0039	Greater Baltimore Medical Center	622	1.08325
Wagner	005-0076	Constellation Power - Notch Cliff	22	1
Wagner	005-0078	Constellation Power - Riverside Generating Station	22	1
Wagner	005-0079	C P Crane Generating Station	22	1
Wagner	005-0146	Diageo North America	311	1

Point Source Growth Factors				
SO2 NAA	State Facility ID	Facility Name	NAICS	2021 GF
Wagner	005-0236	Schmidt Baking Co	311	1
Wagner	005-0256	Cinder and Concrete Block Corporation	327	1
Wagner	005-0282	Social Security Administration	928	1.031862
Wagner	005-0400	Franklin Square Hospital Center	622	1.08325
Wagner	005-0812	Back River WWTP	562	1.05988
Wagner	005-0979	American Yeast Corporation	311	1
Wagner	005-1040	Crown Food Packaging, USA	332	1.003215
Wagner	005-1484	Lafarge Building Materials, Inc.	327	1
Wagner	005-1809	Maryland Paving Rosedale, LLC	324	1
Wagner	005-2075	Eastern Sanitary Landfill Solid Waste Management Facility	562	1.05988
Wagner	005-2152	Synagro - Pelletech at Back River	562	1.05988
Wagner	005-2196	Roebuck Printing, Inc.	323	1
Wagner	005-2262	Honeygo Run Reclamation Center Rubble Landfill	562	1.05988
Wagner	005-2305	Polystyrene Products	326	1
Wagner	005-2322	Ecca Calcium Products - Imerys	212	1
Wagner	005-2407	Middle River Aircraft Systems	531	1.034922
Wagner	005-2436	Maryland Paving - Texas Quarry	324	1
Wagner	005-2581	Eastern Landfill Gas, LLC	22	1
Wagner	005-2589	Fritz Enterprises, Inc.	331	1
Wagner	005-2684	MANN-PAK, Inc.	323	1
Wagner	005-2696	Benjer Inc.	212	1

1.4 QUASI-POINT SOURCES

Quasi-point sources will include all emissions at the facility regardless of whether they are classified as point, area, nonroad, or mobile source emissions. These emissions are actual emissions reported for the facilities. Actual emissions will be forecast to the projection years using surrogates specific to each quasi-point source. The growth factor indicators and their sources are listed below by facility:

Table 3: Quasi-Point Source Growth Factor

Quasi-Point Source	Surrogate Growth Indicator	2021 GF
Baltimore Washington International Airport (BWI)	FAA Enplanement Forecasts	1.2278

1.5 NONPOINT/AREA SOURCES

Area source projections are typically made using local information and/or growth surrogates. The effects of any control measures to be implemented between the base and projection years are then applied (e.g., using an estimate of control efficiency, rule penetration, and rule effectiveness). Projection methods are described below.

For all sources emissions will be projected by multiplying the base year emission rates by the surrogate activity indicator growth factors. Surrogate activity indicators for each area source category are shown in the table below.

Table 4: NonPoint/Area Source Growth Factors

Source Category	Surrogate Growth Indicator
Fire Sources	
Forest Fires	NG
Slash Burning	NG
Prescribed Burning	NG
Structure Fires	POP
Small Stationary Source Fuel Combustion	
Commercial/Institutional Coal Combustion	EMP
Commercial/Institutional Kerosene Combustion	EMP
Commercial/Institutional Distillate Oil Combustion	EMP
Commercial/Institutional Residual Oil Combustion	EMP
Commercial/Institutional LPG Combustion	EMP
Commercial/Institutional Natural Gas Combustion	EMP
Residential Coal Combustion	HSE
Residential Kerosene Combustion	HSE
Residential Distillate Oil Combustion	HSE
Residential Natural Gas Combustion	HSE
Residential LPG Combustion	HSE
Residential Wood Combustion	HSE
Industrial Distillate Oil Combustion	EMP
Industrial Residual Oil Combustion	EMP
Solid Waste Treatment, Disposal, and Recovery	
Incinerators	NG
Open Burning – Land Clearing Debris	HSE
Open Burning – Residential Municipal Solid Waste	HSE
Open Burning – Residential Brush Debris	HSE
Open Burning – Residential Leaf Debris	HSE
Nonroad Sources (Outside NONROAD Model)	
Military Aircraft	FAA

Source Category	Surrogate Growth Indicator
General Aviation Aircraft	FAA
Air Taxi Aviation Aircraft	FAA
Marine Vessels	NG
Railroad Engines	NG

Year	State County FIPS	facility ID	facility name	unit reg number	SCC	Pollutant Code	Annual Emissions (Tons/Yr)	NAICS	2021 GF	2021 Uncontrolled EM (tpy)
2014	24003	003-0023	Valley Proteins, Inc.	003-0023-4-0654	10200602	SO2	0.01935	311	1	0.01935
2014	24003	003-0023	Valley Proteins, Inc.	003-0023-4-0654	10201302	SO2	0.05	311	1	0.05
		003-0023 Total					0.06935			0.06935
2014	24003	003-0033	Jessup Correctional Institute	003-0033-5-0404	10300602	SO2	0.0239524	922	1.002228	0.024005755
2014	24003	003-0033	Jessup Correctional Institute	003-0033-5-0492	10300502	SO2	0.3588408	922	1.002228	0.359640134
2014	24003	003-0033	Jessup Correctional Institute	003-0033-5-0492	10300602	SO2	0.00535	922	1.002228	0.005361917
2014	24003	003-0033	Jessup Correctional Institute	003-0033-5-0493	10300602	SO2	0.0198143	922	1.002228	0.019858437
2014	24003	003-0033	Jessup Correctional Institute	003-0033-5-0494	10300502	SO2	0.6027696	922	1.002228	0.604112297
2014	24003	003-0033	Jessup Correctional Institute	003-0033-5-0494	10300602	SO2	0.0003687	922	1.002228	0.000369521
		003-0033 Total					1.0110958			1.013348062
2014	24003	003-0043	Reliable Contracting Company, Inc.	003-0043-6-0080	30500201	SO2	0.009266	324	1	0.009266
2014	24003	003-0043	Reliable Contracting Company, Inc.	003-0043-6-0866	30500205	SO2	0.6315636	324	1	0.6315636
		003-0043 Total					0.6408296			0.6408296
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-5-0378	10200602	SO2	0.0041	325	1	0.0041
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-5-0412	10200602	SO2	0.0319325	325	1	0.0319325
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-6-0288	30199998	SO2	0.013122	325	1	0.013122
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-6-0288	30199998	SO2	0.013122	325	1	0.013122
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-6-0288	30199998	SO2	0.013122	325	1	0.013122
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-7-0407	30199998	SO2	0.000436	325	1	0.000436
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-7-0407	30199998	SO2	0.000436	325	1	0.000436
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-7-0408	30199998	SO2	0.002416	325	1	0.002416
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-7-0408	30199998	SO2	0.002416	325	1	0.002416
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-7-0408	30199998	SO2	0.002416	325	1	0.002416
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-7-0408	30199998	SO2	0.002416	325	1	0.002416
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-7-0408	30199998	SO2	0.002416	325	1	0.002416
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-7-0408	30199998	SO2	0.002416	325	1	0.002416
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-7-0408	30199998	SO2	0.002416	325	1	0.002416
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-7-0408	30199998	SO2	0.002416	325	1	0.002416
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-7-0408	30199998	SO2	0.002416	325	1	0.002416
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-7-0410	30199998	SO2	0.002205	325	1	0.002205
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-7-0411	30199998	SO2	0.000038	325	1	0.000038
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-7-0411	30199998	SO2	0.000038	325	1	0.000038
2014	24003	003-0056	Erachem Comilog, Inc	003-0056-7-0411	30199998	SO2	0.000038	325	1	0.000038
		003-0056 Total					0.1003335			0.1003335
2014	24003	003-0060	Reliable Contracting Company, Inc.	003-0060-6-1093	30500205	SO2	0.1858355	324	1	0.1858355
		003-0060 Total					0.1858355			0.1858355
2014	24003	003-0118	William T. Burnett and Company	003-0118-5-0287	10200603	SO2	0.0010404	326	1	0.0010404
2014	24003	003-0118	William T. Burnett and Company	003-0118-5-0458	10200603	SO2	0.001274	326	1	0.001274
2014	24003	003-0118	William T. Burnett and Company	003-0118-5-0459	10200603	SO2	0.0004368	326	1	0.0004368
2014	24003	003-0118	William T. Burnett and Company	003-0118-5-0460	10200603	SO2	0.0003094	326	1	0.0003094
2014	24003	003-0118	William T. Burnett and Company	003-0118-5-0461	10200603	SO2	0.0007735	326	1	0.0007735
2014	24003	003-0118	William T. Burnett and Company	003-0118-5-0462	10200603	SO2	0.00091	326	1	0.00091
2014	24003	003-0118	William T. Burnett and Company	003-0118-5-0463	10200603	SO2	0.0005915	326	1	0.0005915
2014	24003	003-0118	William T. Burnett and Company	003-0118-5-0464	10200603	SO2	0.0004732	326	1	0.0004732
2014	24003	003-0118	William T. Burnett and Company	003-0118-5-0465	10200603	SO2	0.0003094	326	1	0.0003094
2014	24003	003-0118	William T. Burnett and Company	003-0118-5-0697	10300603	SO2	0.002184	326	1	0.002184
		003-0118 Total					0.0083022			0.0083022

Year	State County FIPS	facility ID	facility name	unit reg number	SCC	Pollutant Code	Annual Emissions (Tons/Yr)	NAICS	2021 GF	2021 Uncontrolled EM (tpy)
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-4-0284	10300503	SO2	0.00045	488	1.044717	0.000470123
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-4-0285	10300503	SO2	0.00045	488	1.044717	0.000470123
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-4-0867	10500205	SO2	0.00145	488	1.044717	0.00151484
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-5-0681	10200502	SO2	0.0032	488	1.044717	0.003343096
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-5-0681	10200602	SO2	0.018	488	1.044717	0.018804915
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-5-0682	10200502	SO2	0.0032	488	1.044717	0.003343096
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-5-0682	10200602	SO2	0.018	488	1.044717	0.018804915
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-5-0683	10200502	SO2	0.0014	488	1.044717	0.001462604
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-5-0683	10200602	SO2	0.00675	488	1.044717	0.007051843
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-5-0769	10200603	SO2	0.0005382	488	1.044717	0.000562267
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-5-0770	10200603	SO2	0.0005382	488	1.044717	0.000562267
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-5-0771	10200603	SO2	0.001743	488	1.044717	0.001820943
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-5-0772	10200603	SO2	0.001743	488	1.044717	0.001820943
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-5-0773	10200603	SO2	0.001743	488	1.044717	0.001820943
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-5-0774	10200603	SO2	0.001743	488	1.044717	0.001820943
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-9-0909	20300101	SO2	0.000756	488	1.044717	0.000789806
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-9-0910	20300101	SO2	0.000273	488	1.044717	0.000285208
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-9-0911	20300101	SO2	0.0001765	488	1.044717	0.000184393
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-9-0912	20300101	SO2	0.0002007	488	1.044717	0.000209675
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-9-0913	20300101	SO2	0.0001602	488	1.044717	0.000167364
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-9-0914	20300101	SO2	0.00026	488	1.044717	0.000271627
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-9-0915	20300101	SO2	0.0000788	488	1.044717	8.23237E-05
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-9-0916	20300101	SO2	0.0001685	488	1.044717	0.000176035
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-9-0948	20300101	SO2	0.0001862	488	1.044717	0.000194526
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-9-1030	20300101	SO2	0.0008762	488	1.044717	0.000915381
2014	24003	003-0208	Baltimore Washington International Thurgood Marshall Airport	003-0208-9-1070	20100102	SO2	0.0003753	488	1.044717	0.000392082
		003-0208 Total					0.0644598			0.067342281
2014	24003	003-0250	Northrop Grumman Systems Corporation	003-0250-5-0438	10200602	SO2	0.0112	334	1	0.0112
2014	24003	003-0250	Northrop Grumman Systems Corporation	003-0250-5-0438	10500105	SO2	0.0002052	334	1	0.0002052
2014	24003	003-0250	Northrop Grumman Systems Corporation	003-0250-5-0439	10200501	SO2	0.00198	334	1	0.00198
2014	24003	003-0250	Northrop Grumman Systems Corporation	003-0250-5-0439	10200602	SO2	0.009976	334	1	0.009976
2014	24003	003-0250	Northrop Grumman Systems Corporation	003-0250-5-0444	10200501	SO2	0.0020405	334	1	0.0020405
2014	24003	003-0250	Northrop Grumman Systems Corporation	003-0250-5-0444	10200602	SO2	0.0505925	334	1	0.0505925
2014	24003	003-0250	Northrop Grumman Systems Corporation	003-0250-9-0778	20100102	SO2	0.027625	334	1	0.027625
2014	24003	003-0250	Northrop Grumman Systems Corporation	003-0250-9-0812	20100102	SO2	0.0005215	334	1	0.0005215
2014	24003	003-0250	Northrop Grumman Systems Corporation	003-0250-9-0871	20100102	SO2	0.01408	334	1	0.01408
		003-0250 Total					0.1182207			0.1182207
2014	24003	003-0276	Hi Tech Color Inc	003-0276-5-0308	10200603	SO2	0.000009	325	1	0.000009
		003-0276 Total					0.000009			0.000009

Year	State County FIPS	facility ID	facility name	unit reg number	SCC	Pollutant Code	Annual Emissions (Tons/Yr)	NAICS	2021 GF	2021 Uncontrolled EM (tpy)
2014	24003	003-0310	Naval Support Activity Annapolis	003-0310-4-0684	10300503	SO2	0.001575	928	1.031862	0.001625183
2014	24003	003-0310	Naval Support Activity Annapolis	003-0310-4-0685	10300503	SO2	0.0024235	928	1.031862	0.002500718
2014	24003	003-0310	Naval Support Activity Annapolis	003-0310-5-0312	10300402	SO2	0.145962	928	1.031862	0.150612654
2014	24003	003-0310	Naval Support Activity Annapolis	003-0310-5-0312	10300602	SO2	0.0365	928	1.031862	0.037662966
2014	24003	003-0310	Naval Support Activity Annapolis	003-0310-5-0313	10300502	SO2	0.171448	928	1.031862	0.176910691
2014	24003	003-0310	Naval Support Activity Annapolis	003-0310-5-0313	10300602	SO2	0.0293985	928	1.031862	0.030335197
2014	24003	003-0310	Naval Support Activity Annapolis	003-0310-5-0631	10300502	SO2	0.003372	928	1.031862	0.003479439
2014	24003	003-0310	Naval Support Activity Annapolis	003-0310-5-0631	10300602	SO2	0.01255	928	1.031862	0.012949869
2014	24003	003-0310	Naval Support Activity Annapolis	003-0310-5-0736	10300603	SO2	0.000048	928	1.031862	4.95294E-05
2014	24003	003-0310	Naval Support Activity Annapolis	003-0310-5-0737	10300603	SO2	0.000048	928	1.031862	4.95294E-05
2014	24003	003-0310	Naval Support Activity Annapolis	003-0310-9-0963	20100102	SO2	0.002094	928	1.031862	0.002160719
2014	24003	003-0310	Naval Support Activity Annapolis	003-0310-9-0984	20100102	SO2	0.002	928	1.031862	0.002063724
2014	24003	003-0310	Naval Support Activity Annapolis	003-0310-9-0985	20100102	SO2	0.003048	928	1.031862	0.003145116
2014	24003	003-0310	Naval Support Activity Annapolis	003-0310-9-0986	20100102	SO2	0.0026015	928	1.031862	0.002684389
2014	24003	003-0310	Naval Support Activity Annapolis	003-0310-9-1005	20300101	SO2	0.000002	928	1.031862	2.06372E-06
		003-0310 Total					0.4130705			0.426231787
2014	24003	003-0316	US Coast Guard Yard (USCG Yard)	003-0316-4-0824	10300502	SO2	0.001095	926	1	0.001095
2014	24003	003-0316	US Coast Guard Yard (USCG Yard)	003-0316-4-0824	10300602	SO2	0.0001825	926	1	0.0001825
2014	24003	003-0316	US Coast Guard Yard (USCG Yard)	003-0316-5-0277	10300603	SO2	0.0005475	926	1	0.0005475
2014	24003	003-0316	US Coast Guard Yard (USCG Yard)	003-0316-5-0497	10300502	SO2	0.8024525	926	1	0.8024525
2014	24003	003-0316	US Coast Guard Yard (USCG Yard)	003-0316-5-0497	10300602	SO2	0.002555	926	1	0.002555
2014	24003	003-0316	US Coast Guard Yard (USCG Yard)	003-0316-9-0889	20100202	SO2	0.0180675	926	1	0.0180675
2014	24003	003-0316	US Coast Guard Yard (USCG Yard)	003-0316-9-0890	20100802	SO2	0.2279425	926	1	0.2279425
2014	24003	003-0316	US Coast Guard Yard (USCG Yard)	003-0316-9-0891	20100802	SO2	0.2370675	926	1	0.2370675
2014	24003	003-0316	US Coast Guard Yard (USCG Yard)	003-0316-9-0892	20100802	SO2	0.04307	926	1	0.04307
		003-0316 Total					1.33298			1.33298

Year	State County FIPS	facility ID	facility name	unit reg number	SCC	Pollutant Code	Annual Emissions (Tons/Yr)	NAICS	2021 GF	2021 Uncontrolled EM (tpy)
2014	24003	003-0317	National Security Agency	003-0317-5-0502	10200502	SO2	1.10612	928	1.031862	1.141363289
2014	24003	003-0317	National Security Agency	003-0317-5-0502	10300602	SO2	0.40906	928	1.031862	0.422093504
2014	24003	003-0317	National Security Agency	003-0317-5-0503	10200502	SO2	0.46694	928	1.031862	0.481817682
2014	24003	003-0317	National Security Agency	003-0317-5-0503	10300602	SO2	0.41808	928	1.031862	0.4314009
2014	24003	003-0317	National Security Agency	003-0317-5-0504	10200502	SO2	0.438435	928	1.031862	0.452404453
2014	24003	003-0317	National Security Agency	003-0317-5-0504	10300602	SO2	0.17754	928	1.031862	0.183196794
2014	24003	003-0317	National Security Agency	003-0317-5-0505	10200502	SO2	1.063635	928	1.031862	1.097524628
2014	24003	003-0317	National Security Agency	003-0317-5-0505	10300602	SO2	0.957	928	1.031862	0.987492015
2014	24003	003-0317	National Security Agency	003-0317-5-0644	10300603	SO2	0.0511	928	1.031862	0.052728153
2014	24003	003-0317	National Security Agency	003-0317-5-0645	10300603	SO2	0.00365	928	1.031862	0.003766297
2014	24003	003-0317	National Security Agency	003-0317-5-0725	10300603	SO2	0.00091	928	1.031862	0.000938994
2014	24003	003-0317	National Security Agency	003-0317-5-0726	10300603	SO2	0.00123	928	1.031862	0.00126919
2014	24003	003-0317	National Security Agency	003-0317-5-0727	10300603	SO2	0.000655	928	1.031862	0.00067587
2014	24003	003-0317	National Security Agency	003-0317-5-0728	10300603	SO2	0.00039	928	1.031862	0.000402426
2014	24003	003-0317	National Security Agency	003-0317-9-0442	20300102	SO2	0.00132	928	1.031862	0.001362058
2014	24003	003-0317	National Security Agency	003-0317-9-0679	20300101	SO2	0.002	928	1.031862	0.002063724
2014	24003	003-0317	National Security Agency	003-0317-9-0680	20300101	SO2	0.002	928	1.031862	0.002063724
2014	24003	003-0317	National Security Agency	003-0317-9-0682	20300101	SO2	0.002	928	1.031862	0.002063724
2014	24003	003-0317	National Security Agency	003-0317-9-0683	20300101	SO2	0.003	928	1.031862	0.003095586
2014	24003	003-0317	National Security Agency	003-0317-9-0684	20300101	SO2	0.002	928	1.031862	0.002063724
2014	24003	003-0317	National Security Agency	003-0317-9-0685	20300101	SO2	0.003	928	1.031862	0.003095586
2014	24003	003-0317	National Security Agency	003-0317-9-0686	20300101	SO2	0.003	928	1.031862	0.003095586
2014	24003	003-0317	National Security Agency	003-0317-9-0687	20300102	SO2	0.01653	928	1.031862	0.01705668
2014	24003	003-0317	National Security Agency	003-0317-9-0688	20300102	SO2	0.0231	928	1.031862	0.023836014
2014	24003	003-0317	National Security Agency	003-0317-9-0689	20300102	SO2	0.0231	928	1.031862	0.023836014
2014	24003	003-0317	National Security Agency	003-0317-9-0690	20300102	SO2	0.0231	928	1.031862	0.023836014
2014	24003	003-0317	National Security Agency	003-0317-9-0691	20300102	SO2	0.0021	928	1.031862	0.00216691
2014	24003	003-0317	National Security Agency	003-0317-9-0692	20300102	SO2	0.00216	928	1.031862	0.002228822
2014	24003	003-0317	National Security Agency	003-0317-9-0804	20100102	SO2	0.0021	928	1.031862	0.00216691
2014	24003	003-0317	National Security Agency	003-0317-9-0805	20100102	SO2	0.002015	928	1.031862	0.002079202
2014	24003	003-0317	National Security Agency	003-0317-9-0806	20100102	SO2	0.00138	928	1.031862	0.00142397
2014	24003	003-0317	National Security Agency	003-0317-9-0807	20100102	SO2	0.00294	928	1.031862	0.003033675
		003-0317 Total					5.21159			5.37764212

Year	State County FIPS	facility ID	facility name	unit reg number	SCC	Pollutant Code	Annual Emissions (Tons/Yr)	NAICS	2021 GF	2021 Uncontrolled EM (tpy)
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-4-0687	10300503	SO2	0.0025725	928	1.031862	0.002654465
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-4-0687	10300603	SO2	0.0019845	928	1.031862	0.00204773
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-5-0487	10300603	SO2	0.0252	928	1.031862	0.026002925
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-5-0713	10300603	SO2	0.0012915	928	1.031862	0.00133265
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-5-0714	10300603	SO2	0.0012915	928	1.031862	0.00133265
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-5-0715	10300603	SO2	0.0012915	928	1.031862	0.00133265
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-5-0716	10300603	SO2	0.0012915	928	1.031862	0.00133265
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-5-0720	10300603	SO2	0.0002468	928	1.031862	0.000254664
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-5-0721	10300603	SO2	0.0002468	928	1.031862	0.000254664
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-5-0722	10300603	SO2	0.0002468	928	1.031862	0.000254664
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-5-0723	10300603	SO2	0.0002468	928	1.031862	0.000254664
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-5-0724	10300603	SO2	0.0002468	928	1.031862	0.000254664
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-5-0733	10300603	SO2	0.0007161	928	1.031862	0.000738916
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-5-0734	10300603	SO2	0.0007161	928	1.031862	0.000738916
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-5-0735	10300603	SO2	0.0007161	928	1.031862	0.000738916
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-5-0761	10500206	SO2	0.01743	928	1.031862	0.017985356
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-9-0965	20100107	SO2	0.06604	928	1.031862	0.068144172
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-9-0992	20100107	SO2	0.01352	928	1.031862	0.013950775
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-9-1002	20100102	SO2	0.08268	928	1.031862	0.085314357
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-9-1003	20100102	SO2	0.08086	928	1.031862	0.083436368
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-9-1004	20100102	SO2	0.06422	928	1.031862	0.066266183
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-9-1007	20100102	SO2	0.025454	928	1.031862	0.026265017
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-9-1008	20100102	SO2	0.025272	928	1.031862	0.026077219
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-9-1009	20100102	SO2	0.024986	928	1.031862	0.025782106
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-9-1095	20300107	SO2	0	928	1.031862	0
2014	24003	003-0322	Fort George G. Meade, Dept. of the Army	003-0322-9-1096	20300107	SO2	0.004758	928	1.031862	0.0049096
		003-0322 Total					0.4435253			0.457656941
2014	24003	003-0468	Fort Smallwood Road Complex	003-0468-3-0003	10100215	SO2	7,276.12	22	1	7276.124945
2014	24003	003-0468	Fort Smallwood Road Complex	003-0468-3-0015	10100202	SO2	1,669.90	22	1	1669.899789
2014	24003	003-0468	Fort Smallwood Road Complex	003-0468-3-0016	10100202	SO2	1,475.19	22	1	1475.187221
2014	24003	003-0468	Fort Smallwood Road Complex	003-0468-3-0017	10100202	SO2	1,938.99	22	1	1938.990367
2014	24003	003-0468	Fort Smallwood Road Complex	003-0468-4-0007	20100101	SO2	1.632	22	1	1.632
2014	24003	003-0468	Fort Smallwood Road Complex	003-0468-4-0017	10100401	SO2	322.53	22	1	322.5257685
2014	24003	003-0468	Fort Smallwood Road Complex	003-0468-4-0507	10100504	SO2	0.00023	22	1	0.00023
2014	24003	003-0468	Fort Smallwood Road Complex	003-0468-5-0489	10100601	SO2	72.62	22	1	72.6181055
2014	24003	003-0468	Fort Smallwood Road Complex	003-0468-9-0988	20200102	SO2	0.003	22	1	0.003
		003-0468 Total					12756.98142			12756.98142
2014	24003	003-0548	Lafarge Mid-Atlantic, LLC - Jessup Plant	003-0548-6-0951	10300601	SO2	0.0028753	327	1	0.0028753
		003-0548 Total					0.0028753			0.0028753
2014	24003	003-0826	Aggregate Industries - Severn Asphalt	003-0826-6-0926	30500205	SO2	0.21412	324	1	0.21412
2014	24003	003-0826	Aggregate Industries - Severn Asphalt	003-0826-6-1188	30504030	SO2	0.06596	324	1	0.06596
		003-0826 Total					0.28008			0.28008
2014	24003	003-0886	Millersville Landfill & Resource Recovery Facility	003-0886-9-0921	20300101	SO2	0.12225	562	1.05988	0.129570299
2014	24003	003-0886	Millersville Landfill & Resource Recovery Facility	003-0886-9-1038	50200601	SO2	0.129978	562	1.05988	0.13776105
		003-0886 Total					0.252228			0.26733135

Year	State County FIPS	facility ID	facility name	unit reg number	SCC	Pollutant Code	Annual Emissions (Tons/Yr)	NAICS	2021 GF	2021 Uncontrolled EM (tpy)
2014	24003	003-0984	National Security Agency Fanx III	003-0984-5-0633	10300603	SO2	0.00091	928	1.031862	0.000938994
2014	24003	003-0984	National Security Agency Fanx III	003-0984-5-0634	10300603	SO2	0.000675	928	1.031862	0.000696507
2014	24003	003-0984	National Security Agency Fanx III	003-0984-5-0635	10300602	SO2	0.000265	928	1.031862	0.000273443
2014	24003	003-0984	National Security Agency Fanx III	003-0984-5-0636	10300602	SO2	0.000545	928	1.031862	0.000562365
2014	24003	003-0984	National Security Agency Fanx III	003-0984-9-0615	20300101	SO2	0.01001	928	1.031862	0.010328939
		003-0984 Total					0.012405			0.012800249
2014	24003	003-1460	Allan Myers Materials-Jessup (RAP)	003-1460-6-1178	30502099	SO2	0.02739	324	1	0.02739
		003-1460 Total					0.02739			0.02739
2014	24003	003-1471	Millersville Landfill Gas to Electric Project	003-1471-9-1034	20100802	SO2	2.50025	562	1.05988	2.649964344
		003-1471 Total					2.50025			2.649964344
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-5-1537	10300602	SO2	0.01727	61	1.160557	0.020042818
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-5-1637	10300602	SO2	0.01462	61	1.160557	0.016967342
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-5-1709	10300603	SO2	0.0027875	61	1.160557	0.003235052
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-5-1711	10300502	SO2	0.15999	61	1.160557	0.185677499
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-5-1711	10300602	SO2	0.0054385	61	1.160557	0.006311689
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-5-1712	10300602	SO2	0.00245	61	1.160557	0.002843364
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-5-1743	10300603	SO2	0.000663	61	1.160557	0.000769449
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-5-1744	10300603	SO2	0.0011858	61	1.160557	0.001376188
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-5-1745	10300603	SO2	0.0002197	61	1.160557	0.000254974
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-5-1746	10300603	SO2	0.000329	61	1.160557	0.000381823
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-5-1747	10300603	SO2	0.0001075	61	1.160557	0.00012476
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-5-2279	10300502	SO2	1.098755	61	1.160557	1.275167701
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-5-2279	10300603	SO2	0.0305625	61	1.160557	0.03546952
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-9-1366	20300107	SO2	0.007794	61	1.160557	0.009045381
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-9-1368	20300107	SO2	0.00189	61	1.160557	0.002193453
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-9-1369	20300107	SO2	0.004854	61	1.160557	0.005633343
2014	24005	005-0002	University Of Maryland - Baltimore County	005-0002-9-1370	20300107	SO2	0.007524	61	1.160557	0.00873203
		005-0002 Total					1.3564405			1.574226387
2014	24005	005-0003	Bluegrass Materials Texas Quarry	005-0003-4-2027	10300501	SO2	0.2742	212	1	0.2742
		005-0003 Total					0.2742			0.2742
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-5-1150	10300603	SO2	0.0005055	622	1.08325	0.000547583
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-5-1151	10300603	SO2	0.0005055	622	1.08325	0.000547583
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-5-1920	10300603	SO2	0.0006242	622	1.08325	0.000676165
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-5-2114	10500205	SO2	0.00143	622	1.08325	0.001549047
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-5-2114	10500206	SO2	0.01825	622	1.08325	0.019769311
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-5-2124	10500205	SO2	0.00143	622	1.08325	0.001549047
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-5-2124	10500206	SO2	0.01825	622	1.08325	0.019769311
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-5-2125	10500205	SO2	0.00143	622	1.08325	0.001549047
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-5-2125	10500206	SO2	0.01825	622	1.08325	0.019769311
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-5-2148	10300603	SO2	0.0004106	622	1.08325	0.000444782
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-5-2149	10300603	SO2	0.0004106	622	1.08325	0.000444782
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-9-0915	20300102	SO2	0	622	1.08325	0
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-9-1359	20200102	SO2	0.0001547	622	1.08325	0.000167579
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-9-1380	20200102	SO2	0.000112	622	1.08325	0.000121324
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-9-1393	20100102	SO2	0.0007326	622	1.08325	0.000793589
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-9-1427	20100102	SO2	0.00171	622	1.08325	0.001852357
2014	24005	005-0039	Greater Baltimore Medical Center	005-0039-9-1428	20100102	SO2	0.0019035	622	1.08325	0.002061966
		005-0039 Total					0.0661092			0.071612786

Year	State County FIPS	facility ID	facility name	unit reg number	SCC	Pollutant Code	Annual Emissions (Tons/Yr)	NAICS	2021 GF	2021 Uncontrolled EM (tpy)
2014	24005	005-0076	Constellation Power - Notch Cliff	005-0076-9-1094	20100201	SO2	0.00255	22	1	0.00255
2014	24005	005-0076	Constellation Power - Notch Cliff	005-0076-9-1095	20100201	SO2	0.00495	22	1	0.00495
2014	24005	005-0076	Constellation Power - Notch Cliff	005-0076-9-1096	20100201	SO2	0.0051	22	1	0.0051
2014	24005	005-0076	Constellation Power - Notch Cliff	005-0076-9-1097	20100201	SO2	0.0051	22	1	0.0051
2014	24005	005-0076	Constellation Power - Notch Cliff	005-0076-9-1098	20100201	SO2	0.00105	22	1	0.00105
2014	24005	005-0076	Constellation Power - Notch Cliff	005-0076-9-1099	20100201	SO2	0.007	22	1	0.007
2014	24005	005-0076	Constellation Power - Notch Cliff	005-0076-9-1100	20100201	SO2	0.0068	22	1	0.0068
2014	24005	005-0076	Constellation Power - Notch Cliff	005-0076-9-1101	20100201	SO2	0.006	22	1	0.006
		005-0076 Total					0.03855			0.03855
2014	24005	005-0078	Constellation Power - Riverside Generating Station	005-0078-4-0658	10100504	SO2	0.297	22	1	0.297
2014	24005	005-0078	Constellation Power - Riverside Generating Station	005-0078-4-0659	10100504	SO2	0.341	22	1	0.341
2014	24005	005-0078	Constellation Power - Riverside Generating Station	005-0078-4-1082	10100601	SO2	0.064	22	1	0.064
2014	24005	005-0078	Constellation Power - Riverside Generating Station	005-0078-4-1363	10100601	SO2	1.122	22	1	1.122
		005-0078 Total					1.824			1.824
2014	24005	005-0079	C P Crane Generating Station	005-0079-3-0108	10100203	SO2	573.38	22	1	573.3757465
2014	24005	005-0079	C P Crane Generating Station	005-0079-3-0109	10100203	SO2	1,313.78	22	1	1313.780362
2014	24005	005-0079	C P Crane Generating Station	005-0079-4-0089	10100504	SO2	1.5875	22	1	1.5875
2014	24005	005-0079	C P Crane Generating Station	005-0079-4-0091	10100504	SO2	0.8375	22	1	0.8375
2014	24005	005-0079	C P Crane Generating Station	005-0079-4-1107	10100504	SO2	0.621	22	1	0.621
		005-0079 Total					1890.202109			1890.202109
2014	24005	005-0146	Diageo North America	005-0146-5-1739	10200502	SO2	0.00825	311	1	0.00825
2014	24005	005-0146	Diageo North America	005-0146-5-1739	10300602	SO2	0.005355	311	1	0.005355
2014	24005	005-0146	Diageo North America	005-0146-5-1740	10300602	SO2	0.00049	311	1	0.00049
		005-0146 Total					0.014095			0.014095
2014	24005	005-0167	Bluegrass Materials Company, LLC - Marriottsville Quarry	005-0167-6-3084	30599999	SO2	1.1419375	327	1	1.1419375
		005-0167 Total					1.1419375			1.1419375
2014	24005	005-0184	Noxell Corporation	005-0184-5-1478	10200602	SO2	0.0011004	325	1	0.0011004
2014	24005	005-0184	Noxell Corporation	005-0184-5-1633	10200602	SO2	0.0138073	325	1	0.0138073
		005-0184 Total					0.0149077			0.0149077
2014	24005	005-0236	Schmidt Baking Co	005-0236-5-0945	10200603	SO2	0.00182	311	1	0.00182
2014	24005	005-0236	Schmidt Baking Co	005-0236-5-0946	10200603	SO2	0.00183	311	1	0.00183
2014	24005	005-0236	Schmidt Baking Co	005-0236-8-0163	30203201	SO2	0.00936	311	1	0.00936
2014	24005	005-0236	Schmidt Baking Co	005-0236-8-0213	30203201	SO2	0.00468	311	1	0.00468
		005-0236 Total					0.01769			0.01769
2014	24005	005-0256	Cinder and Concrete Block Corporation	005-0256-5-1232	10200602	SO2	0.00228	327	1	0.00228
2014	24005	005-0256	Cinder and Concrete Block Corporation	005-0256-6-0837	30500609	SO2	0.00756	327	1	0.00756
		005-0256 Total					0.00984			0.00984
2014	24005	005-0282	Social Security Administration	005-0282-5-2302	10300602	SO2	0.01825	928	1.031862	0.018831483
2014	24005	005-0282	Social Security Administration	005-0282-9-1180	28888801	SO2	0.143	928	1.031862	0.147556278
2014	24005	005-0282	Social Security Administration	005-0282-9-1180	28888801	SO2	0.143	928	1.031862	0.147556278
2014	24005	005-0282	Social Security Administration	005-0282-9-1181	20300102	SO2	0.0442	928	1.031862	0.045608304
2014	24005	005-0282	Social Security Administration	005-0282-9-1181	20300102	SO2	0.0442	928	1.031862	0.045608304
2014	24005	005-0282	Social Security Administration	005-0282-9-1182	30113210	SO2	0.1456	928	1.031862	0.150239119
2014	24005	005-0282	Social Security Administration	005-0282-9-1182	30113210	SO2	0.1456	928	1.031862	0.150239119
2014	24005	005-0282	Social Security Administration	005-0282-9-1362	20100107	SO2	0.0026	928	1.031862	0.002682841
2014	24005	005-0282	Social Security Administration	005-0282-9-1363	20100107	SO2	0.0026	928	1.031862	0.002682841
2014	24005	005-0282	Social Security Administration	005-0282-9-1436	20300107	SO2	0.0026	928	1.031862	0.002682841
		005-0282 Total					0.69165			0.713687411

Point Sources

Year	State County FIPS	facility ID	facility name	unit reg number	SCC	Pollutant Code	Annual Emissions (Tons/Yr)	NAICS	2021 GF	2021 Uncontrolled EM (tpy)
2014	24005	005-0400	Franklin Square Hospital Center	005-0400-5-2236	10300602	SO2	0.0146	622	1.08325	0.015815449
2014	24005	005-0400	Franklin Square Hospital Center	005-0400-5-2237	10300602	SO2	0.0146	622	1.08325	0.015815449
2014	24005	005-0400	Franklin Square Hospital Center	005-0400-5-2238	10300602	SO2	0.0146	622	1.08325	0.015815449
2014	24005	005-0400	Franklin Square Hospital Center	005-0400-9-1376	20300101	SO2	0.0003919	622	1.08325	0.000424526
2014	24005	005-0400	Franklin Square Hospital Center	005-0400-9-1377	20300101	SO2	0.0002992	622	1.08325	0.000324108
2014	24005	005-0400	Franklin Square Hospital Center	005-0400-9-1378	20300101	SO2	0.00038	622	1.08325	0.000411635
		005-0400 Total					0.0448711			0.048606616
2014	24005	005-0812	Back River WWTP	005-0812-5-0511	10300602	SO2	0.0266175	562	1.05988	0.028211349
2014	24005	005-0812	Back River WWTP	005-0812-5-1426	10300799	SO2	0.043489	562	1.05988	0.04609311
2014	24005	005-0812	Back River WWTP	005-0812-5-1431	10300799	SO2	0.016512	562	1.05988	0.017500734
2014	24005	005-0812	Back River WWTP	005-0812-5-1439	10300799	SO2	0.0318155	562	1.05988	0.033720604
2014	24005	005-0812	Back River WWTP	005-0812-5-2255	10300603	SO2	0.000265	562	1.05988	0.000280868
2014	24005	005-0812	Back River WWTP	005-0812-9-1317	20100702	SO2	0.0112095	562	1.05988	0.011880722
2014	24005	005-0812	Back River WWTP	005-0812-9-1319	20100702	SO2	0.009928	562	1.05988	0.010522486
2014	24005	005-0812	Back River WWTP	005-0812-9-1320	20100702	SO2	0.0081915	562	1.05988	0.008682005
		005-0812 Total					0.148028			0.15689188
2014	24005	005-0979	American Yeast Corporation	005-0979-5-1513	10200503	SO2	0.883025	311	1	0.883025
2014	24005	005-0979	American Yeast Corporation	005-0979-5-1853	10300503	SO2	0.00288	311	1	0.00288
2014	24005	005-0979	American Yeast Corporation	005-0979-5-1853	10300603	SO2	2.326025	311	1	2.326025
2014	24005	005-0979	American Yeast Corporation	005-0979-8-0301	50382599	SO2	0.62835	311	1	0.62835
		005-0979 Total					3.84028			3.84028
2014	24005	005-1040	Crown Food Packaging, USA	005-1040-6-1585	40201735	SO2	0.0146625	332	1.003215	0.014709641
2014	24005	005-1040	Crown Food Packaging, USA	005-1040-6-2655	10200603	SO2	0.002295	332	1.003215	0.002302379
		005-1040 Total					0.0169575			0.017012019
2014	24005	005-1149	Gamse Lithographing Company	005-1149-9-0159	40500511	SO2	0.0013	323	1	0.0013
		005-1149 Total					0.0013			0.0013

Year	State County FIPS	facility ID	facility name	unit reg number	SCC	Pollutant Code	Annual Emissions (Tons/Yr)	NAICS	2021 GF	2021 Uncontrolled EM (tpy)
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.0899	327	1	0.0899
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.0899	327	1	0.0899
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
2014	24005	005-1484	Lafarge Building Materials, Inc.	005-1484-6-2676	30500613	SO2	0.04495	327	1	0.04495
		005-1484 Total					2.20255			2.20255

Year	State County FIPS	facility ID	facility name	unit reg number	SCC	Pollutant Code	Annual Emissions (Tons/Yr)	NAICS	2021 GF	2021 Uncontrolled EM (tpy)
2014	24005	005-1809	Maryland Paving Rosedale, LLC	005-1809-6-3024	30500205	SO2	0.38335	324	1	0.38335
2014	24005	005-1809	Maryland Paving Rosedale, LLC	005-1809-6-3025	30502006	SO2	0.57227	324	1	0.57227
2014	24005	005-1809	Maryland Paving Rosedale, LLC	005-1809-6-3069	10200603	SO2	0.0049275	324	1	0.0049275
		005-1809 Total					0.9605475			0.9605475
2014	24005	005-2075	Eastern Sanitary Landfill Solid Waste Management Facility	005-2075-6-2824	20100102	SO2	0	562	1.05988	0
2014	24005	005-2075	Eastern Sanitary Landfill Solid Waste Management Facility	005-2075-9-1020	50200601	SO2	0.366825	562	1.05988	0.388790389
2014	24005	005-2075	Eastern Sanitary Landfill Solid Waste Management Facility	005-2075-9-1438	20200102	SO2	0.050655	562	1.05988	0.053688209
		005-2075 Total					0.41748			0.442478598
2014	24005	005-2152	Synagro - Pelletech at Back River	005-2152-6-1849	39990003	SO2	0.0584	562	1.05988	0.061896977
		005-2152 Total					0.0584			0.061896977
2014	24005	005-2196	Roebuck Printing, Inc.	005-2196-6-2780	40500421	SO2	0.000771	323	1	0.000771
2014	24005	005-2196	Roebuck Printing, Inc.	005-2196-6-2934	40500401	SO2	0.0006524	323	1	0.0006524
		005-2196 Total					0.0014234			0.0014234
2014	24005	005-2262	Honeygo Run Reclamation Center Rubble Landfill	005-2262-6-2717	30502001	SO2	0.150255	562	1.05988	0.159252232
2014	24005	005-2262	Honeygo Run Reclamation Center Rubble Landfill	005-2262-6-3029	30504034	SO2	0.03268	562	1.05988	0.03463687
2014	24005	005-2262	Honeygo Run Reclamation Center Rubble Landfill	005-2262-6-3030	30504034	SO2	0.017885	562	1.05988	0.018955949
		005-2262 Total					0.20082			0.212845051
2014	24005	005-2305	Polystyrene Products	005-2305-5-1610	10200603	SO2	0.001765	326	1	0.001765
2014	24005	005-2305	Polystyrene Products	005-2305-5-1644	10200603	SO2	0.00167	326	1	0.00167
		005-2305 Total					0.003435			0.003435
2014	24005	005-2322	Ecca Calcium Products - Imerys	005-2322-6-2185	30504031	SO2	0.181168	212	1	0.181168
2014	24005	005-2322	Ecca Calcium Products - Imerys	005-2322-6-2188	30504099	SO2	0.041884	212	1	0.041884
2014	24005	005-2322	Ecca Calcium Products - Imerys	005-2322-6-2189	30504021	SO2	0.03575	212	1	0.03575
		005-2322 Total					0.258802			0.258802
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-5-1259	10300603	SO2	0.000819	531	1.034922	0.000847601
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-5-1261	10300603	SO2	0.000546	531	1.034922	0.000565068
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-5-1262	10300603	SO2	0.000546	531	1.034922	0.000565068
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-5-1263	10300603	SO2	0.000819	531	1.034922	0.000847601
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-5-1466	10300603	SO2	0.001365	531	1.034922	0.001412669
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-5-1467	10300603	SO2	0.001365	531	1.034922	0.001412669
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-5-1468	10300603	SO2	0.001365	531	1.034922	0.001412669
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-5-1469	10300603	SO2	0.001365	531	1.034922	0.001412669
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-5-1577	10300603	SO2	0.000546	531	1.034922	0.000565068
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-5-1579	10300603	SO2	0.000546	531	1.034922	0.000565068
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-5-1657	10300603	SO2	0.004914	531	1.034922	0.005085608
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-5-2222	10300603	SO2	0.001365	531	1.034922	0.001412669
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-5-2300	10300603	SO2	0.0006825	531	1.034922	0.000706334
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-5-2320	10300603	SO2	0.001365	531	1.034922	0.001412669
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-5-2321	10300603	SO2	0.0006825	531	1.034922	0.000706334
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-6-2441	39000699	SO2	0.00039	531	1.034922	0.00040362
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-6-2499	39000699	SO2	0.000945	531	1.034922	0.000978002
2014	24005	005-2407	Middle River Aircraft Systems	005-2407-6-2900	40200101	SO2	0.0036	531	1.034922	0.00372572
		005-2407 Total					0.023226			0.024037105
2014	24005	005-2436	Maryland Paving - Texas Quarry	005-2436-5-2342	10300603	SO2	0.0040905	324	1	0.0040905
2014	24005	005-2436	Maryland Paving - Texas Quarry	005-2436-6-2595	30500205	SO2	0.379665	324	1	0.379665
2014	24005	005-2436	Maryland Paving - Texas Quarry	005-2436-6-3076	30500204	SO2	0.142945	324	1	0.142945
2014	24005	005-2436	Maryland Paving - Texas Quarry	005-2436-6-3077	30500204	SO2	0.42757	324	1	0.42757
		005-2436 Total					0.9542705			0.9542705

Point Sources

Year	State County FIPS	facility ID	facility name	unit reg number	SCC	Pollutant Code	Annual Emissions (Tons/Yr)	NAICS	2021 GF	2021 Uncontrolled EM (tpy)
2014	24005	005-2581	Eastern Landfill Gas, LLC	005-2581-9-1278	20100102	SO2	0.01095	22	1	0.01095
2014	24005	005-2581	Eastern Landfill Gas, LLC	005-2581-9-1279	20100102	SO2	0.005475	22	1	0.005475
2014	24005	005-2581	Eastern Landfill Gas, LLC	005-2581-9-1280	20100102	SO2	0.012775	22	1	0.012775
		005-2581 Total					0.0292			0.0292
2014	24005	005-2589	Fritz Enterprises, Inc.	005-2589-6-2880	30599999	SO2	0.9997	331	1	0.9997
		005-2589 Total					0.9997			0.9997
2014	24005	005-2684	MANN-PAK, Inc.	005-2684-6-1459	40500301	SO2	0.000025	323	1	0.000025
2014	24005	005-2684	MANN-PAK, Inc.	005-2684-6-2967	40500301	SO2	0.000325	323	1	0.000325
		005-2684 Total					0.00035			0.00035
2014	24005	005-2696	Benjer Inc.	005-2696-6-3060	30502001	SO2	0.29355	212	1	0.29355
		005-2696 Total					0.29355			0.29355
		Grand Total					14675.76297			14676.42598

Appendix A-4: Quasi-Point Source Inventory

Year	State Facility Identifier	Facility Name	State County FIPs	SCC	Emission Process Description	Activity Data Source	Source	SOX	GF_2014-2021	SOX 2021
2014	003-0208	BWI	24003		Parking Facilities	MAA Plane	MOBILE	0.007667	1.227755	0.0094132
2014	003-0208	BWI	24003	10200502	Boiler stack	Point Sour	POINT	0.007800	1.227755	0.00957649
2014	003-0208	BWI	24003	10200602	Boiler stack	Point Sour	POINT	0.042750	1.227755	0.05248653
2014	003-0208	BWI	24003	10200603	5-0769	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	10200603	5-0770	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	10200603	5-0771	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	10200603	5-0772	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	10200603	5-0773	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	10200603	5-0774	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	10200603	Boilers	Point Sour	POINT	0.008048	1.227755	0.00988146
2014	003-0208	BWI	24003	10300503	Permitted Point Source	Point Sour	POINT	0.000900	1.227755	0.00110498
2014	003-0208	BWI	24003	10500205	boiler stack at bldg 123	Point Sour	POINT	0.001450	1.227755	0.00178025
2014	003-0208	BWI	24003	20100102	900-XC6DT2 emergency generator	Point Sour	POINT	0.000375	1.227755	0.00046078
2014	003-0208	BWI	24003	20300101	410 kW standby generator stack	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	20300101	500 kW standby generator stack	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	20300101	505 kW standby generator stack	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	20300101	600 kW standby generator stack	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	20300101	600 kW standby generator stack terminal roof	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	20300101	750 kW standby generator stack	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	20300101	900 kW standby generator stack	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	20300101	Diesel Generator Stack	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	20300101	Emergency generator	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	20300101	Engine stack located at Airfield lighting vault	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	20300101	Permitted Point Source	Point Sour	POINT	0.003136	1.227755	0.00385036
2014	003-0208	BWI	24003	40600601	Fugitive	Point Sour	POINT		1.227755	0
2014	003-0208	BWI	24003	2201001133	Highway - Gasoline - Light Duty Vehicles (LDGV)	MAA Plane	MOBILE	0.001304	1.227755	0.00160046
2014	003-0208	BWI	24003	2270008005	GSE	MAA Plane	NONROAD	1.827920	1.227755	2.24423855
2014	003-0208	BWI	24003	2275001000	Emissions from military aircraft LTOs	MAA Plane	MAR	2.003359	1.227755	2.45963488
2014	003-0208	BWI	24003	2275020000	Emissions from commercial aircraft LTOs	MAA Plane	MAR	94.250077	1.227755	115.71602
2014	003-0208	BWI	24003	2275050000	Emissions from general aviation aircraft LTOs	MAA Plane	MAR	7.283561	1.227755	8.94242966
2014	003-0208	BWI	24003	2275060000	Emissions from air taxi aircraft LTOs	MAA Plane	MAR	11.424281	1.227755	14.0262196
2014	003-0208	BWI	24003	2275070000	Emissions from aircraft auxiliary power units	MAA Plane	NONROAD	4.825268	1.227755	5.92424772
2014	003-0208	BWI	24003	2810035000	Firefighting Training	MAA Plane	NONROAD	0.010825	1.227755	0.01329003
		BWI Total						121.698721		149.416235
		Grand Total						121.698721		149.416235

Appendix A-5: Area/Nonpoint Source Inventory

Year	State County FIPS	SCC	SCC Description	Annual SO2 Emissions (Tons/Yr)	Growth Code	2021 Growth Factor	2021 Emisions
2014	24003	2103002000	Stationary Fuel Comb /Commercial/Institutional /Bituminous/Subbituminous Coal /Total: All Boiler Types	2.622864364	MD_EMP_24000	1.06046	2.781450847
2014	24003	2103004000	Stationary Fuel Comb /Commercial/Institutional /Distillate Oil /Total: Boilers and IC Engines	146.0034988	MD_EMP_24000	1.06046	154.8313214
2014	24003	2103005000	Stationary Fuel Comb /Commercial/Institutional /Residual Oil /Total: All Boiler Types	2.395426397	MD_EMP_24000	1.06046	2.540261278
2014	24003	2103006000	Stationary Fuel Comb /Commercial/Institutional /Natural Gas /Total: Boilers and IC Engines	2.31767327	MD_EMP_24000	1.06046	2.457806956
2014	24003	2103007000	Stationary Fuel Comb /Commercial/Institutional /Liquified Petroleum Gas /Total: All Combustor Types	0.039845294	MD_EMP_24000	1.06046	0.042254463
2014	24003	2103011000	Stationary Fuel Comb /Commercial/Institutional /Kerosene /Total: All Combustor Types	0.542360694	MD_EMP_24000	1.06046	0.575153497
2014	24003	2104002000	Stationary Fuel Comb /Residential /Bituminous/Subbituminous Coal /Total: All Combustor Types	0.214042233	MD_HSE_24003	1.00711	0.215563464
2014	24003	2104004000	Stationary Fuel Comb /Residential /Distillate Oil /Total: All Combustor Types	300.2508801	MD_HSE_24003	1.00711	302.3848086
2014	24003	2104006000	Stationary Fuel Comb /Residential /Natural Gas /Total: All Combustor Types	1.820474465	MD_HSE_24003	1.00711	1.833412853
2014	24003	2104007000	Stationary Fuel Comb /Residential /Liquified Petroleum Gas /Total: All Combustor Types	0.163683417	MD_HSE_24003	1.00711	0.16484674
2014	24003	2104008100	Stationary Fuel Comb /Residential /Wood /Fireplace: general	0.489960113	MD_HSE_24003	1.00711	0.493442333
2014	24003	2104008210	Stationary Fuel Comb /Residential /Wood /Woodstove: fireplace inserts; non-EPA certified	0.195984045	MD_HSE_24003	1.00711	0.197376933
2014	24003	2104008220	Stationary Fuel Comb /Residential /Wood /Woodstove: fireplace inserts; EPA certified; non-catalytic	0.128667786	MD_HSE_24003	1.00711	0.129582248
2014	24003	2104008230	Stationary Fuel Comb /Residential /Wood /Woodstove: fireplace inserts; EPA certified; catalytic	3.75E-02	MD_HSE_24003	1.00711	0.037759066
2014	24003	2104008310	Stationary Fuel Comb /Residential /Wood /Woodstove: freestanding, non-EPA certified	0.523857511	MD_HSE_24003	1.00711	0.527580646
2014	24003	2104008320	Stationary Fuel Comb /Residential /Wood /Woodstove: freestanding, EPA certified, non-catalytic	0.649605676	MD_HSE_24003	1.00711	0.654222522
2014	24003	2104008330	Stationary Fuel Comb /Residential /Wood /Woodstove: freestanding, EPA certified, catalytic	0.433070389	MD_HSE_24003	1.00711	0.436148286
2014	24003	2104008400	Stationary Fuel Comb /Residential /Wood /Woodstove: pellet-fired, general (freestanding or FP insert)	0.177792557	MD_HSE_24003	1.00711	0.179056156
2014	24003	2104008510	Stationary Fuel Comb /Residential /Wood /Furnace: Indoor, cordwood-fired, non-EPA certified	8.05E-02	MD_HSE_24003	1.00711	0.081071358
2014	24003	2104008610	Stationary Fuel Comb /Residential /Wood /Hydronic heater: outdoor	0.420777102	MD_HSE_24003	1.00711	0.423767629
2014	24003	2104008700	Stationary Fuel Comb /Residential /Wood /Outdoor wood burning device, NEC (fire-pits, chimeas, etc)	0.008662591	MD_HSE_24003	1.00711	0.008724157
2014	24003	2104009000	Stationary Fuel Comb /Residential /Firelog /Total: All Combustor Types	0	MD_HSE_24003	1.00711	0
2014	24003	2104011000	Stationary Fuel Comb /Residential /Kerosene /Total: All Heater Types	3.362636301	MD_HSE_24003	1.00711	3.386535068
2014	24003	2601020000	On-site Incineration /Commercial/Institutional /Total	0.00065	NG		0
2014	24003	2610000100	Open Burning /All Categories /Yard Waste - Leaf Species Unspecified	0			0
2014	24003	2610000400	Open Burning /All Categories /Yard Waste - Brush Species Unspecified	0			0
2014	24003	2610000500	Open Burning /All Categories /Land Clearing Debris (use 28-10-005-000 for Logging Debris Burning)	0			0
2014	24003	2610030000	Open Burning /Residential /Household Waste (use 26-10-000-xxx for Yard Wastes)	0			0
2014	24003	2810001000	Forest Wildfires - Wildfires - Unspecified	0	NG	1.00000	0
2014	24003	2810060100	Cremation /Humans	0.002458	NG	1.00000	0.002458
2014	24003	2810060200	Cremation /Animals	0.000018	NG	1.00000	0.000018
2014	24003	2811015000	Prescribed Forest Burning - Unspecified	0.301831	NG	1.00000	0.301831
	24003 Total			463.1847119			474.6864535

Year	State County FIPS	SCC	SCC Description	Annual SO2 Emissions (Tons/Yr)	Growth Code	2021 Growth Factor	2021 Emisions
2014	24005	2103002000	Stationary Fuel Comb /Commercial/Institutional /Bituminous/Subbituminous Coal /Total: All Boiler Types	7.006107773	MD_EMP_24000	1.06046	7.429718694
2014	24005	2103004000	Stationary Fuel Comb /Commercial/Institutional /Distillate Oil /Total: Boilers and IC Engines	153.5903911	MD_EMP_24000	1.06046	162.8769407
2014	24005	2103005000	Stationary Fuel Comb /Commercial/Institutional /Residual Oil /Total: All Boiler Types	2.519901786	MD_EMP_24000	1.06046	2.672262833
2014	24005	2103006000	Stationary Fuel Comb /Commercial/Institutional /Natural Gas /Total: Boilers and IC Engines	3.455398369	MD_EMP_24000	1.06046	3.66432243
2014	24005	2103007000	Stationary Fuel Comb /Commercial/Institutional /Liquified Petroleum Gas /Total: All Combustor Types	1.56E-02	MD_EMP_24000	1.06046	0.016593184
2014	24005	2103011000	Stationary Fuel Comb /Commercial/Institutional /Kerosene /Total: All Combustor Types	0.570543801	MD_EMP_24000	1.06046	0.605040641
2014	24005	2104002000	Stationary Fuel Comb /Residential /Bituminous/Subbituminous Coal /Total: All Combustor Types	1.66758221	MD_HSE_24005	1.00389	1.67406544
2014	24005	2104004000	Stationary Fuel Comb /Residential /Distillate Oil /Total: All Combustor Types	315.853048	MD_HSE_24005	1.00389	317.0810221
2014	24005	2104006000	Stationary Fuel Comb /Residential /Natural Gas /Total: All Combustor Types	4.37922607	MD_HSE_24005	1.00389	4.396251634
2014	24005	2104007000	Stationary Fuel Comb /Residential /Liquified Petroleum Gas /Total: All Combustor Types	0.16014962	MD_HSE_24005	1.00389	0.16077225
2014	24005	2104008100	Stationary Fuel Comb /Residential /Wood /Fireplace: general	0.639705295	MD_HSE_24005	1.00389	0.642192343
2014	24005	2104008210	Stationary Fuel Comb /Residential /Wood /Woodstove: fireplace inserts; non-EPA certified	0.255882118	MD_HSE_24005	1.00389	0.256876937
2014	24005	2104008220	Stationary Fuel Comb /Residential /Wood /Woodstove: fireplace inserts; EPA certified; non-catalytic	0.167992173	MD_HSE_24005	1.00389	0.168645294
2014	24005	2104008230	Stationary Fuel Comb /Residential /Wood /Woodstove: fireplace inserts; EPA certified; catalytic	4.90E-02	MD_HSE_24005	1.00389	0.049141675
2014	24005	2104008310	Stationary Fuel Comb /Residential /Wood /Woodstove: freestanding, non-EPA certified	0.747263004	MD_HSE_24005	1.00389	0.750168214
2014	24005	2104008320	Stationary Fuel Comb /Residential /Wood /Woodstove: freestanding, EPA certified, non-catalytic	0.926638024	MD_HSE_24005	1.00389	0.930240609
2014	24005	2104008330	Stationary Fuel Comb /Residential /Wood /Woodstove: freestanding, EPA certified, catalytic	0.617758595	MD_HSE_24005	1.00389	0.620160319
2014	24005	2104008400	Stationary Fuel Comb /Residential /Wood /Woodstove: pellet-fired, general (freestanding or FP insert)	0.253614384	MD_HSE_24005	1.00389	0.254600387
2014	24005	2104008510	Stationary Fuel Comb /Residential /Wood /Furnace: Indoor, cordwood-fired, non-EPA certified	0.110440696	MD_HSE_24005	1.00389	0.110870068
2014	24005	2104008610	Stationary Fuel Comb /Residential /Wood /Hydronic heater: outdoor	0.745729549	MD_HSE_24005	1.00389	0.748628797
2014	24005	2104008700	Stationary Fuel Comb /Residential /Wood /Outdoor wood burning device, NEC (fire-pits, chimeas, etc)	1.34E-02	MD_HSE_24005	1.00389	0.013420385
2014	24005	2104009000	Stationary Fuel Comb /Residential /Firelog /Total: All Combustor Types	0	MD_HSE_24005	1.00389	0
2014	24005	2104011000	Stationary Fuel Comb /Residential /Kerosene /Total: All Heater Types	3.537371563	MD_HSE_24005	1.00389	3.551124164
2014	24005	2601020000	On-site Incineration /Commercial/Institutional /Total	0			0
2014	24005	2610000100	Open Burning /All Categories /Yard Waste - Leaf Species Unspecified	0			0
2014	24005	2610000400	Open Burning /All Categories /Yard Waste - Brush Species Unspecified	0			0
2014	24005	2610000500	Open Burning /All Categories /Land Clearing Debris (use 28-10-005-000 for Logging Debris Burning)	0			0
2014	24005	2610030000	Open Burning /Residential /Household Waste (use 26-10-000-xxx for Yard Wastes)	0			0
2014	24005	2810001000	Forest Wildfires - Wildfires - Unspecified	0.11787	NG	1.00000	0.11787
2014	24005	2810060100	Cremation /Humans	0.001947	NG	1.00000	0.001947
2014	24005	2811015000	Prescribed Forest Burning - Unspecified	0	NG	1.00000	0
	24005 Total			497.402528			508.792876
	Grand Total			960.5872399			983.4793295

Appendix A-6a: Nonroad MOVES Model Inventory (2014)

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2014	24003	2260001010	Off-highway Gasoline, 2-Stroke /Recreational Equipt /Motorcycles: Off-road	SO2	0.013
2014	24003	2260001020	Off-highway Gasoline, 2-Stroke /Recreational Equipt /Snowmobiles	SO2	0.000
2014	24003	2260001030	Off-highway Gasoline, 2-Stroke /Recreational Equipt /All Terrain Vehicles	SO2	0.015
2014	24003	2260001060	Off-highway Gasoline, 2-Stroke /Recreational Equipt /Specialty Vehicles/Carts	SO2	0.004
2014	24003	2260002006	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Tampers/Rammers	SO2	0.001
2014	24003	2260002009	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Plate Compactors	SO2	0.000
2014	24003	2260002021	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Paving Equipt	SO2	0.000
2014	24003	2260002027	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Signal Boards/Light Plants	SO2	0.000
2014	24003	2260002039	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Concrete/Industrial Saws	SO2	0.003
2014	24003	2260002054	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Crushing/Processing Equipt	SO2	0.000
2014	24003	2260003030	Off-highway Gasoline, 2-Stroke /Industrial Equipt /Sweepers/Scrubbers	SO2	0.000
2014	24003	2260003040	Off-highway Gasoline, 2-Stroke /Industrial Equipt /Other General Industrial Equipt	SO2	0.000
2014	24003	2260004015	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Rotary Tillers < 6 HP (Residential)	SO2	0.000
2014	24003	2260004016	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Rotary Tillers < 6 HP (Commercial)	SO2	0.003
2014	24003	2260004020	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Chain Saws < 6 HP (Residential)	SO2	0.005
2014	24003	2260004021	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Chain Saws < 6 HP (Commercial)	SO2	0.032
2014	24003	2260004025	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Trimmers/Edgers/Brush Cutters (Residential)	SO2	0.007
2014	24003	2260004026	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Trimmers/Edgers/Brush Cutters (Commercial)	SO2	0.028
2014	24003	2260004030	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Leafblowers/Vacuums (Residential)	SO2	0.004
2014	24003	2260004031	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Leafblowers/Vacuums (Commercial)	SO2	0.026
2014	24003	2260004035	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Snowblowers (Residential)	SO2	0.002
2014	24003	2260004036	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Snowblowers (Commercial)	SO2	0.008
2014	24003	2260004071	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Turf Equipt (Commercial)	SO2	0.000
2014	24003	2260005035	Off-highway Gasoline, 2-Stroke /Agricultural Equipt /Sprayers	SO2	0.000
2014	24003	2260006005	Off-highway Gasoline, 2-Stroke /Commercial Equipt /Generator Sets	SO2	0.001
2014	24003	2260006010	Off-highway Gasoline, 2-Stroke /Commercial Equipt /Pumps	SO2	0.004
2014	24003	2260006015	Off-highway Gasoline, 2-Stroke /Commercial Equipt /Air Compressors	SO2	0.000
2014	24003	2260006035	Off-highway Gasoline, 2-Stroke /Commercial Equipt /Hydro-power Units	SO2	0.000
2014	24003	2260007005	Off-highway Gasoline, 2-Stroke /Logging Equipt /Chain Saws : 6 HP	SO2	0.000
2014	24003	2265001010	Off-highway Gasoline, 4-Stroke /Recreational Equipt /Motorcycles: Off-road	SO2	0.006
2014	24003	2265001030	Off-highway Gasoline, 4-Stroke /Recreational Equipt /All Terrain Vehicles	SO2	0.067
2014	24003	2265001050	Off-highway Gasoline, 4-Stroke /Recreational Equipt /Golf Carts	SO2	0.014
2014	24003	2265001060	Off-highway Gasoline, 4-Stroke /Recreational Equipt /Specialty Vehicles/Carts	SO2	0.004
2014	24003	2265002003	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Pavers	SO2	0.001
2014	24003	2265002006	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Tampers/Rammers	SO2	0.000
2014	24003	2265002009	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Plate Compactors	SO2	0.002
2014	24003	2265002015	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Rollers	SO2	0.002

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2014	24003	2265002021	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Paving Equipt	SO2	0.004
2014	24003	2265002024	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Surfacing Equipt	SO2	0.002
2014	24003	2265002027	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Signal Boards/Light Plants	SO2	0.000
2014	24003	2265002030	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Trenchers	SO2	0.003
2014	24003	2265002033	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Bore/Drill Rigs	SO2	0.001
2014	24003	2265002039	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Concrete/Industrial Saws	SO2	0.007
2014	24003	2265002042	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Cement & Mortar Mixers	SO2	0.003
2014	24003	2265002045	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Cranes	SO2	0.000
2014	24003	2265002054	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Crushing/Processing Equipt	SO2	0.000
2014	24003	2265002057	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Rough Terrain Forklifts	SO2	0.000
2014	24003	2265002060	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Rubber Tire Loaders	SO2	0.001
2014	24003	2265002066	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Tractors/Loaders/Backhoes	SO2	0.002
2014	24003	2265002072	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Skid Steer Loaders	SO2	0.002
2014	24003	2265002078	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Dumpers/Tenders	SO2	0.001
2014	24003	2265002081	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Other Construction Equipt	SO2	0.000
2014	24003	2265003010	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Aerial Lifts	SO2	0.001
2014	24003	2265003020	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Forklifts	SO2	0.004
2014	24003	2265003030	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Sweepers/Scrubbers	SO2	0.001
2014	24003	2265003040	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Other General Industrial Equipt	SO2	0.002
2014	24003	2265003050	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Other Material H&ling Equipt	SO2	0.000
2014	24003	2265003060	Off-highway Gasoline, 4-Stroke /Industrial Equipt /AC\Refrigeration	SO2	0.000
2014	24003	2265003070	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Terminal Tractors	SO2	0.000
2014	24003	2265004010	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Lawn Mowers (Residential)	SO2	0.060
2014	24003	2265004011	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Lawn Mowers (Commercial)	SO2	0.081
2014	24003	2265004015	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Rotary Tillers < 6 HP (Residential)	SO2	0.005
2014	24003	2265004016	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Rotary Tillers < 6 HP (Commercial)	SO2	0.041
2014	24003	2265004025	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Trimmers/Edgers/Brush Cutters (Residential)	SO2	0.000
2014	24003	2265004026	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Trimmers/Edgers/Brush Cutters (Commercial)	SO2	0.002
2014	24003	2265004030	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Leafblowers/Vacuums (Residential)	SO2	0.001
2014	24003	2265004031	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Leafblowers/Vacuums (Commercial)	SO2	0.078
2014	24003	2265004035	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Snowblowers (Residential)	SO2	0.007
2014	24003	2265004036	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Snowblowers (Commercial)	SO2	0.027
2014	24003	2265004040	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Rear Engine Riding Mowers (Residential)	SO2	0.012
2014	24003	2265004041	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Rear Engine Riding Mowers (Commercial)	SO2	0.009
2014	24003	2265004046	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Front Mowers (Commercial)	SO2	0.010
2014	24003	2265004051	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Shredders < 6 HP (Commercial)	SO2	0.005
2014	24003	2265004055	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Lawn & Garden Tractors (Residential)	SO2	0.162

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2014	24003	2265004056	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Lawn & Garden Tractors (Commercial)	SO2	0.122
2014	24003	2265004066	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Chippers/Stump Grinders (Commercial)	SO2	0.020
2014	24003	2265004071	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Turf Equipt (Commercial)	SO2	0.393
2014	24003	2265004075	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Other Lawn & Garden Equipt (Residential)	SO2	0.006
2014	24003	2265004076	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Other Lawn & Garden Equipt (Commercial)	SO2	0.012
2014	24003	2265005010	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /2-Wheel Tractors	SO2	0.000
2014	24003	2265005015	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Agricultural Tractors	SO2	0.000
2014	24003	2265005020	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Combines	SO2	0.000
2014	24003	2265005025	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Balers	SO2	0.000
2014	24003	2265005030	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Agricultural Mowers	SO2	0.000
2014	24003	2265005035	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Sprayers	SO2	0.000
2014	24003	2265005040	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Tillers : 6 HP	SO2	0.000
2014	24003	2265005045	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Swathers	SO2	0.000
2014	24003	2265005055	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Other Agricultural Equipt	SO2	0.000
2014	24003	2265005060	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Irrigation Sets	SO2	0.000
2014	24003	2265006005	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Generator Sets	SO2	0.139
2014	24003	2265006010	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Pumps	SO2	0.035
2014	24003	2265006015	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Air Compressors	SO2	0.018
2014	24003	2265006025	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Welders	SO2	0.040
2014	24003	2265006030	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Pressure Washers	SO2	0.062
2014	24003	2265006035	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Hydro-power Units	SO2	0.003
2014	24003	2265007010	Off-highway Gasoline, 4-Stroke /Logging Equipt /Shredders : 6 HP	SO2	0.001
2014	24003	2265007015	Off-highway Gasoline, 4-Stroke /Logging Equipt /Forest Equipt - Feller/Bunch/Skidder	SO2	0.000
2014	24003	2265008005	Airport Ground Support Equipment, 4-Stroke Gasoline	SO2	0.006
2014	24003	2265010010	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Other Oil Field Equipt	SO2	0.000
2014	24003	2267001060	Off-highway LPG /Recreational Equipt /Specialty Vehicles/Carts	SO2	0.000
2014	24003	2267002003	Off-highway LPG /Construction & Mining Equipt /Pavers	SO2	0.000
2014	24003	2267002015	Off-highway LPG /Construction & Mining Equipt /Rollers	SO2	0.000
2014	24003	2267002021	Off-highway LPG /Construction & Mining Equipt /Paving Equipt	SO2	0.000
2014	24003	2267002024	Off-highway LPG /Construction & Mining Equipt /Surfacing Equipt	SO2	0.000
2014	24003	2267002030	Off-highway LPG /Construction & Mining Equipt /Trenchers	SO2	0.000
2014	24003	2267002033	Off-highway LPG /Construction & Mining Equipt /Bore/Drill Rigs	SO2	0.000
2014	24003	2267002039	Off-highway LPG /Construction & Mining Equipt /Concrete/Industrial Saws	SO2	0.000
2014	24003	2267002045	Off-highway LPG /Construction & Mining Equipt /Cranes	SO2	0.000
2014	24003	2267002054	Off-highway LPG /Construction & Mining Equipt /Crushing/Processing Equipt	SO2	0.000
2014	24003	2267002057	Off-highway LPG /Construction & Mining Equipt /Rough Terrain Forklifts	SO2	0.000
2014	24003	2267002060	Off-highway LPG /Construction & Mining Equipt /Rubber Tire Loaders	SO2	0.000

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2014	24003	2267002066	Off-highway LPG /Construction & Mining Equipt /Tractors/Loaders/Backhoes	SO2	0.000
2014	24003	2267002072	Off-highway LPG /Construction & Mining Equipt /Skid Steer Loaders	SO2	0.000
2014	24003	2267002081	Off-highway LPG /Construction & Mining Equipt /Other Construction Equipt	SO2	0.000
2014	24003	2267003010	Off-highway LPG /Industrial Equipt /Aerial Lifts	SO2	0.001
2014	24003	2267003020	Off-highway LPG /Industrial Equipt /Forklifts	SO2	0.075
2014	24003	2267003030	Off-highway LPG /Industrial Equipt /Sweepers/Scrubbers	SO2	0.001
2014	24003	2267003040	Off-highway LPG /Industrial Equipt /Other General Industrial Equipt	SO2	0.000
2014	24003	2267003050	Off-highway LPG /Industrial Equipt /Other Material H&ling Equipt	SO2	0.000
2014	24003	2267003070	Off-highway LPG /Industrial Equipt /Terminal Tractors	SO2	0.000
2014	24003	2267004066	Off-highway LPG /Lawn & Garden Equipt /Chippers/Stump Grinders (Commercial)	SO2	0.002
2014	24003	2267005055	Off-highway LPG /Agricultural Equipt /Other Agricultural Equipt	SO2	0.000
2014	24003	2267005060	Off-highway LPG /Agricultural Equipt /Irrigation Sets	SO2	0.000
2014	24003	2267006005	Off-highway LPG /Commercial Equipt /Generator Sets	SO2	0.005
2014	24003	2267006010	Off-highway LPG /Commercial Equipt /Pumps	SO2	0.001
2014	24003	2267006015	Off-highway LPG /Commercial Equipt /Air Compressors	SO2	0.001
2014	24003	2267006025	Off-highway LPG /Commercial Equipt /Welders	SO2	0.002
2014	24003	2267006030	Off-highway LPG /Commercial Equipt /Pressure Washers	SO2	0.000
2014	24003	2267006035	Off-highway LPG /Commercial Equipt /Hydro-power Units	SO2	0.000
2014	24003	2267008005	Airport Ground Support Equipment, LPG	SO2	0.001
2014	24003	2268002081	Off-highway CNG /Construction & Mining Equipt /Other Construction Equipt	SO2	0.000
2014	24003	2268003020	Off-highway CNG /Industrial Equipt /Forklifts	SO2	0.005
2014	24003	2268003030	Off-highway CNG /Industrial Equipt /Sweepers/Scrubbers	SO2	0.000
2014	24003	2268003040	Off-highway CNG /Industrial Equipt /Other General Industrial Equipt	SO2	0.000
2014	24003	2268003060	Off-highway CNG /Industrial Equipt /AC\Refrigeration	SO2	0.000
2014	24003	2268003070	Off-highway CNG /Industrial Equipt /Terminal Tractors	SO2	0.000
2014	24003	2268005055	Off-highway CNG /Agricultural Equipt /Other Agricultural Equipt	SO2	0.000
2014	24003	2268005060	Off-highway CNG /Agricultural Equipt /Irrigation Sets	SO2	0.000
2014	24003	2268006005	Off-highway CNG /Commercial Equipt /Generator Sets	SO2	0.001
2014	24003	2268006010	Off-highway CNG /Commercial Equipt /Pumps	SO2	0.000
2014	24003	2268006015	Off-highway CNG /Commercial Equipt /Air Compressors	SO2	0.000
2014	24003	2268006020	Off-highway CNG /Commercial Equipt /Gas Compressors	SO2	0.003
2014	24003	2268010010	Off-highway CNG /Industrial Equipt /Other Oil Field Equipt	SO2	0.000
2014	24003	2270001060	Off-highway Diesel /Recreational Equipt /Specialty Vehicles/Carts	SO2	0.003
2014	24003	2270002003	Off-highway Diesel /Construction & Mining Equipt /Pavers	SO2	0.021
2014	24003	2270002006	Off-highway Diesel /Construction & Mining Equipt /Tampers/Rammers	SO2	0.000
2014	24003	2270002009	Off-highway Diesel /Construction & Mining Equipt /Plate Compactors	SO2	0.001
2014	24003	2270002015	Off-highway Diesel /Construction & Mining Equipt /Rollers	SO2	0.053

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2014	24003	2270002018	Off-highway Diesel /Construction & Mining Equipt /Scrapers	SO2	0.056
2014	24003	2270002021	Off-highway Diesel /Construction & Mining Equipt /Paving Equipt	SO2	0.003
2014	24003	2270002024	Off-highway Diesel /Construction & Mining Equipt /Surfacing Equipt	SO2	0.002
2014	24003	2270002027	Off-highway Diesel /Construction & Mining Equipt /Signal Boards/Light Plants	SO2	0.006
2014	24003	2270002030	Off-highway Diesel /Construction & Mining Equipt /Trenchers	SO2	0.026
2014	24003	2270002033	Off-highway Diesel /Construction & Mining Equipt /Bore/Drill Rigs	SO2	0.022
2014	24003	2270002036	Off-highway Diesel /Construction & Mining Equipt /Excavators	SO2	0.204
2014	24003	2270002039	Off-highway Diesel /Construction & Mining Equipt /Concrete/Industrial Saws	SO2	0.002
2014	24003	2270002042	Off-highway Diesel /Construction & Mining Equipt /Cement & Mortar Mixers	SO2	0.001
2014	24003	2270002045	Off-highway Diesel /Construction & Mining Equipt /Cranes	SO2	0.049
2014	24003	2270002048	Off-highway Diesel /Construction & Mining Equipt /Graders	SO2	0.051
2014	24003	2270002051	Off-highway Diesel /Construction & Mining Equipt /Off-highway Trucks	SO2	0.170
2014	24003	2270002054	Off-highway Diesel /Construction & Mining Equipt /Crushing/Processing Equipt	SO2	0.009
2014	24003	2270002057	Off-highway Diesel /Construction & Mining Equipt /Rough Terrain Forklifts	SO2	0.069
2014	24003	2270002060	Off-highway Diesel /Construction & Mining Equipt /Rubber Tire Loaders	SO2	0.231
2014	24003	2270002066	Off-highway Diesel /Construction & Mining Equipt /Tractors/Loaders/Backhoes	SO2	0.146
2014	24003	2270002069	Off-highway Diesel /Construction & Mining Equipt /Crawler Tractor/Dozers	SO2	0.208
2014	24003	2270002072	Off-highway Diesel /Construction & Mining Equipt /Skid Steer Loaders	SO2	0.102
2014	24003	2270002075	Off-highway Diesel /Construction & Mining Equipt /Off-highway Tractors	SO2	0.023
2014	24003	2270002078	Off-highway Diesel /Construction & Mining Equipt /Dumpers/Tenders	SO2	0.000
2014	24003	2270002081	Off-highway Diesel /Construction & Mining Equipt /Other Construction Equipt	SO2	0.022
2014	24003	2270003010	Off-highway Diesel /Industrial Equipt /Aerial Lifts	SO2	0.003
2014	24003	2270003020	Off-highway Diesel /Industrial Equipt /Forklifts	SO2	0.042
2014	24003	2270003030	Off-highway Diesel /Industrial Equipt /Sweepers/Scrubbers	SO2	0.020
2014	24003	2270003040	Off-highway Diesel /Industrial Equipt /Other General Industrial Equipt	SO2	0.020
2014	24003	2270003050	Off-highway Diesel /Industrial Equipt /Other Material H&ling Equipt	SO2	0.001
2014	24003	2270003060	Off-highway Diesel /Industrial Equipt /AC\Refrigeration	SO2	0.107
2014	24003	2270003070	Off-highway Diesel /Industrial Equipt /Terminal Tractors	SO2	0.027
2014	24003	2270004031	Off-highway Diesel /Lawn & Garden Equipt /Leafblowers/Vacuums (Commercial)	SO2	0.000
2014	24003	2270004036	Off-highway Diesel /Lawn & Garden Equipt /Snowblowers (Commercial)	SO2	0.002
2014	24003	2270004046	Off-highway Diesel /Lawn & Garden Equipt /Front Mowers (Commercial)	SO2	0.048
2014	24003	2270004056	Off-highway Diesel /Lawn & Garden Equipt /Lawn & Garden Tractors (Commercial)	SO2	0.010
2014	24003	2270004066	Off-highway Diesel /Lawn & Garden Equipt /Chippers/Stump Grinders (Commercial)	SO2	0.064
2014	24003	2270004071	Off-highway Diesel /Lawn & Garden Equipt /Turf Equipt (Commercial)	SO2	0.007
2014	24003	2270004076	Off-highway Diesel /Lawn & Garden Equipt /Other Lawn & Garden Equipt (Commercial)	SO2	0.000
2014	24003	2270005010	Off-highway Diesel /Agricultural Equipt /2-Wheel Tractors	SO2	0.000
2014	24003	2270005015	Off-highway Diesel /Agricultural Equipt /Agricultural Tractors	SO2	0.031

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2014	24003	2270005020	Off-highway Diesel /Agricultural Equipt /Combines	SO2	0.003
2014	24003	2270005025	Off-highway Diesel /Agricultural Equipt /Balers	SO2	0.000
2014	24003	2270005030	Off-highway Diesel /Agricultural Equipt /Agricultural Mowers	SO2	0.000
2014	24003	2270005035	Off-highway Diesel /Agricultural Equipt /Sprayers	SO2	0.000
2014	24003	2270005040	Off-highway Diesel /Agricultural Equipt /Tillers : 6 HP	SO2	0.000
2014	24003	2270005045	Off-highway Diesel /Agricultural Equipt /Swathers	SO2	0.000
2014	24003	2270005055	Off-highway Diesel /Agricultural Equipt /Other Agricultural Equipt	SO2	0.001
2014	24003	2270005060	Off-highway Diesel /Agricultural Equipt /Irrigation Sets	SO2	0.000
2014	24003	2270006005	Off-highway Diesel /Commercial Equipt /Generator Sets	SO2	0.069
2014	24003	2270006010	Off-highway Diesel /Commercial Equipt /Pumps	SO2	0.016
2014	24003	2270006015	Off-highway Diesel /Commercial Equipt /Air Compressors	SO2	0.044
2014	24003	2270006025	Off-highway Diesel /Commercial Equipt /Welders	SO2	0.023
2014	24003	2270006030	Off-highway Diesel /Commercial Equipt /Pressure Washers	SO2	0.002
2014	24003	2270006035	Off-highway Diesel /Commercial Equipt /Hydro-power Units	SO2	0.002
2014	24003	2270007015	Off-highway Diesel /Logging Equipt /Forest Equipt - Feller/Bunch/Skidder	SO2	0.006
2014	24003	2270008005	Airport Ground Support Equipment, Diesel	SO2	0.214
2014	24003	2270009010	Off-highway Diesel /Underground Mining Equipt /Other Underground Mining Equipt	SO2	0.000
2014	24003	2270010010	Off-highway Diesel /Industrial Equipt /Other Oil Field Equipt	SO2	0.000
2014	24003	2282005010	Pleasure Craft /Gasoline 2-Stroke /Outboard	SO2	0.137
2014	24003	2282005015	Pleasure Craft /Gasoline 2-Stroke /Personal Water Craft	SO2	0.058
2014	24003	2282010005	Pleasure Craft /Gasoline 4-Stroke /Inboard/Sterndrive	SO2	0.111
2014	24003	2282020005	Pleasure Craft /Diesel /Inboard/Sterndrive	SO2	0.173
2014	24003	2282020010	Pleasure Craft /Diesel /Outboard	SO2	0.001
2014	24003	2285002015	Railroad Equipt /Diesel /Railway Maintenance	SO2	0.002
2014	24003	2285004015	Railroad Equipt /Gasoline, 4-Stroke /Railway Maintenance	SO2	0.000
2014	24003	2285006015	Railroad Equipt /LPG /Railway Maintenance	SO2	0.000
2014	**24003 Total**				4.473

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2014	24005	2260001010	Off-highway Gasoline, 2-Stroke /Recreational Equipt /Motorcycles: Off-road	SO2	0.006
2014	24005	2260001020	Off-highway Gasoline, 2-Stroke /Recreational Equipt /Snowmobiles	SO2	0.000
2014	24005	2260001030	Off-highway Gasoline, 2-Stroke /Recreational Equipt /All Terrain Vehicles	SO2	0.007
2014	24005	2260001060	Off-highway Gasoline, 2-Stroke /Recreational Equipt /Specialty Vehicles/Carts	SO2	0.002
2014	24005	2260002006	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Tampers/Rammers	SO2	0.003
2014	24005	2260002009	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Plate Compactors	SO2	0.000
2014	24005	2260002021	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Paving Equipt	SO2	0.000
2014	24005	2260002027	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Signal Boards/Light Plants	SO2	0.000
2014	24005	2260002039	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Concrete/Industrial Saws	SO2	0.007
2014	24005	2260002054	Off-highway Gasoline, 2-Stroke /Construction & Mining Equipt /Crushing/Processing Equipt	SO2	0.000
2014	24005	2260003030	Off-highway Gasoline, 2-Stroke /Industrial Equipt /Sweepers/Scrubbers	SO2	0.000
2014	24005	2260003040	Off-highway Gasoline, 2-Stroke /Industrial Equipt /Other General Industrial Equipt	SO2	0.000
2014	24005	2260004015	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Rotary Tillers < 6 HP (Residential)	SO2	0.001
2014	24005	2260004016	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Rotary Tillers < 6 HP (Commercial)	SO2	0.003
2014	24005	2260004020	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Chain Saws < 6 HP (Residential)	SO2	0.008
2014	24005	2260004021	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Chain Saws < 6 HP (Commercial)	SO2	0.038
2014	24005	2260004025	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Trimmers/Edgers/Brush Cutters (Residential)	SO2	0.011
2014	24005	2260004026	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Trimmers/Edgers/Brush Cutters (Commercial)	SO2	0.033
2014	24005	2260004030	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Leafblowers/Vacuums (Residential)	SO2	0.007
2014	24005	2260004031	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Leafblowers/Vacuums (Commercial)	SO2	0.031
2014	24005	2260004035	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Snowblowers (Residential)	SO2	0.003
2014	24005	2260004036	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Snowblowers (Commercial)	SO2	0.010
2014	24005	2260004071	Off-highway Gasoline, 2-Stroke /Lawn & Garden Equipt /Turf Equipt (Commercial)	SO2	0.000
2014	24005	2260005035	Off-highway Gasoline, 2-Stroke /Agricultural Equipt /Sprayers	SO2	0.000
2014	24005	2260006005	Off-highway Gasoline, 2-Stroke /Commercial Equipt /Generator Sets	SO2	0.001
2014	24005	2260006010	Off-highway Gasoline, 2-Stroke /Commercial Equipt /Pumps	SO2	0.007
2014	24005	2260006015	Off-highway Gasoline, 2-Stroke /Commercial Equipt /Air Compressors	SO2	0.000
2014	24005	2260006035	Off-highway Gasoline, 2-Stroke /Commercial Equipt /Hydro-power Units	SO2	0.000
2014	24005	2260007005	Off-highway Gasoline, 2-Stroke /Logging Equipt /Chain Saws : 6 HP	SO2	0.000
2014	24005	2265001010	Off-highway Gasoline, 4-Stroke /Recreational Equipt /Motorcycles: Off-road	SO2	0.003
2014	24005	2265001030	Off-highway Gasoline, 4-Stroke /Recreational Equipt /All Terrain Vehicles	SO2	0.034
2014	24005	2265001050	Off-highway Gasoline, 4-Stroke /Recreational Equipt /Golf Carts	SO2	0.030
2014	24005	2265001060	Off-highway Gasoline, 4-Stroke /Recreational Equipt /Specialty Vehicles/Carts	SO2	0.002
2014	24005	2265002003	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Pavers	SO2	0.003
2014	24005	2265002006	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Tampers/Rammers	SO2	0.000
2014	24005	2265002009	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Plate Compactors	SO2	0.005
2014	24005	2265002015	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Rollers	SO2	0.004

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2014	24005	2265002021	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Paving Equipt	SO2	0.009
2014	24005	2265002024	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Surfacing Equipt	SO2	0.004
2014	24005	2265002027	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Signal Boards/Light Plants	SO2	0.000
2014	24005	2265002030	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Trenchers	SO2	0.008
2014	24005	2265002033	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Bore/Drill Rigs	SO2	0.003
2014	24005	2265002039	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Concrete/Industrial Saws	SO2	0.016
2014	24005	2265002042	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Cement & Mortar Mixers	SO2	0.008
2014	24005	2265002045	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Cranes	SO2	0.001
2014	24005	2265002054	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Crushing/Processing Equipt	SO2	0.001
2014	24005	2265002057	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Rough Terrain Forklifts	SO2	0.001
2014	24005	2265002060	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Rubber Tire Loaders	SO2	0.002
2014	24005	2265002066	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Tractors/Loaders/Backhoes	SO2	0.005
2014	24005	2265002072	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Skid Steer Loaders	SO2	0.004
2014	24005	2265002078	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Dumpers/Tenders	SO2	0.001
2014	24005	2265002081	Off-highway Gasoline, 4-Stroke /Construction & Mining Equipt /Other Construction Equipt	SO2	0.001
2014	24005	2265003010	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Aerial Lifts	SO2	0.002
2014	24005	2265003020	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Forklifts	SO2	0.007
2014	24005	2265003030	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Sweepers/Scrubbers	SO2	0.002
2014	24005	2265003040	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Other General Industrial Equipt	SO2	0.003
2014	24005	2265003050	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Other Material H&ling Equipt	SO2	0.000
2014	24005	2265003060	Off-highway Gasoline, 4-Stroke /Industrial Equipt /AC\Refrigeration	SO2	0.000
2014	24005	2265003070	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Terminal Tractors	SO2	0.001
2014	24005	2265004010	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Lawn Mowers (Residential)	SO2	0.100
2014	24005	2265004011	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Lawn Mowers (Commercial)	SO2	0.098
2014	24005	2265004015	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Rotary Tillers < 6 HP (Residential)	SO2	0.008
2014	24005	2265004016	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Rotary Tillers < 6 HP (Commercial)	SO2	0.050
2014	24005	2265004025	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Trimmers/Edgers/Brush Cutters (Residential)	SO2	0.001
2014	24005	2265004026	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Trimmers/Edgers/Brush Cutters (Commercial)	SO2	0.002
2014	24005	2265004030	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Leafblowers/Vacuums (Residential)	SO2	0.001
2014	24005	2265004031	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Leafblowers/Vacuums (Commercial)	SO2	0.093
2014	24005	2265004035	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Snowblowers (Residential)	SO2	0.011
2014	24005	2265004036	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Snowblowers (Commercial)	SO2	0.032
2014	24005	2265004040	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Rear Engine Riding Mowers (Residential)	SO2	0.020
2014	24005	2265004041	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Rear Engine Riding Mowers (Commercial)	SO2	0.011
2014	24005	2265004046	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Front Mowers (Commercial)	SO2	0.012
2014	24005	2265004051	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Shredders < 6 HP (Commercial)	SO2	0.006
2014	24005	2265004055	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Lawn & Garden Tractors (Residential)	SO2	0.269

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2014	24005	2265004056	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Lawn & Garden Tractors (Commercial)	SO2	0.146
2014	24005	2265004066	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Chippers/Stump Grinders (Commercial)	SO2	0.025
2014	24005	2265004071	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Turf Equipt (Commercial)	SO2	0.473
2014	24005	2265004075	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Other Lawn & Garden Equipt (Residential)	SO2	0.010
2014	24005	2265004076	Off-highway Gasoline, 4-Stroke /Lawn & Garden Equipt /Other Lawn & Garden Equipt (Commercial)	SO2	0.014
2014	24005	2265005010	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /2-Wheel Tractors	SO2	0.000
2014	24005	2265005015	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Agricultural Tractors	SO2	0.000
2014	24005	2265005020	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Combines	SO2	0.000
2014	24005	2265005025	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Balers	SO2	0.000
2014	24005	2265005030	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Agricultural Mowers	SO2	0.000
2014	24005	2265005035	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Sprayers	SO2	0.000
2014	24005	2265005040	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Tillers : 6 HP	SO2	0.001
2014	24005	2265005045	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Swathers	SO2	0.000
2014	24005	2265005055	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Other Agricultural Equipt	SO2	0.000
2014	24005	2265005060	Off-highway Gasoline, 4-Stroke /Agricultural Equipt /Irrigation Sets	SO2	0.000
2014	24005	2265006005	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Generator Sets	SO2	0.213
2014	24005	2265006010	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Pumps	SO2	0.053
2014	24005	2265006015	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Air Compressors	SO2	0.028
2014	24005	2265006025	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Welders	SO2	0.061
2014	24005	2265006030	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Pressure Washers	SO2	0.095
2014	24005	2265006035	Off-highway Gasoline, 4-Stroke /Commercial Equipt /Hydro-power Units	SO2	0.004
2014	24005	2265007010	Off-highway Gasoline, 4-Stroke /Logging Equipt /Shredders : 6 HP	SO2	0.000
2014	24005	2265007015	Off-highway Gasoline, 4-Stroke /Logging Equipt /Forest Equipt - Feller/Bunch/Skidder	SO2	0.000
2014	24005	2265008005	Airport Ground Support Equipment, 4-Stroke Gasoline	SO2	0.000
2014	24005	2265010010	Off-highway Gasoline, 4-Stroke /Industrial Equipt /Other Oil Field Equipt	SO2	0.000
2014	24005	2267001060	Off-highway LPG /Recreational Equipt /Specialty Vehicles/Carts	SO2	0.000
2014	24005	2267002003	Off-highway LPG /Construction & Mining Equipt /Pavers	SO2	0.000
2014	24005	2267002015	Off-highway LPG /Construction & Mining Equipt /Rollers	SO2	0.000
2014	24005	2267002021	Off-highway LPG /Construction & Mining Equipt /Paving Equipt	SO2	0.000
2014	24005	2267002024	Off-highway LPG /Construction & Mining Equipt /Surfacing Equipt	SO2	0.000
2014	24005	2267002030	Off-highway LPG /Construction & Mining Equipt /Trenchers	SO2	0.000
2014	24005	2267002033	Off-highway LPG /Construction & Mining Equipt /Bore/Drill Rigs	SO2	0.000
2014	24005	2267002039	Off-highway LPG /Construction & Mining Equipt /Concrete/Industrial Saws	SO2	0.000
2014	24005	2267002045	Off-highway LPG /Construction & Mining Equipt /Cranes	SO2	0.000
2014	24005	2267002054	Off-highway LPG /Construction & Mining Equipt /Crushing/Processing Equipt	SO2	0.000
2014	24005	2267002057	Off-highway LPG /Construction & Mining Equipt /Rough Terrain Forklifts	SO2	0.000
2014	24005	2267002060	Off-highway LPG /Construction & Mining Equipt /Rubber Tire Loaders	SO2	0.001

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2014	24005	2267002066	Off-highway LPG /Construction & Mining Equipt /Tractors/Loaders/Backhoes	SO2	0.000
2014	24005	2267002072	Off-highway LPG /Construction & Mining Equipt /Skid Steer Loaders	SO2	0.001
2014	24005	2267002081	Off-highway LPG /Construction & Mining Equipt /Other Construction Equipt	SO2	0.000
2014	24005	2267003010	Off-highway LPG /Industrial Equipt /Aerial Lifts	SO2	0.002
2014	24005	2267003020	Off-highway LPG /Industrial Equipt /Forklifts	SO2	0.138
2014	24005	2267003030	Off-highway LPG /Industrial Equipt /Sweepers/Scrubbers	SO2	0.001
2014	24005	2267003040	Off-highway LPG /Industrial Equipt /Other General Industrial Equipt	SO2	0.000
2014	24005	2267003050	Off-highway LPG /Industrial Equipt /Other Material H&ling Equipt	SO2	0.000
2014	24005	2267003070	Off-highway LPG /Industrial Equipt /Terminal Tractors	SO2	0.001
2014	24005	2267004066	Off-highway LPG /Lawn & Garden Equipt /Chippers/Stump Grinders (Commercial)	SO2	0.002
2014	24005	2267005055	Off-highway LPG /Agricultural Equipt /Other Agricultural Equipt	SO2	0.000
2014	24005	2267005060	Off-highway LPG /Agricultural Equipt /Irrigation Sets	SO2	0.000
2014	24005	2267006005	Off-highway LPG /Commercial Equipt /Generator Sets	SO2	0.008
2014	24005	2267006010	Off-highway LPG /Commercial Equipt /Pumps	SO2	0.002
2014	24005	2267006015	Off-highway LPG /Commercial Equipt /Air Compressors	SO2	0.002
2014	24005	2267006025	Off-highway LPG /Commercial Equipt /Welders	SO2	0.002
2014	24005	2267006030	Off-highway LPG /Commercial Equipt /Pressure Washers	SO2	0.000
2014	24005	2267006035	Off-highway LPG /Commercial Equipt /Hydro-power Units	SO2	0.000
2014	24005	2267008005	Airport Ground Support Equipment, LPG	SO2	0.000
2014	24005	2268002081	Off-highway CNG /Construction & Mining Equipt /Other Construction Equipt	SO2	0.000
2014	24005	2268003020	Off-highway CNG /Industrial Equipt /Forklifts	SO2	0.009
2014	24005	2268003030	Off-highway CNG /Industrial Equipt /Sweepers/Scrubbers	SO2	0.000
2014	24005	2268003040	Off-highway CNG /Industrial Equipt /Other General Industrial Equipt	SO2	0.000
2014	24005	2268003060	Off-highway CNG /Industrial Equipt /AC\Refrigeration	SO2	0.000
2014	24005	2268003070	Off-highway CNG /Industrial Equipt /Terminal Tractors	SO2	0.000
2014	24005	2268005055	Off-highway CNG /Agricultural Equipt /Other Agricultural Equipt	SO2	0.000
2014	24005	2268005060	Off-highway CNG /Agricultural Equipt /Irrigation Sets	SO2	0.000
2014	24005	2268006005	Off-highway CNG /Commercial Equipt /Generator Sets	SO2	0.002
2014	24005	2268006010	Off-highway CNG /Commercial Equipt /Pumps	SO2	0.000
2014	24005	2268006015	Off-highway CNG /Commercial Equipt /Air Compressors	SO2	0.000
2014	24005	2268006020	Off-highway CNG /Commercial Equipt /Gas Compressors	SO2	0.005
2014	24005	2268010010	Off-highway CNG /Industrial Equipt /Other Oil Field Equipt	SO2	0.000
2014	24005	2270001060	Off-highway Diesel /Recreational Equipt /Specialty Vehicles/Carts	SO2	0.002
2014	24005	2270002003	Off-highway Diesel /Construction & Mining Equipt /Pavers	SO2	0.048
2014	24005	2270002006	Off-highway Diesel /Construction & Mining Equipt /Tampers/Rammers	SO2	0.000
2014	24005	2270002009	Off-highway Diesel /Construction & Mining Equipt /Plate Compactors	SO2	0.001
2014	24005	2270002015	Off-highway Diesel /Construction & Mining Equipt /Rollers	SO2	0.122

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2014	24005	2270002018	Off-highway Diesel /Construction & Mining Equipt /Scrapers	SO2	0.131
2014	24005	2270002021	Off-highway Diesel /Construction & Mining Equipt /Paving Equipt	SO2	0.007
2014	24005	2270002024	Off-highway Diesel /Construction & Mining Equipt /Surfacing Equipt	SO2	0.005
2014	24005	2270002027	Off-highway Diesel /Construction & Mining Equipt /Signal Boards/Light Plants	SO2	0.014
2014	24005	2270002030	Off-highway Diesel /Construction & Mining Equipt /Trenchers	SO2	0.059
2014	24005	2270002033	Off-highway Diesel /Construction & Mining Equipt /Bore/Drill Rigs	SO2	0.052
2014	24005	2270002036	Off-highway Diesel /Construction & Mining Equipt /Excavators	SO2	0.473
2014	24005	2270002039	Off-highway Diesel /Construction & Mining Equipt /Concrete/Industrial Saws	SO2	0.004
2014	24005	2270002042	Off-highway Diesel /Construction & Mining Equipt /Cement & Mortar Mixers	SO2	0.002
2014	24005	2270002045	Off-highway Diesel /Construction & Mining Equipt /Cranes	SO2	0.113
2014	24005	2270002048	Off-highway Diesel /Construction & Mining Equipt /Graders	SO2	0.118
2014	24005	2270002051	Off-highway Diesel /Construction & Mining Equipt /Off-highway Trucks	SO2	0.393
2014	24005	2270002054	Off-highway Diesel /Construction & Mining Equipt /Crushing/Processing Equipt	SO2	0.020
2014	24005	2270002057	Off-highway Diesel /Construction & Mining Equipt /Rough Terrain Forklifts	SO2	0.160
2014	24005	2270002060	Off-highway Diesel /Construction & Mining Equipt /Rubber Tire Loaders	SO2	0.536
2014	24005	2270002066	Off-highway Diesel /Construction & Mining Equipt /Tractors/Loaders/Backhoes	SO2	0.339
2014	24005	2270002069	Off-highway Diesel /Construction & Mining Equipt /Crawler Tractor/Dozers	SO2	0.482
2014	24005	2270002072	Off-highway Diesel /Construction & Mining Equipt /Skid Steer Loaders	SO2	0.236
2014	24005	2270002075	Off-highway Diesel /Construction & Mining Equipt /Off-highway Tractors	SO2	0.053
2014	24005	2270002078	Off-highway Diesel /Construction & Mining Equipt /Dumpers/Tenders	SO2	0.001
2014	24005	2270002081	Off-highway Diesel /Construction & Mining Equipt /Other Construction Equipt	SO2	0.052
2014	24005	2270003010	Off-highway Diesel /Industrial Equipt /Aerial Lifts	SO2	0.006
2014	24005	2270003020	Off-highway Diesel /Industrial Equipt /Forklifts	SO2	0.078
2014	24005	2270003030	Off-highway Diesel /Industrial Equipt /Sweepers/Scrubbers	SO2	0.036
2014	24005	2270003040	Off-highway Diesel /Industrial Equipt /Other General Industrial Equipt	SO2	0.037
2014	24005	2270003050	Off-highway Diesel /Industrial Equipt /Other Material H&ling Equipt	SO2	0.001
2014	24005	2270003060	Off-highway Diesel /Industrial Equipt /AC\Refrigeration	SO2	0.164
2014	24005	2270003070	Off-highway Diesel /Industrial Equipt /Terminal Tractors	SO2	0.049
2014	24005	2270004031	Off-highway Diesel /Lawn & Garden Equipt /Leafblowers/Vacuums (Commercial)	SO2	0.000
2014	24005	2270004036	Off-highway Diesel /Lawn & Garden Equipt /Snowblowers (Commercial)	SO2	0.002
2014	24005	2270004046	Off-highway Diesel /Lawn & Garden Equipt /Front Mowers (Commercial)	SO2	0.058
2014	24005	2270004056	Off-highway Diesel /Lawn & Garden Equipt /Lawn & Garden Tractors (Commercial)	SO2	0.012
2014	24005	2270004066	Off-highway Diesel /Lawn & Garden Equipt /Chippers/Stump Grinders (Commercial)	SO2	0.076
2014	24005	2270004071	Off-highway Diesel /Lawn & Garden Equipt /Turf Equipt (Commercial)	SO2	0.009
2014	24005	2270004076	Off-highway Diesel /Lawn & Garden Equipt /Other Lawn & Garden Equipt (Commercial)	SO2	0.000
2014	24005	2270005010	Off-highway Diesel /Agricultural Equipt /2-Wheel Tractors	SO2	0.000
2014	24005	2270005015	Off-highway Diesel /Agricultural Equipt /Agricultural Tractors	SO2	0.064

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2014	24005	2270005020	Off-highway Diesel /Agricultural Equipt /Combines	SO2	0.006
2014	24005	2270005025	Off-highway Diesel /Agricultural Equipt /Balers	SO2	0.000
2014	24005	2270005030	Off-highway Diesel /Agricultural Equipt /Agricultural Mowers	SO2	0.000
2014	24005	2270005035	Off-highway Diesel /Agricultural Equipt /Sprayers	SO2	0.000
2014	24005	2270005040	Off-highway Diesel /Agricultural Equipt /Tillers : 6 HP	SO2	0.000
2014	24005	2270005045	Off-highway Diesel /Agricultural Equipt /Swathers	SO2	0.000
2014	24005	2270005055	Off-highway Diesel /Agricultural Equipt /Other Agricultural Equipt	SO2	0.001
2014	24005	2270005060	Off-highway Diesel /Agricultural Equipt /Irrigation Sets	SO2	0.001
2014	24005	2270006005	Off-highway Diesel /Commercial Equipt /Generator Sets	SO2	0.106
2014	24005	2270006010	Off-highway Diesel /Commercial Equipt /Pumps	SO2	0.025
2014	24005	2270006015	Off-highway Diesel /Commercial Equipt /Air Compressors	SO2	0.067
2014	24005	2270006025	Off-highway Diesel /Commercial Equipt /Welders	SO2	0.035
2014	24005	2270006030	Off-highway Diesel /Commercial Equipt /Pressure Washers	SO2	0.003
2014	24005	2270006035	Off-highway Diesel /Commercial Equipt /Hydro-power Units	SO2	0.003
2014	24005	2270007015	Off-highway Diesel /Logging Equipt /Forest Equipt - Feller/Bunch/Skidder	SO2	0.003
2014	24005	2270008005	Airport Ground Support Equipment, Diesel	SO2	0.000
2014	24005	2270009010	Off-highway Diesel /Underground Mining Equipt /Other Underground Mining Equipt	SO2	0.000
2014	24005	2270010010	Off-highway Diesel /Industrial Equipt /Other Oil Field Equipt	SO2	0.001
2014	24005	2282005010	Pleasure Craft /Gasoline 2-Stroke /Outboard	SO2	0.105
2014	24005	2282005015	Pleasure Craft /Gasoline 2-Stroke /Personal Water Craft	SO2	0.045
2014	24005	2282010005	Pleasure Craft /Gasoline 4-Stroke /Inboard/Sterndrive	SO2	0.064
2014	24005	2282020005	Pleasure Craft /Diesel /Inboard/Sterndrive	SO2	0.099
2014	24005	2282020010	Pleasure Craft /Diesel /Outboard	SO2	0.000
2014	24005	2285002015	Railroad Equipt /Diesel /Railway Maintenance	SO2	0.004
2014	24005	2285004015	Railroad Equipt /Gasoline, 4-Stroke /Railway Maintenance	SO2	0.000
2014	24005	2285006015	Railroad Equipt /LPG /Railway Maintenance	SO2	0.000
2014	**24005 Total**				6.943
2014	**Grand Total**				11.416

Appendix A-6b: Nonroad MOVES Model Inventory (2021)

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2021	24003	2260001010	Recreational Equipment - Motorcycles: Off-road - Non-Road Gasoline	SO2	0.005038367
2021	24003	2260001020	Recreational Equipment - Snowmobiles - Non-Road Gasoline	SO2	1.53854E-35
2021	24003	2260001030	Recreational Equipment - All Terrain Vehicles - Non-Road Gasoline	SO2	0.006503011
2021	24003	2260001060	Recreational Equipment - Specialty Vehicles/Carts - Non-Road Gasoline	SO2	0.001358264
2021	24003	2260002006	Construction and Mining Equipment - Tampers/Rammers - Non-Road Gasoline	SO2	0.000416447
2021	24003	2260002009	Construction and Mining Equipment - Plate Compactors - Non-Road Gasoline	SO2	2.71175E-05
2021	24003	2260002021	Construction and Mining Equipment - Paving Equipment - Non-Road Gasoline	SO2	3.24153E-05
2021	24003	2260002027	Construction and Mining Equipment - Signal Boards/Light Plants - Non-Road Gasoline	SO2	2.42662E-07
2021	24003	2260002039	Construction and Mining Equipment - Concrete/Industrial Saws - Non-Road Gasoline	SO2	0.001076096
2021	24003	2260002054	Construction and Mining Equipment - Crushing/Processing Equipment - Non-Road Gasoline	SO2	6.31871E-06
2021	24003	2260003030	Industrial Equipment - Sweepers/Scrubbers - Non-Road Gasoline	SO2	1.17082E-06
2021	24003	2260003040	Industrial Equipment - Other General Industrial Equipment - Non-Road Gasoline	SO2	9.22124E-08
2021	24003	2260004015	Lawn and Garden Equipment - Rotary Tillers < 6 HP (Residential) - Non-Road Gasoline	SO2	0.000131438
2021	24003	2260004016	Lawn and Garden Equipment - Rotary Tillers < 6 HP (Commercial) - Non-Road Gasoline	SO2	0.001065755
2021	24003	2260004020	Lawn and Garden Equipment - Chain Saws < 6 HP (Residential) - Non-Road Gasoline	SO2	0.001801166
2021	24003	2260004021	Lawn and Garden Equipment - Chain Saws < 6 HP (Commercial) - Non-Road Gasoline	SO2	0.011787022
2021	24003	2260004025	Lawn and Garden Equipment - Trimmers/Edgers/Brush Cutters (Residential) - Non-Road Gasoline	SO2	0.002501532
2021	24003	2260004026	Lawn and Garden Equipment - Trimmers/Edgers/Brush Cutters (Commercial) - Non-Road Gasoline	SO2	0.010336037
2021	24003	2260004030	Lawn and Garden Equipment - Leafblowers/Vacuums (Residential) - Non-Road Gasoline	SO2	0.001609927
2021	24003	2260004031	Lawn and Garden Equipment - Leafblowers/Vacuums (Commercial) - Non-Road Gasoline	SO2	0.009640629
2021	24003	2260004035	Lawn and Garden Equipment - Snowblowers (Residential) - Non-Road Gasoline	SO2	0.000765817
2021	24003	2260004036	Lawn and Garden Equipment - Snowblowers (Commercial) - Non-Road Gasoline	SO2	0.003009268
2021	24003	2260004071	Lawn and Garden Equipment - Turf Equipment (Commercial) - Non-Road Gasoline	SO2	4.41342E-06
2021	24003	2260005035	Agricultural Equipment - Sprayers - Non-Road Gasoline	SO2	2.36901E-06
2021	24003	2260006005	Commercial Equipment - Generator Sets - Non-Road Gasoline	SO2	0.000261415
2021	24003	2260006010	Commercial Equipment - Pumps - Non-Road Gasoline	SO2	0.001743104
2021	24003	2260006015	Commercial Equipment - Air Compressors - Non-Road Gasoline	SO2	6.72353E-07
2021	24003	2260006035	Commercial Equipment - Hydro-power Units - Non-Road Gasoline	SO2	1.05794E-05
2021	24003	2260007005	Logging Equipment - Chain Saws : 6 HP - Non-Road Gasoline	SO2	0.000140107
2021	24003	2265001010	Recreational Equipment - Motorcycles: Off-road - Non-Road Gasoline	SO2	0.002311148
2021	24003	2265001030	Recreational Equipment - All Terrain Vehicles - Non-Road Gasoline	SO2	0.023896181
2021	24003	2265001050	Recreational Equipment - Golf Carts - Non-Road Gasoline	SO2	0.004964125
2021	24003	2265001060	Recreational Equipment - Specialty Vehicles/Carts - Non-Road Gasoline	SO2	0.001269376
2021	24003	2265002003	Construction and Mining Equipment - Pavers - Non-Road Gasoline	SO2	0.000371612
2021	24003	2265002006	Construction and Mining Equipment - Tampers/Rammers - Non-Road Gasoline	SO2	2.7594E-06
2021	24003	2265002009	Construction and Mining Equipment - Plate Compactors - Non-Road Gasoline	SO2	0.000699923
2021	24003	2265002015	Construction and Mining Equipment - Rollers - Non-Road Gasoline	SO2	0.000659163

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2021	24003	2265002021	Construction and Mining Equipment - Paving Equipment - Non-Road Gasoline	SO2	0.00131302
2021	24003	2265002024	Construction and Mining Equipment - Surfacing Equipment - Non-Road Gasoline	SO2	0.000553609
2021	24003	2265002027	Construction and Mining Equipment - Signal Boards/Light Plants - Non-Road Gasoline	SO2	2.87553E-05
2021	24003	2265002030	Construction and Mining Equipment - Trenchers - Non-Road Gasoline	SO2	0.001154279
2021	24003	2265002033	Construction and Mining Equipment - Bore/Drill Rigs - Non-Road Gasoline	SO2	0.000396493
2021	24003	2265002039	Construction and Mining Equipment - Concrete/Industrial Saws - Non-Road Gasoline	SO2	0.002414583
2021	24003	2265002042	Construction and Mining Equipment - Cement and Mortar Mixers - Non-Road Gasoline	SO2	0.001157708
2021	24003	2265002045	Construction and Mining Equipment - Cranes - Non-Road Gasoline	SO2	8.78281E-05
2021	24003	2265002054	Construction and Mining Equipment - Crushing/Processing Equipment - Non-Road Gasoline	SO2	0.000155708
2021	24003	2265002057	Construction and Mining Equipment - Rough Terrain Forklifts - Non-Road Gasoline	SO2	0.000135927
2021	24003	2265002060	Construction and Mining Equipment - Rubber Tire Loaders - Non-Road Gasoline	SO2	0.000331157
2021	24003	2265002066	Construction and Mining Equipment - Tractors/Loaders/Backhoes - Non-Road Gasoline	SO2	0.000792889
2021	24003	2265002072	Construction and Mining Equipment - Skid Steer Loaders - Non-Road Gasoline	SO2	0.000531196
2021	24003	2265002078	Construction and Mining Equipment - Dumpers/Tenders - Non-Road Gasoline	SO2	0.00017796
2021	24003	2265002081	Construction and Mining Equipment - Other Construction Equipment - Non-Road Gasoline	SO2	0.000119219
2021	24003	2265003010	Industrial Equipment - Aerial Lifts - Non-Road Gasoline	SO2	0.000153221
2021	24003	2265003020	Industrial Equipment - Forklifts - Non-Road Gasoline	SO2	0.000422133
2021	24003	2265003030	Industrial Equipment - Sweepers/Scrubbers - Non-Road Gasoline	SO2	0.000106908
2021	24003	2265003040	Industrial Equipment - Other General Industrial Equipment - Non-Road Gasoline	SO2	0.00019933
2021	24003	2265003050	Industrial Equipment - Other Material Handling Equipment - Non-Road Gasoline	SO2	9.79143E-06
2021	24003	2265003060	Industrial Equipment - AC\Refrigeration - Non-Road Gasoline	SO2	7.20189E-06
2021	24003	2265003070	Industrial Equipment - Terminal Tractors - Non-Road Gasoline	SO2	4.32037E-05
2021	24003	2265004010	Lawn and Garden Equipment - Lawn Mowers (Residential) - Non-Road Gasoline	SO2	0.022948249
2021	24003	2265004011	Lawn and Garden Equipment - Lawn Mowers (Commercial) - Non-Road Gasoline	SO2	0.030333565
2021	24003	2265004015	Lawn and Garden Equipment - Rotary Tillers < 6 HP (Residential) - Non-Road Gasoline	SO2	0.001923675
2021	24003	2265004016	Lawn and Garden Equipment - Rotary Tillers < 6 HP (Commercial) - Non-Road Gasoline	SO2	0.015637155
2021	24003	2265004025	Lawn and Garden Equipment - Trimmers/Edgers/Brush Cutters (Residential) - Non-Road Gasoline	SO2	0.000127179
2021	24003	2265004026	Lawn and Garden Equipment - Trimmers/Edgers/Brush Cutters (Commercial) - Non-Road Gasoline	SO2	0.000702415
2021	24003	2265004030	Lawn and Garden Equipment - Leafblowers/Vacuums (Residential) - Non-Road Gasoline	SO2	0.000242617
2021	24003	2265004031	Lawn and Garden Equipment - Leafblowers/Vacuums (Commercial) - Non-Road Gasoline	SO2	0.02877483
2021	24003	2265004035	Lawn and Garden Equipment - Snowblowers (Residential) - Non-Road Gasoline	SO2	0.002515031
2021	24003	2265004036	Lawn and Garden Equipment - Snowblowers (Commercial) - Non-Road Gasoline	SO2	0.009882783
2021	24003	2265004040	Lawn and Garden Equipment - Rear Engine Riding Mowers (Residential) - Non-Road Gasoline	SO2	0.004517868
2021	24003	2265004041	Lawn and Garden Equipment - Rear Engine Riding Mowers (Commercial) - Non-Road Gasoline	SO2	0.003341544
2021	24003	2265004046	Lawn and Garden Equipment - Front Mowers (Commercial) - Non-Road Gasoline	SO2	0.003772004
2021	24003	2265004051	Lawn and Garden Equipment - Shredders < 6 HP (Commercial) - Non-Road Gasoline	SO2	0.001801857
2021	24003	2265004055	Lawn and Garden Equipment - Lawn and Garden Tractors (Residential) - Non-Road Gasoline	SO2	0.060565774

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2021	24003	2265004056	Lawn and Garden Equipment - Lawn and Garden Tractors (Commercial) - Non-Road Gasoline	SO2	0.045413024
2021	24003	2265004066	Lawn and Garden Equipment - Chippers/Stump Grinders (Commercial) - Non-Road Gasoline	SO2	0.007578562
2021	24003	2265004071	Lawn and Garden Equipment - Turf Equipment (Commercial) - Non-Road Gasoline	SO2	0.146593929
2021	24003	2265004075	Lawn and Garden Equipment - Other Lawn and Garden Equipment (Residential) - Non-Road Gasoline	SO2	0.002152704
2021	24003	2265004076	Lawn and Garden Equipment - Other Lawn and Garden Equipment (Commercial) - Non-Road Gasoline	SO2	0.004504723
2021	24003	2265005010	Agricultural Equipment - 2-Wheel Tractors - Non-Road Gasoline	SO2	5.76854E-06
2021	24003	2265005015	Agricultural Equipment - Agricultural Tractors - Non-Road Gasoline	SO2	2.22269E-05
2021	24003	2265005020	Agricultural Equipment - Combines - Non-Road Gasoline	SO2	1.3461E-07
2021	24003	2265005025	Agricultural Equipment - Balers - Non-Road Gasoline	SO2	1.45318E-05
2021	24003	2265005030	Agricultural Equipment - Agricultural Mowers - Non-Road Gasoline	SO2	4.77319E-06
2021	24003	2265005035	Agricultural Equipment - Sprayers - Non-Road Gasoline	SO2	5.10583E-05
2021	24003	2265005040	Agricultural Equipment - Tillers : 6 HP - Non-Road Gasoline	SO2	0.000106097
2021	24003	2265005045	Agricultural Equipment - Swathers - Non-Road Gasoline	SO2	2.30604E-05
2021	24003	2265005055	Agricultural Equipment - Other Agricultural Equipment - Non-Road Gasoline	SO2	3.37845E-05
2021	24003	2265005060	Agricultural Equipment - Irrigation Sets - Non-Road Gasoline	SO2	3.87562E-05
2021	24003	2265006005	Commercial Equipment - Generator Sets - Non-Road Gasoline	SO2	0.053971316
2021	24003	2265006010	Commercial Equipment - Pumps - Non-Road Gasoline	SO2	0.013465685
2021	24003	2265006015	Commercial Equipment - Air Compressors - Non-Road Gasoline	SO2	0.007123579
2021	24003	2265006025	Commercial Equipment - Welders - Non-Road Gasoline	SO2	0.015338266
2021	24003	2265006030	Commercial Equipment - Pressure Washers - Non-Road Gasoline	SO2	0.024261758
2021	24003	2265006035	Commercial Equipment - Hydro-power Units - Non-Road Gasoline	SO2	0.001139364
2021	24003	2265007010	Logging Equipment - Shredders : 6 HP - Non-Road Gasoline	SO2	0.000315354
2021	24003	2265007015	Logging Equipment - Forest Eqp - Feller/Bunch/Skidder - Non-Road Gasoline	SO2	3.73764E-06
2021	24003	2265008005	Airport Ground Support Equipment - Airport Ground Support Equipment - Non-Road Gasoline	SO2	0.001983054
2021	24003	2265010010	Industrial Equipment - Other Oil Field Equipment - Non-Road Gasoline	SO2	8.84648E-37
2021	24003	2267001060	Recreational Equipment - Specialty Vehicles/Carts - Other	SO2	7.06623E-05
2021	24003	2267002003	Construction and Mining Equipment - Pavers - Other	SO2	6.22786E-05
2021	24003	2267002015	Construction and Mining Equipment - Rollers - Other	SO2	0.00010624
2021	24003	2267002021	Construction and Mining Equipment - Paving Equipment - Other	SO2	1.67814E-05
2021	24003	2267002024	Construction and Mining Equipment - Surfacing Equipment - Other	SO2	1.08734E-05
2021	24003	2267002030	Construction and Mining Equipment - Trenchers - Other	SO2	0.000191446
2021	24003	2267002033	Construction and Mining Equipment - Bore/Drill Rigs - Other	SO2	6.69924E-05
2021	24003	2267002039	Construction and Mining Equipment - Concrete/Industrial Saws - Other	SO2	0.00018114
2021	24003	2267002045	Construction and Mining Equipment - Cranes - Other	SO2	6.82948E-05
2021	24003	2267002054	Construction and Mining Equipment - Crushing/Processing Equipment - Other	SO2	1.10287E-05
2021	24003	2267002057	Construction and Mining Equipment - Rough Terrain Forklifts - Other	SO2	0.000122035
2021	24003	2267002060	Construction and Mining Equipment - Rubber Tire Loaders - Other	SO2	0.000303041

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2021	24003	2267002066	Construction and Mining Equipment - Tractors/Loaders/Backhoes - Other	SO2	3.18251E-05
2021	24003	2267002072	Construction and Mining Equipment - Skid Steer Loaders - Other	SO2	0.000252984
2021	24003	2267002081	Construction and Mining Equipment - Other Construction Equipment - Other	SO2	0.000103125
2021	24003	2267003010	Industrial Equipment - Aerial Lifts - Other	SO2	0.000928275
2021	24003	2267003020	Industrial Equipment - Forklifts - Other	SO2	0.085531409
2021	24003	2267003030	Industrial Equipment - Sweepers/Scrubbers - Other	SO2	0.000650231
2021	24003	2267003040	Industrial Equipment - Other General Industrial Equipment - Other	SO2	0.000201119
2021	24003	2267003050	Industrial Equipment - Other Material Handling Equipment - Other	SO2	4.96607E-05
2021	24003	2267003070	Industrial Equipment - Terminal Tractors - Other	SO2	0.000397287
2021	24003	2267004066	Lawn and Garden Equipment - Chippers/Stump Grinders (Commercial) - Other	SO2	0.002027184
2021	24003	2267005055	Agricultural Equipment - Other Agricultural Equipment - Other	SO2	1.49394E-07
2021	24003	2267005060	Agricultural Equipment - Irrigation Sets - Other	SO2	2.1304E-07
2021	24003	2267006005	Commercial Equipment - Generator Sets - Other	SO2	0.005914598
2021	24003	2267006010	Commercial Equipment - Pumps - Other	SO2	0.001333355
2021	24003	2267006015	Commercial Equipment - Air Compressors - Other	SO2	0.001583804
2021	24003	2267006025	Commercial Equipment - Welders - Other	SO2	0.00197453
2021	24003	2267006030	Commercial Equipment - Pressure Washers - Other	SO2	2.59159E-05
2021	24003	2267006035	Commercial Equipment - Hydro-power Units - Other	SO2	2.48643E-05
2021	24003	2267008005	Airport Ground Support Equipment - Airport Ground Support Equipment - Other	SO2	0.001640611
2021	24003	2268002081	Construction and Mining Equipment - Other Construction Equipment - Other	SO2	3.91131E-06
2021	24003	2268003020	Industrial Equipment - Forklifts - Other	SO2	0.005779617
2021	24003	2268003030	Industrial Equipment - Sweepers/Scrubbers - Other	SO2	6.56819E-06
2021	24003	2268003040	Industrial Equipment - Other General Industrial Equipment - Other	SO2	3.57923E-06
2021	24003	2268003060	Industrial Equipment - AC\Refrigeration - Other	SO2	2.07177E-05
2021	24003	2268003070	Industrial Equipment - Terminal Tractors - Other	SO2	2.66303E-05
2021	24003	2268005055	Agricultural Equipment - Other Agricultural Equipment - Other	SO2	1.71327E-08
2021	24003	2268006005	Commercial Equipment - Generator Sets - Other	SO2	0.00145038
2021	24003	2268006010	Commercial Equipment - Pumps - Other	SO2	7.29844E-05
2021	24003	2268006015	Commercial Equipment - Air Compressors - Other	SO2	0.000102505
2021	24003	2268006020	Commercial Equipment - Gas Compressors - Other	SO2	0.003612601
2021	24003	2268010010	Industrial Equipment - Other Oil Field Equipment - Other	SO2	5.65969E-39
2021	24003	2270001060	Recreational Equipment - Specialty Vehicles/Carts - Non-Road Diesel	SO2	0.001982583
2021	24003	2270002003	Construction and Mining Equipment - Pavers - Non-Road Diesel	SO2	0.010828805
2021	24003	2270002006	Construction and Mining Equipment - Tampers/Rammers - Non-Road Diesel	SO2	2.35696E-05
2021	24003	2270002009	Construction and Mining Equipment - Plate Compactors - Non-Road Diesel	SO2	0.000388278
2021	24003	2270002015	Construction and Mining Equipment - Rollers - Non-Road Diesel	SO2	0.027723521
2021	24003	2270002018	Construction and Mining Equipment - Scrapers - Non-Road Diesel	SO2	0.030239643

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2021	24003	2270002021	Construction and Mining Equipment - Paving Equipment - Non-Road Diesel	SO2	0.001730777
2021	24003	2270002024	Construction and Mining Equipment - Surfacing Equipment - Non-Road Diesel	SO2	0.001116637
2021	24003	2270002027	Construction and Mining Equipment - Signal Boards/Light Plants - Non-Road Diesel	SO2	0.003719055
2021	24003	2270002030	Construction and Mining Equipment - Trenchers - Non-Road Diesel	SO2	0.01365325
2021	24003	2270002033	Construction and Mining Equipment - Bore/Drill Rigs - Non-Road Diesel	SO2	0.012715796
2021	24003	2270002036	Construction and Mining Equipment - Excavators - Non-Road Diesel	SO2	0.107235605
2021	24003	2270002039	Construction and Mining Equipment - Concrete/Industrial Saws - Non-Road Diesel	SO2	0.000962295
2021	24003	2270002042	Construction and Mining Equipment - Cement and Mortar Mixers - Non-Road Diesel	SO2	0.000516353
2021	24003	2270002045	Construction and Mining Equipment - Cranes - Non-Road Diesel	SO2	0.026134624
2021	24003	2270002048	Construction and Mining Equipment - Graders - Non-Road Diesel	SO2	0.026820702
2021	24003	2270002051	Construction and Mining Equipment - Off-highway Trucks - Non-Road Diesel	SO2	0.090601754
2021	24003	2270002054	Construction and Mining Equipment - Crushing/Processing Equipment - Non-Road Diesel	SO2	0.004712834
2021	24003	2270002057	Construction and Mining Equipment - Rough Terrain Forklifts - Non-Road Diesel	SO2	0.036738998
2021	24003	2270002060	Construction and Mining Equipment - Rubber Tire Loaders - Non-Road Diesel	SO2	0.124384104
2021	24003	2270002066	Construction and Mining Equipment - Tractors/Loaders/Backhoes - Non-Road Diesel	SO2	0.08240226
2021	24003	2270002069	Construction and Mining Equipment - Crawler Tractor/Dozers - Non-Road Diesel	SO2	0.110203062
2021	24003	2270002072	Construction and Mining Equipment - Skid Steer Loaders - Non-Road Diesel	SO2	0.058270527
2021	24003	2270002075	Construction and Mining Equipment - Off-highway Tractors - Non-Road Diesel	SO2	0.012353558
2021	24003	2270002078	Construction and Mining Equipment - Dumpers/Tenders - Non-Road Diesel	SO2	0.000186184
2021	24003	2270002081	Construction and Mining Equipment - Other Construction Equipment - Non-Road Diesel	SO2	0.012426348
2021	24003	2270003010	Industrial Equipment - Aerial Lifts - Non-Road Diesel	SO2	0.00195444
2021	24003	2270003020	Industrial Equipment - Forklifts - Non-Road Diesel	SO2	0.022739745
2021	24003	2270003030	Industrial Equipment - Sweepers/Scrubbers - Non-Road Diesel	SO2	0.010260686
2021	24003	2270003040	Industrial Equipment - Other General Industrial Equipment - Non-Road Diesel	SO2	0.011065293
2021	24003	2270003050	Industrial Equipment - Other Material Handling Equipment - Non-Road Diesel	SO2	0.000471558
2021	24003	2270003060	Industrial Equipment - AC\Refrigeration - Non-Road Diesel	SO2	0.055348216
2021	24003	2270003070	Industrial Equipment - Terminal Tractors - Non-Road Diesel	SO2	0.014389552
2021	24003	2270004031	Lawn and Garden Equipment - Leafblowers/Vacuums (Commercial) - Non-Road Diesel	SO2	4.43183E-06
2021	24003	2270004036	Lawn and Garden Equipment - Snowblowers (Commercial) - Non-Road Diesel	SO2	0.001071387
2021	24003	2270004046	Lawn and Garden Equipment - Front Mowers (Commercial) - Non-Road Diesel	SO2	0.029693382
2021	24003	2270004056	Lawn and Garden Equipment - Lawn and Garden Tractors (Commercial) - Non-Road Diesel	SO2	0.006726532
2021	24003	2270004066	Lawn and Garden Equipment - Chippers/Stump Grinders (Commercial) - Non-Road Diesel	SO2	0.038680146
2021	24003	2270004071	Lawn and Garden Equipment - Turf Equipment (Commercial) - Non-Road Diesel	SO2	0.004093092
2021	24003	2270004076	Lawn and Garden Equipment - Other Lawn and Garden Equipment (Commercial) - Non-Road Diesel	SO2	0.00011505
2021	24003	2270005010	Agricultural Equipment - 2-Wheel Tractors - Non-Road Diesel	SO2	4.76228E-07
2021	24003	2270005015	Agricultural Equipment - Agricultural Tractors - Non-Road Diesel	SO2	0.017145952
2021	24003	2270005020	Agricultural Equipment - Combines - Non-Road Diesel	SO2	0.00160467

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2021	24003	2270005025	Agricultural Equipment - Balers - Non-Road Diesel	SO2	9.05014E-06
2021	24003	2270005030	Agricultural Equipment - Agricultural Mowers - Non-Road Diesel	SO2	1.81798E-06
2021	24003	2270005035	Agricultural Equipment - Sprayers - Non-Road Diesel	SO2	0.000136408
2021	24003	2270005040	Agricultural Equipment - Tillers : 6 HP - Non-Road Diesel	SO2	3.40543E-07
2021	24003	2270005045	Agricultural Equipment - Swathers - Non-Road Diesel	SO2	0.000127148
2021	24003	2270005055	Agricultural Equipment - Other Agricultural Equipment - Non-Road Diesel	SO2	0.000344341
2021	24003	2270005060	Agricultural Equipment - Irrigation Sets - Non-Road Diesel	SO2	0.00023994
2021	24003	2270006005	Commercial Equipment - Generator Sets - Non-Road Diesel	SO2	0.040973
2021	24003	2270006010	Commercial Equipment - Pumps - Non-Road Diesel	SO2	0.009653445
2021	24003	2270006015	Commercial Equipment - Air Compressors - Non-Road Diesel	SO2	0.024336666
2021	24003	2270006025	Commercial Equipment - Welders - Non-Road Diesel	SO2	0.013699429
2021	24003	2270006030	Commercial Equipment - Pressure Washers - Non-Road Diesel	SO2	0.001322703
2021	24003	2270006035	Commercial Equipment - Hydro-power Units - Non-Road Diesel	SO2	0.001063236
2021	24003	2270007015	Logging Equipment - Forest Eqp - Feller/Bunch/Skidder - Non-Road Diesel	SO2	0.00268363
2021	24003	2270008005	Airport Ground Support Equipment - Airport Ground Support Equipment - Non-Road Diesel	SO2	0.122364083
2021	24003	2270009010	Underground Mining Equipment - Other Underground Mining Equipment - Non-Road Diesel	SO2	2.98786E-36
2021	24003	2270010010	Industrial Equipment - Other Oil Field Equipment - Non-Road Diesel	SO2	7.83256E-36
2021	24003	2282005010	Gasoline 2-Stroke - Outboard - Non-Road Gasoline	SO2	0.048062586
2021	24003	2282005015	Gasoline 2-Stroke - Personal Water Craft - Non-Road Gasoline	SO2	0.020334455
2021	24003	2282010005	Gasoline 4-Stroke - Inboard/Sterndrive - Non-Road Gasoline	SO2	0.037729576
2021	24003	2282020005	Diesel - Inboard/Sterndrive - Non-Road Diesel	SO2	0.209698606
2021	24003	2282020010	Diesel - Outboard - Non-Road Diesel	SO2	0.00068401
2021	24003	2285002015	Diesel - Railway Maintenance - Non-Road Diesel	SO2	0.001059953
2021	24003	2285004015	Gasoline, 4-Stroke - Railway Maintenance - Non-Road Gasoline	SO2	4.33866E-05
2021	24003	2285006015	LPG - Railway Maintenance - Other	SO2	1.19801E-06
2021	**24003 Total**				2.278

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2021	24005	2260001010	Recreational Equipment - Motorcycles: Off-road - Non-Road Gasoline	SO2	0.003
2021	24005	2260001020	Recreational Equipment - Snowmobiles - Non-Road Gasoline	SO2	0.000
2021	24005	2260001030	Recreational Equipment - All Terrain Vehicles - Non-Road Gasoline	SO2	0.003
2021	24005	2260001060	Recreational Equipment - Specialty Vehicles/Carts - Non-Road Gasoline	SO2	0.001
2021	24005	2260002006	Construction and Mining Equipment - Tampers/Rammers - Non-Road Gasoline	SO2	0.001
2021	24005	2260002009	Construction and Mining Equipment - Plate Compactors - Non-Road Gasoline	SO2	0.000
2021	24005	2260002021	Construction and Mining Equipment - Paving Equipment - Non-Road Gasoline	SO2	0.000
2021	24005	2260002027	Construction and Mining Equipment - Signal Boards/Light Plants - Non-Road Gasoline	SO2	0.000
2021	24005	2260002039	Construction and Mining Equipment - Concrete/Industrial Saws - Non-Road Gasoline	SO2	0.002
2021	24005	2260002054	Construction and Mining Equipment - Crushing/Processing Equipment - Non-Road Gasoline	SO2	0.000
2021	24005	2260003030	Industrial Equipment - Sweepers/Scrubbers - Non-Road Gasoline	SO2	0.000
2021	24005	2260003040	Industrial Equipment - Other General Industrial Equipment - Non-Road Gasoline	SO2	0.000
2021	24005	2260004015	Lawn and Garden Equipment - Rotary Tillers < 6 HP (Residential) - Non-Road Gasoline	SO2	0.000
2021	24005	2260004016	Lawn and Garden Equipment - Rotary Tillers < 6 HP (Commercial) - Non-Road Gasoline	SO2	0.001
2021	24005	2260004020	Lawn and Garden Equipment - Chain Saws < 6 HP (Residential) - Non-Road Gasoline	SO2	0.003
2021	24005	2260004021	Lawn and Garden Equipment - Chain Saws < 6 HP (Commercial) - Non-Road Gasoline	SO2	0.014
2021	24005	2260004025	Lawn and Garden Equipment - Trimmers/Edgers/Brush Cutters (Residential) - Non-Road Gasoline	SO2	0.004
2021	24005	2260004026	Lawn and Garden Equipment - Trimmers/Edgers/Brush Cutters (Commercial) - Non-Road Gasoline	SO2	0.012
2021	24005	2260004030	Lawn and Garden Equipment - Leafblowers/Vacuums (Residential) - Non-Road Gasoline	SO2	0.003
2021	24005	2260004031	Lawn and Garden Equipment - Leafblowers/Vacuums (Commercial) - Non-Road Gasoline	SO2	0.012
2021	24005	2260004035	Lawn and Garden Equipment - Snowblowers (Residential) - Non-Road Gasoline	SO2	0.001
2021	24005	2260004036	Lawn and Garden Equipment - Snowblowers (Commercial) - Non-Road Gasoline	SO2	0.004
2021	24005	2260004071	Lawn and Garden Equipment - Turf Equipment (Commercial) - Non-Road Gasoline	SO2	0.000
2021	24005	2260005035	Agricultural Equipment - Sprayers - Non-Road Gasoline	SO2	0.000
2021	24005	2260006005	Commercial Equipment - Generator Sets - Non-Road Gasoline	SO2	0.000
2021	24005	2260006010	Commercial Equipment - Pumps - Non-Road Gasoline	SO2	0.003
2021	24005	2260006015	Commercial Equipment - Air Compressors - Non-Road Gasoline	SO2	0.000
2021	24005	2260006035	Commercial Equipment - Hydro-power Units - Non-Road Gasoline	SO2	0.000
2021	24005	2260007005	Logging Equipment - Chain Saws : 6 HP - Non-Road Gasoline	SO2	0.000
2021	24005	2265001010	Recreational Equipment - Motorcycles: Off-road - Non-Road Gasoline	SO2	0.001
2021	24005	2265001030	Recreational Equipment - All Terrain Vehicles - Non-Road Gasoline	SO2	0.012
2021	24005	2265001050	Recreational Equipment - Golf Carts - Non-Road Gasoline	SO2	0.010
2021	24005	2265001060	Recreational Equipment - Specialty Vehicles/Carts - Non-Road Gasoline	SO2	0.001
2021	24005	2265002003	Construction and Mining Equipment - Pavers - Non-Road Gasoline	SO2	0.001
2021	24005	2265002006	Construction and Mining Equipment - Tampers/Rammers - Non-Road Gasoline	SO2	0.000
2021	24005	2265002009	Construction and Mining Equipment - Plate Compactors - Non-Road Gasoline	SO2	0.002
2021	24005	2265002015	Construction and Mining Equipment - Rollers - Non-Road Gasoline	SO2	0.002

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2021	24005	2265002021	Construction and Mining Equipment - Paving Equipment - Non-Road Gasoline	SO2	0.003
2021	24005	2265002024	Construction and Mining Equipment - Surfacing Equipment - Non-Road Gasoline	SO2	0.001
2021	24005	2265002027	Construction and Mining Equipment - Signal Boards/Light Plants - Non-Road Gasoline	SO2	0.000
2021	24005	2265002030	Construction and Mining Equipment - Trenchers - Non-Road Gasoline	SO2	0.003
2021	24005	2265002033	Construction and Mining Equipment - Bore/Drill Rigs - Non-Road Gasoline	SO2	0.001
2021	24005	2265002039	Construction and Mining Equipment - Concrete/Industrial Saws - Non-Road Gasoline	SO2	0.006
2021	24005	2265002042	Construction and Mining Equipment - Cement and Mortar Mixers - Non-Road Gasoline	SO2	0.003
2021	24005	2265002045	Construction and Mining Equipment - Cranes - Non-Road Gasoline	SO2	0.000
2021	24005	2265002054	Construction and Mining Equipment - Crushing/Processing Equipment - Non-Road Gasoline	SO2	0.000
2021	24005	2265002057	Construction and Mining Equipment - Rough Terrain Forklifts - Non-Road Gasoline	SO2	0.000
2021	24005	2265002060	Construction and Mining Equipment - Rubber Tire Loaders - Non-Road Gasoline	SO2	0.001
2021	24005	2265002066	Construction and Mining Equipment - Tractors/Loaders/Backhoes - Non-Road Gasoline	SO2	0.002
2021	24005	2265002072	Construction and Mining Equipment - Skid Steer Loaders - Non-Road Gasoline	SO2	0.001
2021	24005	2265002078	Construction and Mining Equipment - Dumpers/Tenders - Non-Road Gasoline	SO2	0.000
2021	24005	2265002081	Construction and Mining Equipment - Other Construction Equipment - Non-Road Gasoline	SO2	0.000
2021	24005	2265003010	Industrial Equipment - Aerial Lifts - Non-Road Gasoline	SO2	0.000
2021	24005	2265003020	Industrial Equipment - Forklifts - Non-Road Gasoline	SO2	0.001
2021	24005	2265003030	Industrial Equipment - Sweepers/Scrubbers - Non-Road Gasoline	SO2	0.000
2021	24005	2265003040	Industrial Equipment - Other General Industrial Equipment - Non-Road Gasoline	SO2	0.000
2021	24005	2265003050	Industrial Equipment - Other Material Handling Equipment - Non-Road Gasoline	SO2	0.000
2021	24005	2265003060	Industrial Equipment - AC\Refrigeration - Non-Road Gasoline	SO2	0.000
2021	24005	2265003070	Industrial Equipment - Terminal Tractors - Non-Road Gasoline	SO2	0.000
2021	24005	2265004010	Lawn and Garden Equipment - Lawn Mowers (Residential) - Non-Road Gasoline	SO2	0.038
2021	24005	2265004011	Lawn and Garden Equipment - Lawn Mowers (Commercial) - Non-Road Gasoline	SO2	0.036
2021	24005	2265004015	Lawn and Garden Equipment - Rotary Tillers < 6 HP (Residential) - Non-Road Gasoline	SO2	0.003
2021	24005	2265004016	Lawn and Garden Equipment - Rotary Tillers < 6 HP (Commercial) - Non-Road Gasoline	SO2	0.019
2021	24005	2265004025	Lawn and Garden Equipment - Trimmers/Edgers/Brush Cutters (Residential) - Non-Road Gasoline	SO2	0.000
2021	24005	2265004026	Lawn and Garden Equipment - Trimmers/Edgers/Brush Cutters (Commercial) - Non-Road Gasoline	SO2	0.001
2021	24005	2265004030	Lawn and Garden Equipment - Leafblowers/Vacuums (Residential) - Non-Road Gasoline	SO2	0.000
2021	24005	2265004031	Lawn and Garden Equipment - Leafblowers/Vacuums (Commercial) - Non-Road Gasoline	SO2	0.035
2021	24005	2265004035	Lawn and Garden Equipment - Snowblowers (Residential) - Non-Road Gasoline	SO2	0.004
2021	24005	2265004036	Lawn and Garden Equipment - Snowblowers (Commercial) - Non-Road Gasoline	SO2	0.012
2021	24005	2265004040	Lawn and Garden Equipment - Rear Engine Riding Mowers (Residential) - Non-Road Gasoline	SO2	0.007
2021	24005	2265004041	Lawn and Garden Equipment - Rear Engine Riding Mowers (Commercial) - Non-Road Gasoline	SO2	0.004
2021	24005	2265004046	Lawn and Garden Equipment - Front Mowers (Commercial) - Non-Road Gasoline	SO2	0.005
2021	24005	2265004051	Lawn and Garden Equipment - Shredders < 6 HP (Commercial) - Non-Road Gasoline	SO2	0.002
2021	24005	2265004055	Lawn and Garden Equipment - Lawn and Garden Tractors (Residential) - Non-Road Gasoline	SO2	0.100

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2021	24005	2265004056	Lawn and Garden Equipment - Lawn and Garden Tractors (Commercial) - Non-Road Gasoline	SO2	0.055
2021	24005	2265004066	Lawn and Garden Equipment - Chippers/Stump Grinders (Commercial) - Non-Road Gasoline	SO2	0.009
2021	24005	2265004071	Lawn and Garden Equipment - Turf Equipment (Commercial) - Non-Road Gasoline	SO2	0.176
2021	24005	2265004075	Lawn and Garden Equipment - Other Lawn and Garden Equipment (Residential) - Non-Road Gasoline	SO2	0.004
2021	24005	2265004076	Lawn and Garden Equipment - Other Lawn and Garden Equipment (Commercial) - Non-Road Gasoline	SO2	0.005
2021	24005	2265005010	Agricultural Equipment - 2-Wheel Tractors - Non-Road Gasoline	SO2	0.000
2021	24005	2265005015	Agricultural Equipment - Agricultural Tractors - Non-Road Gasoline	SO2	0.000
2021	24005	2265005020	Agricultural Equipment - Combines - Non-Road Gasoline	SO2	0.000
2021	24005	2265005025	Agricultural Equipment - Balers - Non-Road Gasoline	SO2	0.000
2021	24005	2265005030	Agricultural Equipment - Agricultural Mowers - Non-Road Gasoline	SO2	0.000
2021	24005	2265005035	Agricultural Equipment - Sprayers - Non-Road Gasoline	SO2	0.000
2021	24005	2265005040	Agricultural Equipment - Tillers : 6 HP - Non-Road Gasoline	SO2	0.000
2021	24005	2265005045	Agricultural Equipment - Swathers - Non-Road Gasoline	SO2	0.000
2021	24005	2265005055	Agricultural Equipment - Other Agricultural Equipment - Non-Road Gasoline	SO2	0.000
2021	24005	2265005060	Agricultural Equipment - Irrigation Sets - Non-Road Gasoline	SO2	0.000
2021	24005	2265006005	Commercial Equipment - Generator Sets - Non-Road Gasoline	SO2	0.083
2021	24005	2265006010	Commercial Equipment - Pumps - Non-Road Gasoline	SO2	0.021
2021	24005	2265006015	Commercial Equipment - Air Compressors - Non-Road Gasoline	SO2	0.011
2021	24005	2265006025	Commercial Equipment - Welders - Non-Road Gasoline	SO2	0.023
2021	24005	2265006030	Commercial Equipment - Pressure Washers - Non-Road Gasoline	SO2	0.037
2021	24005	2265006035	Commercial Equipment - Hydro-power Units - Non-Road Gasoline	SO2	0.002
2021	24005	2265007010	Logging Equipment - Shredders : 6 HP - Non-Road Gasoline	SO2	0.000
2021	24005	2265007015	Logging Equipment - Forest Eqp - Feller/Bunch/Skidder - Non-Road Gasoline	SO2	0.000
2021	24005	2265008005	Airport Ground Support Equipment - Airport Ground Support Equipment - Non-Road Gasoline	SO2	0.000
2021	24005	2265010010	Industrial Equipment - Other Oil Field Equipment - Non-Road Gasoline	SO2	0.000
2021	24005	2267001060	Recreational Equipment - Specialty Vehicles/Carts - Other	SO2	0.000
2021	24005	2267002003	Construction and Mining Equipment - Pavers - Other	SO2	0.000
2021	24005	2267002015	Construction and Mining Equipment - Rollers - Other	SO2	0.000
2021	24005	2267002021	Construction and Mining Equipment - Paving Equipment - Other	SO2	0.000
2021	24005	2267002024	Construction and Mining Equipment - Surfacing Equipment - Other	SO2	0.000
2021	24005	2267002030	Construction and Mining Equipment - Trenchers - Other	SO2	0.000
2021	24005	2267002033	Construction and Mining Equipment - Bore/Drill Rigs - Other	SO2	0.000
2021	24005	2267002039	Construction and Mining Equipment - Concrete/Industrial Saws - Other	SO2	0.000
2021	24005	2267002045	Construction and Mining Equipment - Cranes - Other	SO2	0.000
2021	24005	2267002054	Construction and Mining Equipment - Crushing/Processing Equipment - Other	SO2	0.000
2021	24005	2267002057	Construction and Mining Equipment - Rough Terrain Forklifts - Other	SO2	0.000
2021	24005	2267002060	Construction and Mining Equipment - Rubber Tire Loaders - Other	SO2	0.001

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2021	24005	2267002066	Construction and Mining Equipment - Tractors/Loaders/Backhoes - Other	SO2	0.000
2021	24005	2267002072	Construction and Mining Equipment - Skid Steer Loaders - Other	SO2	0.001
2021	24005	2267002081	Construction and Mining Equipment - Other Construction Equipment - Other	SO2	0.000
2021	24005	2267003010	Industrial Equipment - Aerial Lifts - Other	SO2	0.002
2021	24005	2267003020	Industrial Equipment - Forklifts - Other	SO2	0.157
2021	24005	2267003030	Industrial Equipment - Sweepers/Scrubbers - Other	SO2	0.001
2021	24005	2267003040	Industrial Equipment - Other General Industrial Equipment - Other	SO2	0.000
2021	24005	2267003050	Industrial Equipment - Other Material Handling Equipment - Other	SO2	0.000
2021	24005	2267003070	Industrial Equipment - Terminal Tractors - Other	SO2	0.001
2021	24005	2267004066	Lawn and Garden Equipment - Chippers/Stump Grinders (Commercial) - Other	SO2	0.002
2021	24005	2267005055	Agricultural Equipment - Other Agricultural Equipment - Other	SO2	0.000
2021	24005	2267005060	Agricultural Equipment - Irrigation Sets - Other	SO2	0.000
2021	24005	2267006005	Commercial Equipment - Generator Sets - Other	SO2	0.009
2021	24005	2267006010	Commercial Equipment - Pumps - Other	SO2	0.002
2021	24005	2267006015	Commercial Equipment - Air Compressors - Other	SO2	0.002
2021	24005	2267006025	Commercial Equipment - Welders - Other	SO2	0.003
2021	24005	2267006030	Commercial Equipment - Pressure Washers - Other	SO2	0.000
2021	24005	2267006035	Commercial Equipment - Hydro-power Units - Other	SO2	0.000
2021	24005	2267008005	Airport Ground Support Equipment - Airport Ground Support Equipment - Other	SO2	0.000
2021	24005	2268002081	Construction and Mining Equipment - Other Construction Equipment - Other	SO2	0.000
2021	24005	2268003020	Industrial Equipment - Forklifts - Other	SO2	0.011
2021	24005	2268003030	Industrial Equipment - Sweepers/Scrubbers - Other	SO2	0.000
2021	24005	2268003040	Industrial Equipment - Other General Industrial Equipment - Other	SO2	0.000
2021	24005	2268003060	Industrial Equipment - AC\Refrigeration - Other	SO2	0.000
2021	24005	2268003070	Industrial Equipment - Terminal Tractors - Other	SO2	0.000
2021	24005	2268005055	Agricultural Equipment - Other Agricultural Equipment - Other	SO2	0.000
2021	24005	2268006005	Commercial Equipment - Generator Sets - Other	SO2	0.002
2021	24005	2268006010	Commercial Equipment - Pumps - Other	SO2	0.000
2021	24005	2268006015	Commercial Equipment - Air Compressors - Other	SO2	0.000
2021	24005	2268006020	Commercial Equipment - Gas Compressors - Other	SO2	0.006
2021	24005	2268010010	Industrial Equipment - Other Oil Field Equipment - Other	SO2	0.000
2021	24005	2270001060	Recreational Equipment - Specialty Vehicles/Carts - Non-Road Diesel	SO2	0.001
2021	24005	2270002003	Construction and Mining Equipment - Pavers - Non-Road Diesel	SO2	0.025
2021	24005	2270002006	Construction and Mining Equipment - Tampers/Rammers - Non-Road Diesel	SO2	0.000
2021	24005	2270002009	Construction and Mining Equipment - Plate Compactors - Non-Road Diesel	SO2	0.001
2021	24005	2270002015	Construction and Mining Equipment - Rollers - Non-Road Diesel	SO2	0.064
2021	24005	2270002018	Construction and Mining Equipment - Scrapers - Non-Road Diesel	SO2	0.070

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2021	24005	2270002021	Construction and Mining Equipment - Paving Equipment - Non-Road Diesel	SO2	0.004
2021	24005	2270002024	Construction and Mining Equipment - Surfacing Equipment - Non-Road Diesel	SO2	0.003
2021	24005	2270002027	Construction and Mining Equipment - Signal Boards/Light Plants - Non-Road Diesel	SO2	0.009
2021	24005	2270002030	Construction and Mining Equipment - Trenchers - Non-Road Diesel	SO2	0.032
2021	24005	2270002033	Construction and Mining Equipment - Bore/Drill Rigs - Non-Road Diesel	SO2	0.029
2021	24005	2270002036	Construction and Mining Equipment - Excavators - Non-Road Diesel	SO2	0.248
2021	24005	2270002039	Construction and Mining Equipment - Concrete/Industrial Saws - Non-Road Diesel	SO2	0.002
2021	24005	2270002042	Construction and Mining Equipment - Cement and Mortar Mixers - Non-Road Diesel	SO2	0.001
2021	24005	2270002045	Construction and Mining Equipment - Cranes - Non-Road Diesel	SO2	0.061
2021	24005	2270002048	Construction and Mining Equipment - Graders - Non-Road Diesel	SO2	0.062
2021	24005	2270002051	Construction and Mining Equipment - Off-highway Trucks - Non-Road Diesel	SO2	0.210
2021	24005	2270002054	Construction and Mining Equipment - Crushing/Processing Equipment - Non-Road Diesel	SO2	0.011
2021	24005	2270002057	Construction and Mining Equipment - Rough Terrain Forklifts - Non-Road Diesel	SO2	0.085
2021	24005	2270002060	Construction and Mining Equipment - Rubber Tire Loaders - Non-Road Diesel	SO2	0.288
2021	24005	2270002066	Construction and Mining Equipment - Tractors/Loaders/Backhoes - Non-Road Diesel	SO2	0.191
2021	24005	2270002069	Construction and Mining Equipment - Crawler Tractor/Dozers - Non-Road Diesel	SO2	0.255
2021	24005	2270002072	Construction and Mining Equipment - Skid Steer Loaders - Non-Road Diesel	SO2	0.135
2021	24005	2270002075	Construction and Mining Equipment - Off-highway Tractors - Non-Road Diesel	SO2	0.029
2021	24005	2270002078	Construction and Mining Equipment - Dumpers/Tenders - Non-Road Diesel	SO2	0.000
2021	24005	2270002081	Construction and Mining Equipment - Other Construction Equipment - Non-Road Diesel	SO2	0.029
2021	24005	2270003010	Industrial Equipment - Aerial Lifts - Non-Road Diesel	SO2	0.004
2021	24005	2270003020	Industrial Equipment - Forklifts - Non-Road Diesel	SO2	0.042
2021	24005	2270003030	Industrial Equipment - Sweepers/Scrubbers - Non-Road Diesel	SO2	0.019
2021	24005	2270003040	Industrial Equipment - Other General Industrial Equipment - Non-Road Diesel	SO2	0.020
2021	24005	2270003050	Industrial Equipment - Other Material Handling Equipment - Non-Road Diesel	SO2	0.001
2021	24005	2270003060	Industrial Equipment - AC\Refrigeration - Non-Road Diesel	SO2	0.085
2021	24005	2270003070	Industrial Equipment - Terminal Tractors - Non-Road Diesel	SO2	0.026
2021	24005	2270004031	Lawn and Garden Equipment - Leafblowers/Vacuums (Commercial) - Non-Road Diesel	SO2	0.000
2021	24005	2270004036	Lawn and Garden Equipment - Snowblowers (Commercial) - Non-Road Diesel	SO2	0.001
2021	24005	2270004046	Lawn and Garden Equipment - Front Mowers (Commercial) - Non-Road Diesel	SO2	0.036
2021	24005	2270004056	Lawn and Garden Equipment - Lawn and Garden Tractors (Commercial) - Non-Road Diesel	SO2	0.008
2021	24005	2270004066	Lawn and Garden Equipment - Chippers/Stump Grinders (Commercial) - Non-Road Diesel	SO2	0.046
2021	24005	2270004071	Lawn and Garden Equipment - Turf Equipment (Commercial) - Non-Road Diesel	SO2	0.005
2021	24005	2270004076	Lawn and Garden Equipment - Other Lawn and Garden Equipment (Commercial) - Non-Road Diesel	SO2	0.000
2021	24005	2270005010	Agricultural Equipment - 2-Wheel Tractors - Non-Road Diesel	SO2	0.000
2021	24005	2270005015	Agricultural Equipment - Agricultural Tractors - Non-Road Diesel	SO2	0.035
2021	24005	2270005020	Agricultural Equipment - Combines - Non-Road Diesel	SO2	0.003

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)
2021	24005	2270005025	Agricultural Equipment - Balers - Non-Road Diesel	SO2	0.000
2021	24005	2270005030	Agricultural Equipment - Agricultural Mowers - Non-Road Diesel	SO2	0.000
2021	24005	2270005035	Agricultural Equipment - Sprayers - Non-Road Diesel	SO2	0.000
2021	24005	2270005040	Agricultural Equipment - Tillers : 6 HP - Non-Road Diesel	SO2	0.000
2021	24005	2270005045	Agricultural Equipment - Swathers - Non-Road Diesel	SO2	0.000
2021	24005	2270005055	Agricultural Equipment - Other Agricultural Equipment - Non-Road Diesel	SO2	0.001
2021	24005	2270005060	Agricultural Equipment - Irrigation Sets - Non-Road Diesel	SO2	0.000
2021	24005	2270006005	Commercial Equipment - Generator Sets - Non-Road Diesel	SO2	0.063
2021	24005	2270006010	Commercial Equipment - Pumps - Non-Road Diesel	SO2	0.015
2021	24005	2270006015	Commercial Equipment - Air Compressors - Non-Road Diesel	SO2	0.037
2021	24005	2270006025	Commercial Equipment - Welders - Non-Road Diesel	SO2	0.021
2021	24005	2270006030	Commercial Equipment - Pressure Washers - Non-Road Diesel	SO2	0.002
2021	24005	2270006035	Commercial Equipment - Hydro-power Units - Non-Road Diesel	SO2	0.002
2021	24005	2270007015	Logging Equipment - Forest Eqp - Feller/Bunch/Skidder - Non-Road Diesel	SO2	0.001
2021	24005	2270008005	Airport Ground Support Equipment - Airport Ground Support Equipment - Non-Road Diesel	SO2	0.000
2021	24005	2270009010	Underground Mining Equipment - Other Underground Mining Equipment - Non-Road Diesel	SO2	0.000
2021	24005	2270010010	Industrial Equipment - Other Oil Field Equipment - Non-Road Diesel	SO2	0.000
2021	24005	2282005010	Gasoline 2-Stroke - Outboard - Non-Road Gasoline	SO2	0.037
2021	24005	2282005015	Gasoline 2-Stroke - Personal Water Craft - Non-Road Gasoline	SO2	0.016
2021	24005	2282010005	Gasoline 4-Stroke - Inboard/Sterndrive - Non-Road Gasoline	SO2	0.022
2021	24005	2282020005	Diesel - Inboard/Sterndrive - Non-Road Diesel	SO2	0.120
2021	24005	2282020010	Diesel - Outboard - Non-Road Diesel	SO2	0.001
2021	24005	2285002015	Diesel - Railway Maintenance - Non-Road Diesel	SO2	0.002
2021	24005	2285004015	Gasoline, 4-Stroke - Railway Maintenance - Non-Road Gasoline	SO2	0.000
2021	24005	2285006015	LPG - Railway Maintenance - Other	SO2	0.000
2021	**24005 Total**				3.531
2021	**Grand Total**				5.809

Appendix A-7: Nonroad M-A-R Inventory

Year	State County FIPS	SCC	SCC Description	Pollutant Code	Annual Emissions (Tons/Yr)	Growth Code	2021 Growth Factor	2021 Emissions
2014	24003	2275001000	Aircraft /Military Aircraft /Total	SO2	0.188045	EMP_24_NAICS=481	1.0410	0.195751524
2014	24003	2275020000	Aircraft /Commercial Aircraft /Total: All Types	SO2	0.002840	EMP_24_NAICS=481	1.0410	0.00295639
2014	24003	2275050000	Aircraft /General Aviation /Total	SO2	1.600700	EMP_24_NAICS=481	1.0410	1.666300429
2014	24003	2275060000	Aircraft /Air Taxi /Total	SO2	0.000000	EMP_24_NAICS=481	1.0410	0
2014	24003	2280002100	Marine Vessels, Commercial /Diesel /Port emissions	SO2	0.044269	EMP_24_NAICS=483	1.1551	0.05113341
2014	24003	2280002200	Marine Vessels, Commercial /Diesel /Underway emissions	SO2	0.029192	EMP_24_NAICS=483	1.1551	0.033718254
2014	24003	2280003100	Marine Vessels, Commercial /Residual /Port emissions	SO2	15.820030	EMP_24_NAICS=483	1.1551	18.27323545
2014	24003	2280003200	Marine Vessels, Commercial /Residual /Underway emissions	SO2	89.834000	EMP_24_NAICS=483	1.1551	103.7645209
2014	24003	2285002006	Railroad Equipment /Diesel /Line Haul Locomotives: Class I Operations	SO2	0.010370	EMP_24_NAICS=482	1.0000	0.010369582
2014	24003	2285002009	Railroad Equipment /Diesel /Line Haul Locomotives: Commuter Lines	SO2	0.017956	EMP_24_NAICS=482	1.0000	0.017956287
2014	24003	2285002010	Railroad Equipment /Diesel /Yard Locomotives	SO2	0.004148	EMP_24_NAICS=482	1.0000	0.00414765
2014	24005	2275001000	Aircraft /Military Aircraft /Total	SO2	0.300061	EMP_24_NAICS=481	1.0410	0.31235841
2014	24005	2275020000	Aircraft /Commercial Aircraft /Total: All Types	SO2	0.519230	EMP_24_NAICS=481	1.0410	0.540509442
2014	24005	2275050000	Aircraft /General Aviation /Total	SO2	4.108719	EMP_24_NAICS=481	1.0410	4.277103828
2014	24005	2275060000	Aircraft /Air Taxi /Total	SO2	1.726439	EMP_24_NAICS=481	1.0410	1.797192542
2014	24005	2280002100	Marine Vessels, Commercial /Diesel /Port emissions	SO2	0.220411	EMP_24_NAICS=483	1.1551	0.254590169
2014	24005	2280002200	Marine Vessels, Commercial /Diesel /Underway emissions	SO2	0.006353	EMP_24_NAICS=483	1.1551	0.007338255
2014	24005	2280003100	Marine Vessels, Commercial /Residual /Port emissions	SO2	77.425000	EMP_24_NAICS=483	1.1551	89.43126243
2014	24005	2280003200	Marine Vessels, Commercial /Residual /Underway emissions	SO2	35.358400	EMP_24_NAICS=483	1.1551	40.84141233
2014	24005	2285002006	Railroad Equipment /Diesel /Line Haul Locomotives: Class I Operations	SO2	0.052729	EMP_24_NAICS=482	1.0000	0.05272881
2014	24005	2285002009	Railroad Equipment /Diesel /Line Haul Locomotives: Commuter Lines	SO2	0.016900	EMP_24_NAICS=482	1.0000	0.016900035
2014	24005	2285002010	Railroad Equipment /Diesel /Yard Locomotives	SO2	0.009092	EMP_24_NAICS=482	1.0000	0.009091944
					227.294883			261.560578

Appendix A-9: EGU Emission Reduction Documentation

Facility / Unit	SO2 Reduction Summary (from a 2014 Baseline)
Brandon Shores Unit 1	No Change
Brandon Shores Unit 2	No Change
Wagner Unit 3	Wagner Unit 3 does not have any operational constraints and is therefore considered more of a baseload unit. Emission reductions were estimated from the 2014 baseline by analyzing hourly emission values for the unit. The 2014 reported hourly emissions were normalized to the 30-day rolling average permit limit. For every hour of operation (represented by an SO2 emission value), the 30-day rolling average permit limit was subtracted from the actual reported emission. The resulting hourly emission value can be positive or negative. The sum of these hourly values represents the maximum annual SO2 emissions allowable under the 30-day rolling average permit limit from the 2014 baseline. This sum was then subtracted from the actual 2014 emissions to estimate the emission reductions.
Wagner Unit 1	No Change
Wagner Unit 2	Unit will either shut down or convert to natural gas. In either case the expected SO_2 emissions will approach zero. The emission reductions were estimated from the 2014 baseline by setting the SO_2 emissions from the unit to zero.
Wagner Unit 4	No Change
C.P. Crane Unit 1	Emission reductions were estimated from the 2014 baseline by analyzing hourly emission values for the unit. Any hourly value that exceeded the permit limit was reduced to the permit limit emission rate of 1450 lbs SO_2 per hour. The sum of these hourly changes for the year is reported as an expected reduction.
C.P. Crane Unit 2	Emission reductions were estimated from the 2014 baseline by analyzing hourly emission values for the unit. Any hourly value that exceeded the permit limit was reduced to the permit limit emission rate of 1450 lbs SO_2 per hour. The sum of these hourly changes for the year is reported as an expected reduction.