**2020 INVENTORY RUNS FOR MARAMA MANE-VU REPORT**

**Using MOVES2010b**

**General Methods Documentation**

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**Introduction**

The Maine Department of Environmental Protection (MEDEP) used the MOVES2010b transportation model to generate 2020 emissions projections*.* The intended purpose of these model runs is to correct erroneous projection values included in the first draft of the *MARAMA MANE-VU & VA 2007 and 2020 Mobile Status Report and Emissions Analysis.*  The original results for a group of states that choose to use the EPA converter tools to develop MOVES input tables forecast increases in emissions for 2020 for multiple pollutants when the expected result was a decrease. Maine requested that the original modeling results generated in the draft version of the report either be omitted or replaced. This document provides the final results and outlines the process that the MEDEP used to conduct the new modeling runs including a description of data inputs, outputs and assumptions.

**Results and Discussion**

The final projected emissions for all pollutants included in the modeling are:

|  |
| --- |
| **MAINE 2020 EMISSIONS (Tons)** |
| **CarbonMonoxide (CO)** | **Oxides of Nitrogen (NOx)** | **SUM of all PM10** | **SUM of all PM2.5** | **Sulfur Dioxide (SO2)** | **Volatile Organic Compounds (VOC)** |
| 85,891 | 9,729 | 932 | 691 | 104 | 4,197 |

The *MARAMA MANE-VU & VA 2007 and 2020 Mobile Status Report and Emissions Analysis* document produced by MARAMA on April 3, 2013 included a summary of the Mobile Emission Changes from 2007 to 2020 for NOX, VOC, and PM2.5 (SO2 projections were variable). In that analysis, Maine’s projections for VOC, and PM2.5 were well out of range. We compared our new projections to the typical percent reduction reported and found that they are now within range. NOX is still within range. The SO2 percent difference is -72% which is similar to VT and PA.

Three separate modeling runs per county were conducted to generate the merged emissions results for all of the primary criteria pollutants in tons per year for the entire state. The methodology for each of the runs is explained below.

**Methodology for modeling set up and runs**

**Generating the RunSpec Files**

**Scale & Geographic Bounds**

MEDEP used the County / Inventory Scale to generate emissions inventory estimates (in tons) for all 16 Maine counties. The custom domain window was not used to turn the Stage II controls “on” and “off” within each inventory as Maine opted out of Stage II in 2012. Stage II controls were not applied to the 2020 emissions results.

**Multiple Model Runs**

Most of the input and output settings remained the same for each of the three RunSpec files. The set-up differences occurred when we applied National Low Emitting Vehicle (NLEV), California Low Emission Vehicle (LEV) and Zero Emission Vehicle (ZEV) standards to the modeling runs. The first run applies all of the NLEV and LEV data to collect all of the primary criteria pollutants that can be aggregated out to one year. Evaporative emissions needed to be set-up in separate runs to aggregate out to the hourly levels. Two runs had to be generated for evaporative emissions, one to collect the NLEV and LEV results and a second to collect the ZEV results.

**Run 1)** Collects all primary criteria pollutant data that can be aggregated out to one year and it applies NLEV and LEV data as determined in Maine’s regulations. (This includes all CO, NOX, PM10, PM2.5, SO2, and VOC emissions that are NOT evaporative). Files and naming conventions for this type of run contains some of the following information in the descriptions - Run #1, 2020\_LEV\_Emissions or 2020\_INVLEV\_noevaps.

**Run 2)** Collects the remaining primary criteria pollutant data that has to be aggregated out to the hourly level and it applies NLEV and LEV data as determined in Maine’s regulations. (This includes all VOC evaporative fuel vapor venting and evaporative fuel leak emissions). Files and naming conventions for this type of run contains some of the following information in the descriptions – Run#2, 2020\_LEVVOC\_Emissions, or 2020\_INVLEV\_VOC\_noevapperm.

**Run 3)** Collects the remaining primary criteria pollutant data that has to be aggregated out to the hourly level and it applies ZEV data as determined in Maine’s regulations. (This includes all VOC evaporative permeation emissions). Files and naming conventions for this type of run contains some of the following information in the descriptions – Run#3, 2020\_ZEV\_Emissions, or 2020\_INVZEV\_VOC\_evapperm.

**Time Spans**

For all three run spec files 2020 was selected: all months, all days and all hours. These were the time span options and fields chosen to set up each modeled run:

 **Run 1 Run 2 Run 3**

Time Aggregation Level - Year Hour Hour

Months - All months All months All months

Days - Weekday Weekday Weekday

 Weekend Weekend Weekend

Hours - Start 00:00-00:59 00:00-00:59 00:00-00:59

 End 23:00-23:59 23:00-23:59 23:00-23:59

**Vehicles/Equipment - OnRoad Vehicles Equipment**

Of the following fuel types, we chose Diesel and Gasoline for all Vehicle Source Use Types for all runs:

**Fuels** **Source Use Types**

 Compressed Natural Gas (CNG) x Combination Long-haul Truck

x Diesel Fuel x Combination Short-haul Truck Electricity x Intercity Bus

x Gasoline x Light Commercial Truck

 Liquefied Petroleum Gas (LPG) x Motor Home

 Placeholder Fuel Type x Motorcycle

 x Passenger Car

 x Passenger Truck

 x School Bus

 x Single Unit Long-haul Truck

 x Single Unit Short-haul Truck

 x Transit Bus

After grouping the selections the motorcycle diesel, single unit long haul gasoline, and intercity bus gasoline combinations were removed from the table as these are not viable options.

**Road Types**

We chose all of the road types available in the selection for all runs:

x Off-Network - (parking lots)

x Rural Restricted Access

x Rural Unrestricted Access

x Urban Restricted Access

x Urban Unrestricted Access

**Pollutants and Processes**

The following table illustrates how we selected the pollutants for each of the three runs:

**Pollutants selected for runs 1, 2, and 3:**



As a default in the model, if VOC is chosen, then Total Gaseous Hydrocarbons and Non-Methane Hydrocarbons must also be selected. If SO2 is chosen then Total Energy Consumption must also be selected. The PM10 and PM2.5 primary criteria pollutants are broken down into several categories. All of them must be selected and then summed together in the output databases.

**Manage Input Data Sets**

We used this panel to import Maine’s regulatory National Low Emitting Vehicle (NLEV) and the California Low Emission Vehicle (LEV) program information. MEDEP followed the instructions for building and inputting these two tables found in the *“Instructions for using LEV and NLEV Inputs for MOVES”* dated August 30, 2010. Maine is one of the Ozone Transport States that adopted California LEV standards beginning with model year 2001 or later.

We used the NLEV and LEV files found on the OTAQ website

<http://www.epa.gov/otaq/models/moves/tools.htm> under Tools to develop special case MOVES inputs. The early\_NLEV file was loaded without any changes and the LEV file was modified to delete all years prior to 2001. We applied both of these files to runs 1 and 2.

NOTE: The instructions for inputting the Zero Emission Vehicle (ZEV) inputs can be found in the NLEV and LEV guidance. MEDEP modified the ZEV table to exclude years prior to 2009 and followed the instructions to input them through the County Data Manager Fuel Type and Technologies tab screen. The modified AVFT file was imported with other local data input tables.

**Strategies**

We did not use this part of the model used to enter On-Road Retrofit and Rate of Progress information. MEDEP does not have any retrofit information at this time.

**Output / General Output**

The output database file name contains the same naming convention as the RunSpec and input database. The .mrs extension used in the naming convention for the RunSpec is replaced with a \_OU.

We selected U.S. Ton and miles for mass and distance units respectively. Energy units are not used for this analysis but something must be selected so we chose Million BTU. Distance traveled and populations were the activities needed.

**Units Activity**

Mass Units Tons x Distance Traveled

Energy Units Million BTU Source Hours

Distance Units miles Source Hours Idling

 Source Hours Operating

 Source Hours Parked

 x Population

 Starts

**Output/Output Emissions**

Many of the panel selections in this window are pre-selected based on the inputs selected in the RunSpec. We chose to leave all pre-selected items as is in the Always panel. We left All Vehicle/Equipment Categories blank. The On Road/Off Road feature is selected automatically in the defaults. We chose to select Source Use Type in the On Road category.

**Always** \***On Road/Off Road**

x Time \*Year x On Road/Off Road

x Location County

x Pollutant \*Off Road not available

**\* All of the runs use the same time selection for the outputs. Year is also used for the evaporative emissions that aggregate at the hourly level.**

**For All Vehicle/Equipment Categories None Selected On Road-** Model Year Road Type

 Fuel Type x Source Use Type

 Emissions Process SCC

NOTE: We selected Source Use Type for these modeling activities as we were only interested in the total tons per year for all the primary criteria pollutants. If these tables were used for Smoke-Moves then we might have selected SCC for the outputs.

**Advanced Performance Features**

We did not edit this panel.

**County Data Manager Processing Activities**

Two procedures were conducted to get data into the MOVES2010b model. First, MEDEP created a set of RunSpec files for all of the counties for the year 2020 using the ***County Inventory mode***. When the County Inventory mode is used, the County Data Manager (CDM) pulls the individual county data information out of the MOVES default database and builds it into template formats that can then be used to import information back into MOVES in the correct format. Templates and default data tables were found in the individual CDM tabs where they were exported in an Excel file format.

The Excel data templates were then used to populate the templates with actual data. A description of the tables and the information used to populate them is explained below.

We saved the empty input database in the new RunSpec file and replaced the default tables with the newly populated tables. These files were generated using the same naming convention as the RunSpec and output database files. The .mrs extension used in the naming convention for the RunSpec was replaced with a \_IN. The RunSpec file was then saved again containing the empty CDM tables.

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The following contains a list of the RunSpec files used in the database with their corresponding input and output database files.

**2020 Cumberland County Run #1**

2020\_23005\_INVLEV\_noevaps\_MARA\_mmddyy.mrs

2020\_23005\_INVLEV\_noevaps\_MARA\_mmddyy\_in

2020\_23005\_INVLEV\_noevaps\_MARA\_mmddyy\_ou

**2020 Cumberland County Run #2**

2020\_23005\_INVLEV\_VOC\_noevapperm\_MARA\_mmddyy.mrs

2020\_23005\_INVLEV\_VOC\_noevapperm\_MARA\_mmddyy\_in

2020\_23005\_INVLEV\_VOC\_noevapperm\_MARA\_mmddyy\_ou

**2020 Cumberland County Run #3**

2020\_23005\_INVzev\_VOC\_evapperm\_MARA\_mmddyy.mrs

2020\_23005\_INVzev\_VOC\_evapperm\_MARA\_mmddyy\_in

2020\_23005\_INVzev\_VOC\_evapperm\_MARA\_mmddyy\_ou

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**COUNTY DATA MANAGER TABLE INVENTORY**

After the RunSpec.mrs, output and input files were generated and saved, we used the enter/edit feature in the CDM window to clear the empty databases stored under each tab and imported the Excel files containing actual data.

The following list includes the tabs and files contained in the County Data Manager screen on the left. On the right are the files containing data that we imported through the County Data Manager screens. We created Excel workbooks for each of the files listed in the county database screens. Some screens contain multiple databases. Each Excel worksheet contains one input table for every county.

**County Database Screen File used containing excel worksheet with local CDM inputs**

**Age Distribution**

sourceTypeAgeDistribution.xls MOVES\_All\_County\_Inputs\_sourceTypeAgeDistribution.xls

**Average Speed Distribution**

avgSpeedDistribution.xls MOVES\_All\_County\_Inputs\_avgSpeedDistribution.xls

**Fueltype and Technologies**

avft.xls MEZEV.xls

**Fuel This file contains both fuel inputs…**

FuelSupply.xls MOVES\_2020\_ALL\_County\_Inputs\_FuelSupplyData

FuelFormulation.xls \_existing\_regulatory\_requirements.xls

**Meteorology Data**

zoneMonthHour.xls MOVES\_2020\_ALL\_County\_Inputs\_USE2008\_zoneMonthHour.xls

**Ramp Fraction**

roadType.xls MOVES\_All\_County\_Inputs\_roadType.xls

**Road Type Distribution**

roadTypeDistribution.xls MOVES\_All\_County\_Inputs\_roadTypeDistribution.xls

**Source Type Population**

sourceTypeYear.xls MOVES\_2020\_ALL County\_Inputs\_sourceTypeYear.xls

**Vehicle Type VMT**

HPMSVTypeYear.xls MOVES\_2020\_All\_County\_Inputs\_HPMSVTypeYEAR.xls

monthVMTFraction.xls MOVES\_All\_County\_Inputs\_fixmonthVMTFraction.xls

dayVMTFraction.xls MOVES\_All\_County\_Inputs\_dayVMTFraction.xls

hourVMTFraction.xls MOVES\_All\_County\_Inputs\_hourVMTFraction.xls

**I/M Programs**

IMCoverage.xls MOVES\_2020\_ALL\_County\_Inputs\_IMPrograms.xls

**Generic N/A**

**Tools N/A**

NOTE: The MOVES\_All\_County\_Inputs\_fixmonthVMTFraction.xls file contains the word “fix” for a reason. We learned with the assistance from NESCAUM’s Andrew Dick that MOVES has a glitch. Where 2020 is a leap year, this table was set for leap year inputs. Andrew discovered that MOVES will load leap year inputs for 2020 but the model will not generate output files. The original tables had to be converted over to indicate that it was a non-leap year by changing the “Y” field to an “N”.

**COUNTY DATA MANAGER INPUT DATA TABLE INFORMATION**

All County Data Manager tables were populated with information collected at the State and County levels using appropriate methodologies. Some of the data tables were constructed using tools and converters provided by the Office of Transportation and Air Quality: http://www.epa.gov/otaq/models/moves/tools.htm.

**Age Distribution** – MEDEP used actual VIN decoded Maine vehicle registration data obtained from a study conducted by the University of Maine at Orono, in 2005 to populate the tables in the **sourceTypeAgeDistribution.xls** file. A private contractor decoded vehicle registration data and put it into usable vehicle classes that we were able to map to a Mobile 6 format. A fractions table was developed and used with EPA’s (**Registration Distribution Converter Veh16.xls**) file to convert the data over into MOVES formats.

The data was developed for statewide distributions as we do not have vehicle populations by county at this time. The same fractions table is used for all counties in the MOVES model. It is also used for all future years as we do not have any methodologies for redistributing the data to future years at this time.

**Average Speed Distribution, Ramp Fractions, Road Type Distribution, and Vehicle Type VMT** – All of the files used in these CDM tabs were populated with actual information obtained and projected by the Maine Department of Transportation (MEDOT). All of the MOVES input data and factors have been reviewed to satisfy Transportation Analysis requirements. MEDOT approved the use of these numbers by the MOVES air quality software for MEDOT and MEDEP’s modeling activities. The files populated include **avgSpeedDistribution.xls, roadType.xls, roadTypeDistribution.xls, HPMSVTypeYear.xls, monthVMTFraction.xls, dayVMTFraction.xls**, and **hourVMTFraction.xls.**

**Fuel** – Existing Maine regulatory fuel formulations were used to populate the **FuelSupply.xls** and **FuelFormulation.xls** files. Effective through 2013 Maine regulates fuel subtype blends of ETOH, MTBE, RVP and Sulfur levels. Maine uses an Ethanol based Fuel supply (12). The (ETOHVolume) volume of ethanol used in Maine fuels is 10%. The MTBE volume in Maine fuels is zero. Maine's regulatory RVP limit for the seven southern counties from May 1st - September 30th is 7.8 or less. Remaining counties are 9.0 or less. All counties from October 1st - April 30th have a regulatory RVP limit of 14.0 or less. Maine’s regulatory sulfur level for gasoline is 30ppm or less. Maine's regulatory sulfur level for diesel is 15ppm or less. The volToWtPercentOxy content Maine uses is the default value for ethanol which is 0.3488. It is no longer required in the MOVES2010b tables. The field is listed as Null.

**Fueltype and Technologies** – Maine made adjustments to the ZEV\_AVFT\_2020a.xls file downloaded from the MOVES website and followed the instructions to modify the table to omit fractions prior to 2009. The file MEZEV.xls contains Maine’s modifications. The **avft.xls** file was imported into the run spec using the county data manager screen.

**I/M Program** – Default tables were exported out of the MOVES County Data Manager Inventory run and adjusted to represent Maine specific inspection and maintenance programs. MOVES 2010b is not equipped to handle I/M emissions effects for diesel fuel. The inputs for this testing have to be excluded from the model until it is updated. All gasoline and ethanol fueled passenger cars, trucks and light commercial trucks are tested annually for HC (Hydrocarbons), CO and NOx emissions for start and running exhaust. To meet Stage II requirements HC testing is also done for Evaporative Fuel Vapor Venting and Evaporative Fuel. Maine only has one county with an inspection and maintenance program. The only county with actual I/M data is 23005 (Cumberland), the remaining county worksheets contain blank data for the IMCoverage.

**Meteorology** – Maine specific meteorological data for temperature and relative humidity was located in the EPA Emissions Inventory System and downloaded.

An Excel converter tool (meteorologicaldataconverter\_nmim.xls) was used to convert the NMIM formats into MOVES from the NMIM CountyYearMonthHour table and used to populate the **zoneMonthHour.xls** table for each county. For 2020 inputs, we used the most current NMIM (2008) MET data that was available.

**NLEV, LEV Program - Manage Input Data Sets**

MEDEP used the Manage Input Data panel to import Maine’s regulatory National Low Emitting Vehicle (NLEV) and the California Low Emission Vehicle (LEV) program information. MEDEP followed the instructions for building and inputting these two tables into the database found in the “Instructions for using LEV and NLEV Inputs for MOVES” dated August 30, 2010. Maine is one of the Ozone Transport States that adopted California LEV standards beginning with model year 2001 or later.

The NLEV and LEV files used for inputs were found on the OTAQ website

<http://www.epa.gov/otaq/models/moves/tools.htm> under Tools to develop special case MOVES inputs. The early\_NLEV file was loaded without any changes and the LEV file was modified to delete all years prior to 2001. Both of these files were applied to runs 1 & 2. The table that gets populated with data for the run spec after the early\_NLEV and mylevs databases are imported through the Manage Input Data feature in MOVES2010b is the **emissionsratebyage.**

**Source Type Population** – For the Source Population data, Maine used real vehicle registration data. We did **NOT** generate national vehicle population data for heavy duty vehicle classes. Maine DEP used files obtained from the Maine Department of Motor Vehicles (MEDMV), MOVES defaults, national source type vehicle population fractions tables and census residential population data to construct each county database.

All vehicle counts used were distributed to the county levels using census population data fractions. The county populations were summed together and fractions determined by dividing the county by the sum total. Each county fraction was multiplied by the source population data to determine source population by county.

Some of our DMV records contained good counts for certain vehicle classes, others were summed together and redistributed using the national source type vehicle population fractions. Descriptions of the databases used from the MEDMV files with uncertainties are listed below:

**Motorcycles (11) & Motor homes (54**)

We have a good representation of motor cycles, and motor homes in our state DMV plate registration database. The DMV plate registration database counts were used to represent the 2011 motorcycle and motor home results.

**Passenger Cars (21) and Passenger Trucks (31)**

We have a good representation of passenger cars for 2011 that we generated out of an excel file compiled by the DMV as a special request. The registration (make model and year) data were sorted by model year. We went through each model and placed them into vehicle classes as cars, trucks, heavy duty trucks, some buses, trailers, golf carts and miscellaneous that we could not identify. From this database we compiled the best representation of passenger cars and passenger trucks for 2011.

**Buses (41, 42, 43)**

Buses are recorded in the DMV commercial registration database with separate plate registration codes strictly for buses. We could not determine the mix of each bus type so we determined how they were distributed nationally and used the National fractions to distribute bus registrations to each of the three MOVES bus categories (41, 42, and 43).

**Lights Commercial (32), Refuse (51), Single Unit Short-haul (52) & Long-haul (53),**

**Combination Short-haul (61) and Long-haul (62) Trucks**

We used the balance of the counts left over from the DMV plate registration database summary to represent the remaining source types. From our 2011 MOVES National default runs we determined MOVES fractions for each of the remaining source types and then applied it to the balance of plate registration data. This distributed the data to each of the remaining source type categories.

**Uncertainties**

It is expected that we missed some vehicle registrations for 2011 because we took all model year 2012 records out of the database. We used two files from the DMV to compile the MOVES tables. One was for registrations for 2011 which was compiled on 01/02/12. The second was a summary for vehicles listed by make and model year. This file was compiled in October of 2012. We did not count any records for Model year 2012 which may have been in the 2011 registration database. Overall, the amount of records not accounted for in the combined databases was less than 7,000 records out of 1.2 million.

Other problems we have noted with the DMV records are the inaccuracies for reporting the vehicle registrations. Trailers are given passenger plates and we have found just about everything in the automobile plate registration database. The only way to improve upon any of these inaccuracies is to decode the vin numbers for all of the vehicles listed in all DMV databases.

**MOVES OUTPUT DATA PROCESSING**

MySQL Query Browser was used to extract the movesoutput tables from the MOVES database. Each output database was saved as an excel worksheet and then brought into an Access database where all county runs were combined together for each run type. The run tables were then exported back to an excel database where they were summed together by pollutant type.

**MOVES MODELING FILES AND DOCUMENTATION**

All of the modeling files, input tables and documentation used to create the Maine DEP 2020 emissions results for the MARAMA MANE-VU report are maintained within the Maine Department of Environmental Protection, Bureau of Air Quality, Emissions Inventory Program.

All files are available on the following ftp site:

[**http://www.maine.gov/dep/ftp/Mobile/MOVES/2020MOVES/**](http://www.maine.gov/dep/ftp/Mobile/MOVES/2020MOVES/)

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