Estimating On-road Air Toxics Emissions in Maine Using MOBILE6.2

Prepared for the
Maine Air Toxics Initiative
Mobile Sources Subcommittee

by

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Addendum to
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<u>Missing VMT for Federal Functional Class 16 in Sagadahoc County</u>

The data generated for the Maine Air Toxics Initiative was also used to develop Maine's 2005 National Emissions Inventory (NEI), on-road inventory submittal. U.S. EPA requires that states submit on-road inventories every three years. The NEI data must also be submitted according to specifications known as the NEI Input Format (NIF). Prior to submitting NIF-formatted data files, states are encouraged to run an EPA-supplied, NIF Basic Format and Content Checker (version 3.1, November 2006).

When Maine DEP ran the Basic Format and Content Checker against our NIF-formatted, on-road inventory, the checker discovered that no emission records had been supplied for roads in Sagadahoc County which were classified as Federal Functional Classification (FFC) 16 – Urban, Minor Arterial. Looking for the source of the omission, Maine DEP discovered that seasonal scenarios for FFC 16 had been omitted from all MOBILE6.2 runs for Sagadahoc County for years 2005 and later. Approximately 20,000 VMT from the 2005 inventory were missed by this error. Also, seasonal allocation factors for FFC 16 in Sagadahoc County had not been supplied by Maine DOT.

Maine DEP ran the additional seasonal scenarios for FFC 16 in Sagadahoc County and appended the emission factors to the 2005 emission factor table. Maine DEP then extrapolated seasonal growth factors for FFC 16, based on a comparison with other highway classifications in Sagadahoc County. Emission estimates were recalculated for 2005 for all vehicle classes and reported out. The data was once again packaged in NIF and passed the checker without error.

Next, Maine DEP tried to determine the magnitude of the error and determine the inventories affected. The following inventories would be affected by an this omission:

1. 2005 Annual On-road Inventory (corrected by Maine DEP in supplemental spreadsheet, February 9, 2007)
2. 2008 Annual On-road Inventory
3. 2011 Annual On-road Inventory
4. 2005 Annual On-road Inventory Using Maine Vehicle Registration Data
5. 2008 Annual On-road Inventory Using Reformulated Gasoline

In 2005, the omission of VMT from roadways classified as FFC 16 in Sagadahoc County accounted for a 0.05% reduction in emissions. Because it was an omission of VMT, all pollutants were affected equally. Although not calculated, later years are unlikely to show a greater error percentage because VMT growth factors for those later years are comparatively small in Sagadahoc County. Therefore, after review, we do not believe there is sufficient reason to recalculate the remaining inventories affected by this error. These errors will be corrected at a later date.

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Appended to this document is a set of charts and tables which display the emission estimates for six air toxics, PM2.5, PM10 and VOC, by year and vehicle class. Further supporting documentation, the calculation database, and detailed emission estimates are available from Maine DEP.

I. Purpose and Scope

At the request of the Maine Air Toxics Initiative, Mobile Sources Subcommittee, Maine DEP is compiling a series of statewide, annual, air toxics emissions inventories for on-road mobile sources using EPA's MOBILE6.2 model. The inventory years are 1999, 2002, 2005, 2008 and 2011; years which coincide with EPA's National Emission Inventories and National Air Toxics Assessments.

II. MOBILE6.2

MOBILE6.2 is a software application designed by the U.S. Environmental Protection Agency (EPA) that provides estimates of current and future emissions from highway motor vehicles. The current version of the model (6.2.03) was release in August 2003 and is considered the only acceptable model for use by state and local planning agencies to develop on-road emission inventories.

A. *Air Toxics Modeled by MOBILE6.2*

Beginning with MOBILE6.2, EPA consolidated the air toxics inventory components from a separate model, MOBTOX, into the MOBILE model. MOBILE6.2 has the ability to estimate emission for six air toxic pollutants and, by use of an external file, to estimate emissions for another 27 air toxics which are ratioed from VOC or PM10 estimates. Therefore, when estimating air toxics using MOBILE6.2, the user must also estimate VOC and all particulate matter emissions (PM2.5 and PM10). **Error! Reference source not found.** provides a complete list of all air pollutants modeled by Maine DEP for these inventories.

B. *MOBILE6.2 Vehicle Classifications*

MOBILE6.2 allows users to calculate emissions for 28 vehicle classes. For presentation and discussion purposes, Maine DEP is combining the 28 vehicle classes into 9 vehicle classes. While not presented, emission calculations are available for all 28 vehicle classes and are available upon request. Table 2 describes all 28 vehicle classifications and how Maine DEP has chosen to group the classes.

Poll #	Poll Name	CASNUMBER
1	Volatile Organic Compounds (Express HC as VOC)	VOC
2	Carbon Monoxide	CO
3	Nitrogen Oxides	NOX
4	Carbon Dioxide	CO2
7	Sulfate Portion of Exhaust Particulate (Exhaust PM as PM10)	PM10
8	Organic Carbon Portion of Exhaust Particulate (Exhaust PM as PM10)	PM10
9	Elemental Carbon Portion of Exhaust Particulate (Exhaust PM as PM10)	PM10
10	Total Carbon Portion of Gasoline Exhaust Particulate (Exhaust PM as PM10)	PM10
11	Lead	PB
12	Sulfur Dioxide (gaseous)	SO2
13	Ammonia (gaseous)	NH3
14	Brake PM (Non-exhaust PM as PM10)	PM10
15	Tire PM (Non-exhaust PM as PM10)	PM10
16	Benzene	71432
17	Methyl Tert Butyl Ether	1634044
18	1,3 Butadiene	106990
19	Formaldehyde	50000
20	Acetaldehyde	75070
21	Acrolein	107028
60	Acenaphthene	83329
61	Acenaphthylene	208968
62	Anthracene	120127
63	Benzo(a)anthracene	56553
64	Benzo(a)pyrene	50328
65	Benzo(b)fluoranthene	205992
66	Benzo(ghi)perylene	191242
67	Benzo(k)fluoranthene	207089
68	Chrysene	103
69	Dibenz(ah)anthracene	53703
70	Fluoranthene	206440
71	Fluorene	86737
72	Indeno(123cd)pyrene	193395
73	Napthalene	91203
74	Phenanthrene	85018
75	Pyrene	129000
76	Ethylbenzene	100414
77	n-Hexane	110543
78	Styrene	100425
79	Toluene	108883
80	Xylene	1330207
81	Chromim (Cr6)	18540299
82	Chromim (Cr3)	7440473
83	Manganese	7439965
84	Nickel	7440020

Poll #	Poll Name	CASNUMBER
85	Mercury	7439976
86	Arsenic	7440382
87	2,2,4-Trimethylpentane	540841
88	Propionaldehyde	123386
110	Total Carbon Portion of Gasoline Exhaust Particulate (Exhaust PM as PM2.5)	PM25
114	Brake PM (Non-exhaust PM as PM2.5)	PM25
115	Tire PM (Non-exhaust PM as PM2.5)	PM25
117	Sulfate Portion of Exhaust Particulate (Exhaust PM as PM2.5)	PM25
118	Organic Carbon Portion of Exhaust Particulate (Exhaust PM as PM2.5)	PM25
119	Elemental Carbon Portion of Exhaust Particulate (Exhaust PM as PM2.5)	PM25

Table 1: Pollutants Modeled in MOBILE6.2[1]

Class	Abbrev.	Description	DEP Grouping
1	LDGV	Light-Duty Gasoline Vehicles (Passenger Cars)	LDGV
2	LDGT1	Light-Duty Gasoline Trucks 1(0-6,000 lbs. GVWR, 0-3,750 lbs. LVW)	LDGT
3	LDGT2	Light-Duty Gasoline Trucks 2 (0-6,000 lbs. GVWR, 3,751-5,750 lbs. LVW)	
4	LDGT3	Light-Duty Gasoline Trucks 3 (6,001-8,500 lbs. GVWR, 0-5,750 ALVW)	
5	LDGT4	Light-Duty Gasoline Trucks 4 (6,001-8,500 lbs. GVWR, greater than 5,751 lbs. ALVW)	
6	HDGV2b	Class 2b Heavy-Duty Gasoline Vehicles (8,501-10,000 lbs. GVWR)	HDGV
7	HDGV3	Class 3 Heavy-Duty Gasoline Vehicles (10,001-14,000 lbs. GVWR)	
8	HDGV4	Class 4 Heavy-Duty Gasoline Vehicles (14,001-16,000 lbs. GVWR)	
9	HDGV5	Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs. GVWR)	
10	HDGV6	Class 6 Heavy-Duty Gasoline Vehicles (19,501-26,000 lbs. GVWR)	
11	HDGV7	Class 7 Heavy-Duty Gasoline Vehicles (26,001-33,000 lbs. GVWR)	
12	HDGV8a	Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs. GVWR)	
13	HDGV8b	Class 8b Heavy-Duty Gasoline Vehicles (>60,000 lbs. GVWR)	
14	LDDV	Light-Duty Diesel Vehicles (Passenger Cars)	LDDV
15	LDDT12	Light-Duty Diesel Trucks 1 and 2 (0-6,000 lbs. GVWR)	LDDT
16	HDDV2b	Class 3b Heavy-Duty Diesel Vehicles (8,501-10,000 lbs. GVWR)	HDDV
17	HDDV3	Class 3 Heavy-Duty Diesel Vehicles (10,001-14,000 lbs. GVWR)	
18	HDDV4	Class 4 Heavy-Duty Diesel Vehicles (14,001-16,000 lbs. GVWR)	
19	HDDV5	Class 5 Heavy-Duty Diesel Vehicles (16,001-19,500 lbs. GVWR)	
20	HDDV6	Class 6 Heavy-Duty Diesel Vehicles (19,501-26,000 lbs. GVWR)	
21	HDDV7	Class 7 Heavy-Duty Diesel Vehicles (26,001-33,000 lbs. GVWR)	
22	HDDV8a	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	
23	HDDV8b	Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs. GVWR)	
24	MC	Motorcycles (Gasoline)	MC
25	HDGB	Gasoline Buses (School, Transit and Urban)	HDGB
26	HDDBT	Diesel Transit and Urban Buses	HDDB
27	HDDBS	Diesel School Buses	
28	LDDT34	Light-Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs. GVWR)	LDDT

Table 2: MOBILE6.2 Vehicle Classifications

[1] In MOBILE6.2, all particulate emissions are expressed as solely as PM and the particle size (2.5 or 10) is identified in a separate field. To simplify pollutant reporting, five new pollutant codes were created for PM2.5 emissions so that all pollutants and PM species could be reported out at the same time.

C. *Modeling Annual Emissions*

MOBILE6.2 guidance for modeling annual emissions recommends users model semi-annually (summer and winter); quarterly (seasonal); or monthly. Maine DEP has selected the quarterly/seasonal emission estimation method, as depicted in Table 3.

Season	MOBILE6.2 Evaluation Month	Months Included	Days Per Season
Winter	1 (January)	January, February, March	90
Spring	7 (July)	April, May, June	91
Summer	7 (July)	July, August, September	92
Autumn	1 (January)	October, November, December	92

Table 3: Seasonal Descriptions

D. *Modeling Emissions for the Entire State of Maine*

Because of Stage II vehicle refueling programs in Cumberland, Sagadahoc and York Counties, Maine DEP must prepare five separate runs to accurately model emissions in the state. In addition to county-specific runs for the three counties above, two separate files – one for the remaining four Southern counties and one for nine Northern counties – are also prepared. Table 4 depicts the counties included in each input file.

File/County Code	County(ies) included in MOBILE6.2 Input File
CD	Cumberland County
SC	Sagadahoc County
YK	York County
SO	Androscoggin, Kennebec, Knox and Lincoln Counties
NO	Aroostook, Franklin, Hancock, Oxford, Penobscot, Piscataquis, Somerset, Waldo and Washington Counties

Table 4: Counties Groupings by MOBILE6.2 Input File

E. *MOBILE6.2 Input Parameters*

MOBILE6.2 includes default values for a wide range of conditions that affect emissions. These defaults are designed to represent "national average" input data values. Basic emission rates are derived from emissions tests conducted under standard conditions such as temperature, fuel, and driving cycle. Emission rates further assume a pattern of deterioration in emission performance over time, again, based on results of standardized emission tests. MOBILE6.2 allows users to input parameters for conditions that differ from typical standard testing and then calculates adjustments to basic emission rates.

The following provides a brief discussion of those input parameters for which Maine DEP provides state- or county-specific input data. More detailed data about each parameter can be found in the "User's Guide to MOBILE6.1 and MOBILE6.2: Mobile Source Emission Factor Model," U.S. Environmental Protection Agency, EPA420-R-03-010 (August 2003), http://www.epa.gov/otaq/m6.htm. The section of the guidance document is referenced in the heading of each parameter discussion.

1. *External Condition Parameters*

   a) Month of Evaluation (Section 2.8.6.2)

   The EVALUATION MONTH command provides the option of calculating emission factors for January 1 or July 1 of the calendar year of evaluation. The specified month affects emission calculations by changing the composition of the fleet. July 1 emission factors reflect an additional six months of fleet turnover, or replacement of older vehicles by new vehicles.

   When calculating annual emissions, MOBILE 6.2 technical guidance recommends the following EVALUATION MONTH and CALENDAR YEAR inputs for annual inventory calculation.

Month	EVALUATION MONTH	CALENDAR YEAR
January	1	Current Year
February	1	Current Year
March	1	Current Year
April	7	Current Year
May	7	Current Year
June	7	Current Year
July	7	Current Year
August	7	Current Year
September	7	Current Year
October	1	Current Year + 1
November	1	Current Year + 1
December	1	Current Year + 1

Table 5: Selecting Evaluation Month and Calendar Year of Annual Inventory Calculations

   Note that the CALENDAR YEAR used for the months of October, November and December is not the current calendar year, but the following calendar year. This makes the fleet mix and, therefore, the emission rates calculated for these months more closely resemble the emission rates for January of the following calendar year, rather than January or July of the current calendar year. Because Maine does not use any RFG, it is unnecessary to use the SEASON command.

   b) Daily Temperature Range (Section 2.8.6.3)

   The MIN/MAX TEMPERATURE command sets the minimum and maximum daily temperatures for a given seasonal run. As Maine DEP does not routinely estimate emissions for other than the summer season, we looked at MIN/MAX TEMPERATURE values used by EPA or contractors in recent annual, on-road emission estimates. For the MANE-VU Regional Inventory, on-road emission estimates were calculated by MANE-VU's contractor, E.H. Pechan. In reviewing their MOBILE6.2 input files, we found the MIN/MAX TEMPERATURE values shown in Table 6. Because Pechan had estimated annual emissions using twelve, monthly runs, Maine DEP selected the temperature pairings from January for Winter; April for Spring; July for Summer and October for Autumn.

However, models are only as good as the data which is input into them. The MIN/MAX TEMPERATURE values used by Pechan seemed high for all counties, especially for northern Maine counties in the Winter months. Maine DEP then looked at temperature inputs used by EPA for the 2002 National Emissions Inventory in the National Mobile Inventory Model (NMIM). NMIM uses average hourly temperatures for each month. Maine DEP selected the hourly maximum and minimum temperatures for each month and averaged the values for northern and southern county groupings. Even though these values were averaged, they seemed much closer to typical conditions and have been selected to be used in this project. Also, lacking any other year-specific data, 2002 temperature values are used in all modeled years.

Season	2002 MANE-VU Inventory (Pechan, April 2004)		2002 NEI (NMIM Database, Nov. 2004)			
			Northern Counties		Southern Counties	
	Min	Max	Min	Max	Min	Max
Winter	26	42	7	29	14	33
Spring	41	63	29	51	33	53
Summer	63	87	53	76	56	77
Autumn	41	60	35	55	39	58

Table 6: Daily Temperature Range Inputs

2. *Fuel Parameters*

a) Fuel Program (Section 2.8.10.1)

The FUEL PROGRAM command allows users to specify one of two Tier 2 sulfur phase-in schedules, to model the impact of a reformulated gasoline (RFG) program, or to specify sulfur content for gasoline after 1999. Although RFG was in use through July 1999, Maine DEP uses the MOBILE6.2 default, 1 – Conventional Gasoline East, for its FUEL PROGRAM input for all modeled years. The Conventional Gasoline East input supplies post-1999 gasoline sulfur levels by year under the phase-in schedule prescribed by the Tier 2 rule for most states. The default sulfur content value for gasoline in years 1999 and prior is 300 ppm.

b) Reid Vapor Pressure (RVP) (Section 2.8.10.5)

Reid Vapor Pressure (RVP) is one measure of the volatility of gasoline. Exhaust and especially non-exhaust emissions vary with fuel volatility. The RVP value (in psi) reflects the average in-use RVP of gasoline.

In Maine, two sets are RVP values are used, characteristic of fuels distributed in the Northern and Southern Counties. Table 7 depicts RVP fuel values used for all modeled years by season. The 1999 Summer RVP value is representative of the changeover from reformulated gas to conventional gas.

Season	Northern Counties	Southern Counties
Winter	13.5	12.3
Spring	10.8	10.3
Summer	9.0	8.0 (1999) / 7.8
Autumn	10.8	10.3

Table 7: Reid Vapor Pressure (RVP) Inputs

It should be noted that actual values are not used; rather, values selected are either specified by rule (summer season) or are representative, in-use averages for the region.

The MOBILE6.2 Guidance manual has two important notes about RVP and the model. First, at temperatures below 45 degrees F, fuel evaporation becomes negligible and RVP is assumed to have no effect on emissions. Second, the RVP effects are the same for all RVP values greater than 11.7 psi.

c) <u>Fuel Commands Used Only in Air Toxic Emission Calculations (Section 2.8.10.7)</u>

There are six commands used solely when calculating air toxics emissions with MOBILE6.2. All are gasoline parameters that allow the user to describe in detail all of the physical properties of the gasoline being modeled.

Three of the six parameters – Gas Aromatic %; Gas Benzene %; and Oxygenates – are currently captured in the Annual Maine Fuels Report and actual values will be used as model inputs for 2002 and 2005. The remaining three parameters – Gas Olefin %; E200; and E300 – could be collected by the Department with a change in the law that governs fuel reporting, but currently are not. For those parameters, Maine DEP had to look elsewhere for acceptable inputs. For 2002, Maine DEP is using values used by U.S. EPA for the National Emissions Inventory on-road calculations in the NMIM model. For 2005 and later years, Maine DEP will carry over the 2002 input values.

Maine DEP is using annual average values for these inputs, not seasonal or geographic-based values, as we are with other parameters. Given that seasonal inputs would be available for only three of the six parameters and in only two of the five inventory years, we chose annual average values as much for consistency as simplicity.

The 1999 inputs are from notes left by the previous MOBILE modeler at DEP and are assumed to be the inputs used to develop the last on-road, air toxics inventory. Table 8 lists all six parameters and the inputs used, by inventory year. Italicized values are those carried forward or for which we currently have no actual data. Note that MTBE concentrations are zero in years 2008 and 2011. Maine law will ban MTBE by that date, but as of yet, we do not know which oxygenate will replace it. All other values for those future years have been held over from 2005.

Year	Gas Aromatic % (by volume)	Gas Benzene % (by volume)	Gas Olefin % (by volume)	E200	E300	Oxygenates		
						Oxygenate	Vol %	Market Share
1999	21.02	0.65	10.72	53.74	84.39	MTBE	9.42	1.00
						ETBE	0	0
						ETOH	0	0
						TAME	1.96	0
2002	27.69	0.81	10.85	48.08	83.43	MTBE	2.44	0.94
						ETBE	0.89	0
						ETOH	0	0
						TAME	0.80	0
2005	28.23	*0.81*	*10.85*	*48.08*	*83.43*	MTBE	2.07	0.70
						ETBE	0.46	0.01
						ETOH	0	0
						TAME	0.54	0
2008	*28.23*	*0.81*	*10.85*	*48.08*	*83.43*	MTBE	**0**	**0**
						ETBE	*0.46*	*0.01*
						ETOH	*0*	*0*
						TAME	*0.54*	*0*
2011	*28.23*	*0.81*	*10.85*	*48.08*	*83.43*	MTBE	**0**	**0**
						ETBE	*0.46*	*0.01*
						ETOH	*0*	*0*
						TAME	*0.54*	*0*

Table 8: Gasoline Inputs Required to Run MOBILE6.2 for Air Toxics

d) <u>Sulfur Content of Diesel Fuel (Section 2.8.10.3)</u>

The DIESEL SULFUR command provides the input of the average diesel fuel sulfur level for the scenario. Maine DEP does not collect data on diesel sulfur levels and are, therefore, using values from EPA's 2002 NMIM database. New on-road diesel sulfur rules will lower the sulfur content to 15 ppm by year 2007. Table 9 shows the diesel sulfur values used by season and year.

Year	Winter	Spring	Summer	Autumn
1999	338	364	390	364
2002	338	364	390	364
2005	338	364	390	364
2008	15	15	15	15
2011	15	15	15	15

Table 9: Diesel Sulfur Inputs

3. *State Programs*

a) <u>Stage II Refueling Program (Section 2.8.9.2)</u>

Stage II systems reduce hydrocarbon and associated air toxic emissions by reducing the amount of gasoline vapor that escapes to the atmosphere during vehicle refueling and fuel spillage. Only three of sixteen Maine counties are mandated to have Stage II systems at the pump: Cumberland, Sagadahoc and York Counties.

The STAGE II REFUELING command in MOBILE6.2 requires four additional pieces of data: (1) the year in which the Stage II program began; (2) the number of phase-in years of the program; (3) the percent efficiency for light-duty gasoline vehicles and trucks; and (4) the percent efficiency for heavy-duty gasoline vehicles. The percent efficiency is ratioed to the amount of gasoline sold to those vehicle types compared to the total amount of gasoline sold in the county.

Maine DEP has worked with the U.S. EPA, Region I office to develop the four inputs for the Stage II programs in each of these three counties. Until further guidance is issued form the Region I office, these same inputs will be used for all inventory years. Table 10 depicts the inputs used for each of the counties.

County	Starting Year	Phase-In Years	% Efficiency for LDGV and LDGT	% Efficiency for HDGV
Cumberland	95	3	45.	4.
Sagadahoc	95	3	41.	3.
York	95	3	35.	3.

Table 10: Stage II Refueling Program Inputs

b) Anti-Tampering Programs (Section 2.8.9.3)

Anti-tampering programs refer to a wide variety of programs which states have implemented to reduce the frequency and impact of emission control system tampering and removal or disablement of catalytic converters. During annual vehicle inspections throughout the state, inspection stations check for catalyst removal. In addition, Cumberland County has an anti-tampering program that checks for missing gas caps. Therefore, two different anti-tampering command lines are used in Maine – one for Cumberland County and one for the four remaining input files.

File/County Code	Anti-Tampering Program Command Line
CD	`ANTI-TAMP PROG     :` `99 83 20 22222 11111111 1 11 096. 12111112`
SC, YK, SO and NO	`ANTI-TAMP PROG     :` `99 83 20 22222 11111111 1 11 096. 12111111`

Table 11: Anti-Tampering Program Inputs

c) Inspection/Maintenance (I/M) Programs (Section 2.8.9.4)

MOBILE6.2 has the capability of modeling the impact of up to seven different exhaust and evaporative emission inspection and maintenance (I/M) programs. This capability, however, is limited when modeling air toxics. MOBILE6.2 does not model the impact of I/M programs on particulate emissions and only affects other air toxics by modeling a change in base year hydrocarbon emissions.

Cumberland County is the only county with an I/M program and it is a gas cap pressure test. Per instructions from Don Cooke, EPA (March 2005), Maine can take full credit for the gas cap check program in determining emissions in 1999 and later years. EPA also provided new command lines to be used in modeling the I/M program, replacing previously used external data files. No other counties in Maine have I/M programs.

d) <u>Vehicle Emissions Programs (Section 2.8.11.4)</u>

MOBILE6.2 allows users to model alternative fleet penetration fractions for light-duty gasoline vehicles. Known more commonly as the Tier 2 and Maine Low Emission Vehicle (LEV) II programs, these programs assume a greater fraction of vehicles meeting specified emissions standard programs in years 1994 and later.

For model years prior to 2005, Maine DEP uses the National LEV New England data file (NLEVNE.d) provided by EPA to model the Tier 2 vehicle emissions program.

For years 2005 and later, Maine DEP uses a set of external data files provided by EPA to model the Maine LEV II Program. For SIP and other planning purposes, the Maine LEV II Program is limited to 90% of the credit from a LEV program. When determining LEV credit in Maine, two MOBILE6.2 runs are necessary to calculate this 90% credit. The first MOBILE6.2 run includes the commands for the Tier 2 program. The second MOBILE6.2 run has the Maine LEV II Program commands. Then, 90% of the difference between emission factors is calculated and applied to the Tier 2 emission factor.

The reason that EPA limits Maine to only 90% credit for the LEV program is because Maine has yet to enact a registration denial program for vehicles which to not meet the California LEV or fifty state emission program. However, Maine DEP has found this additional level of complexity to be unnecessary. Working with the Secretary of State's Office, Division of Motor Vehicles, Maine DEP has been able to prove that less than 1% of all vehicles registered in Maine do not meet state emission standards. Therefore, for these inventories, Maine DEP is modeling air toxics assuming 100% credit for the Maine LEV II program.

4. *Activity Commands*

a) <u>Average Speed and Roadway Types (Section 2.8.8.2.d)</u>

The AVERAGE SPEED command allows users to designate a single average speed to use for all freeways and/or arterial/collectors for the entire modeled day.

This is an extremely important command as emissions are greatly influenced by vehicle speed.

This command requires six data elements. The first is an average speed value, between 2.5 and 65 mph for the roadway scenario being modeled. Maine DEP obtains average speed values from Maine DOT.

The second is roadway scenario. The roadway scenario indicates the type of road and driving which occurs on the road. There are four possible roadway scenarios, but Maine DEP uses only two. A FREEWAY roadway assigns all vehicle miles traveled (VMT) to either the freeway or the freeway ramp roadway type. Maine uses the national average fraction of freeway to freeway ramp (8% freeway ramp and 92% freeway). Examples of FREEWAY roadways in Maine include I-95, I-295 and their connectors.

Freeway ramps have a constant speed in MOBILE6.2 of 34.6 mph, which cannot be changed by the user, so the average speed value is assigned solely to the freeway portion. However, given the default freeway ramp fraction (8%), the maximum combined non-ramp freeway and ramp average speed in MOBILE6.2 is 60.73 mph. Therefore, while scenarios may be notated that the average speed is 65 mph, the command line will always read 60.7 mph.

An ARTERIAL roadway scenario assigns all VMT to the arterial/collector roadway type. All roadways, not identified as FREEWAY, are assigned as ARTERIAL in Maine. This includes urban and rural major and minor collectors and local roads.

The final four data elements are the distribution, by fraction, of the roadway by road type (freeway, arterial/collector, local or freeway ramps).

See the discussion under Section III. **MDOT Data** for more information about roadway scenarios and average speed.

III. MDOT Data

Maine DEP relies on the Maine Department of Transportation for four key pieces of information used in calculating emissions from on-road vehicles. These are: (1) Daily Vehicle Miles Traveled (DVMT), by Federal Functional Classification, for each county; (2) Average Speed, by Federal Functional Classification, for each county; (3) Seasonal adjustment factors, by Federal Functional Classification, for each county; and (4) VMT Growth Factors for future years.

A. *Daily Vehicle Miles Traveled (DVMT)*

Vehicle Miles Traveled (VMT) is the sum of distances traveled by all motor vehicles in a specified system of highway for a given time period. The VMT for each road section is calculated by multiplying the average daily traffic (ADT) by the length of the road section and the length of the time period. VMT is one of the most useful measures of the amount of use that a highway or system of highways receives over a given period of time.

Maine DOT uses the Highway Performance Monitoring System (HPMS) as a source of VMT estimates. HPMS includes sample section data, which provides VMT through a systematic, stratified, random sampling process. However, HPMS is only statistically valid on a statewide basis. MDOT must use local transportation data to break the statewide VMT down to the county level by Federal Functional Classification. Federal Functional Classification (FFC) is the system by which roads are grouped into functional systems according to the type of service and amount of traffic the facility carries. An FFC is assigned to all public roads using federal guidelines.

Daily VMT is reported to Maine DEP by county and applicable FFCs within each county. Maine DEP has matched the HPMS FFC Codes to roadway scenarios in the AVERAGE SPEED command in MOBILE6.2. Table 12 shows the linkage between HPMS FFC Code, road type and roadway scenario.

HPMS FFC Code	Federal Urban or Rural	Federal Functional Classification	MOBILE6.2 Roadway Scenario
1	Rural	Principal arterial interstate	FREEWAY
2	Rural	Other principal arterial	FREEWAY
6	Rural	Minor arterial	ARTERIAL
7	Rural	Major collector	ARTERIAL
8	Rural	Minor collector	ARTERIAL
9	Rural	Local	ARTERIAL
11	Urban	Principal arterial interstate	FREEWAY
12	Urban	Principal arterial freeways and expressways	FREEWAY
14	Urban	Other principal arterial	ARTERIAL
16	Urban	Minor arterial	ARTERIAL
17	Urban	Major collector	ARTERIAL
19	Urban	Local	ARTERIAL

Table 12: HPMS/Federal Funcational Classification System

B. *Average Speed*

Maine DOT assigns to each Federal Functional Classification in each county an average speed for the classification. Average speed varies among counties and is not consistent for Federal Functional Classifications across counties. Maine DEP has no further information on how average speed is assigned.

C. *Seasonal Adjustment Factors*

Daily VMT is derived from Annual VMT and is, at best, representative of an average day in the calendar year. When calculating emissions on an annual basis, a seasonal adjustment factor is needed to adequately represent differences in driving patterns throughout the year. At the request of Maine DEP, Maine DOT developed seasonal adjustment factors, by county and FFC, which are applied to Daily VMT.

D. *VMT Growth Factors*

Future years growth factors are developed by MDOT and their statewide travel demand model. This model uses socioeconomic data to estimate travel demand. Population and employment data are forecasted using a REMI model. The data from these two models are combined to provide estimates of VMT growth. The growth factors change annually as the previous year's VMT is calculated and added to the model.

Table 13 shows the VMT Growth Projections prepared for the 2004-2025 Long-Range Transportation Improvement Plan, based on actual VMT from 2004[2].

COUNTY	Linear Growth Rate 1995 to 2015	Average Annual DVMT Growth Increment 1995 to 2015	Linear Growth Rate 2016 to 2025	Average Annual DVMT Growth Increment 2016 to 2025
ANDROSCOGGIN	0.77%	18,541	0.37%	10,410
AROOSTOOK	1.78%	29,596	0.26%	5,893
CUMBERLAND	1.58%	110,199	0.37%	34,140
FRANKLIN	1.87%	14,512	0.38%	4,074
HANCOCK	2.40%	36,243	0.28%	6,209
KENNEBEC	1.32%	45,015	0.41%	17,873
KNOX	4.25%	26,227	0.38%	4,368
LINCOLN	0.57%	5,889	0.23%	2,590
OXFORD	1.00%	14,842	0.33%	5,940
PENOBSCOT	1.42%	58,827	0.46%	24,703
PISCATAQUIS	1.36%	5,632	0.08%	401
SAGADAHOC	-0.48%	-7,026	0.27%	3,617
SOMERSET	1.28%	21,174	0.50%	10,365
WALDO	1.05%	11,138	0.49%	6,262
WASHINGTON	0.24%	3,104	0.41%	5,603
YORK	0.22%	13,359	0.50%	32,083

Table 13: VMT Growth Projections (1995-2025)

IV. Sample Calculation

The following example calculates benzene emissions from light-duty gas vehicles in Cumberland County in 1999. As mentioned earlier, the annual emissions are simply the sum of the seasonal emissions. To calculate annual emissions, a database query is used to calculate all seasonal emissions for each vehicle type, emission type, roadway (FFC), and season for each county in Maine.

[2] In late 2006, Maine DEP received 2005 VMT data from Maine DOT. The statewide 2005 VMT was 0.1% less than the estimated 2005 VMT derived from base year 2004 VMT and growth factors. Because of this very small difference, Maine DEP decided not to recalculate emission estimates for 2005 and later years. Maine DEP will compare the 2008 and 2011 VMT totals, when available, and recalculate, if deemed significant.

$$EM_{(benzene,LDGV,tons)} = \sum SeasonalEM_{(benzene,LDGV,tons)}$$

Equation 1: Annual Emissions Equal the Sum of the Seasonal Emissions

$$SeasonalEM_{(benzene,LDGV,season,tons)} = \left(EF_{(benzene,EType,LDGV,season)} \div EFUnitMultiplier\right) \times SeasonalAllocationFactor_{(County,FFC)} \times Days_{(Season)} \times VMTFraction_{(LDGV)} \times VMT_{(County,FFC)} \times 0.000001102 tons/g$$

Equation 2: Seasonal Emissions Equal the Sum, by Season, of All Vehicle Types, Emission Types and Roadway Calculations

An emission factor unit multiplier (EFUnitMulitplier) is used to convert all emission factors into similar units. MOBILE6.2 outputs criteria pollutant emission factors in grams/mile, but outputs toxic pollutant emission factors in milligrams/mile.

To add to the complexity, the MOBILE6.2 SPREADSHEET output does not provide a composite emission factor for all vehicle activities but provides an emission factor based on Emission Type (Column C of Table 15.) Table 14 provides a description of the emission type codes. (NOTE: Start (2) emissions are included with Running (1) emissions and Crankcase emissions are not provided for air toxics.)

Emission Type Code	Emission Type Description
1	Exhaust Running Emissions
2	Exhaust Engine Start Emissions (trip start)
3	Evaporative Host Soak Emissions (trip end)
4	Evaporative Diurnal Emissions (heat rise)
5	Evaporative Resting Loss Emissions (leaks and seepage)
6	Evaporative Running Loss Emissions
7	Evaporative Crankcase Emissions (blow-by)
8	Evaporative Refueling emissions (fuel displacement and spillage)
9	Particulate matter from brake component wear
10	Particulate matter from tire wear

Table 14: MOBILE6 Emission Type Classifications

There are 288 separate calculations (12 roadway FFCs *x* 6 emission types *x* 4 seasons) used to determine benzene emissions from light-duty gas vehicles in Cumberland County in 1999. Table 15, on the next page, provides a sampling of calculations for roadway FFC 11, Urban Interstate. Equation 2, simplified to the column headings in Table 15, can be re-written as:

L (Seasonal Emissions) = (E / G) x I x J x F x K x 0.000001102

A	B	C	D	E	F	G	H	I	J	K	L
County Code	FFC	Emission Type	Poll Name	LDGV EF	VMT Fraction	Unit	Season	Seasonal Factor	Days	1999 ADVMT	1999 LDGV Seasonal Emissions (tons)
05	11	1	Benzene	43.71	0.5033	1000	AUTUMN	1.08	92	925672.84	2.23
05	11	1	Benzene	49.12	0.5138	1000	SPRING	1.05	91	925672.84	2.46
05	11	1	Benzene	37.23	0.5033	1000	SUMMER	1.15	92	925672.84	2.02
05	11	1	Benzene	61.25	0.5138	1000	WINTER	1.02	90	925672.84	2.95
05	11	3	Benzene	0.52	0.5033	1000	AUTUMN	1.08	92	925672.84	0.03
05	11	3	Benzene	0.38	0.5138	1000	SPRING	1.05	91	925672.84	0.02
05	11	3	Benzene	0.67	0.5033	1000	SUMMER	1.15	92	925672.84	0.04
05	11	3	Benzene	0	0.5138	1000	WINTER	1.02	90	925672.84	0.00
05	11	4	Benzene	0.09	0.5033	1000	AUTUMN	1.08	92	925672.84	0.00
05	11	4	Benzene	0.07	0.5138	1000	SPRING	1.05	91	925672.84	0.00
05	11	4	Benzene	0.12	0.5033	1000	SUMMER	1.15	92	925672.84	0.01
05	11	4	Benzene	0	0.5138	1000	WINTER	1.02	90	925672.84	0.00
05	11	5	Benzene	0.38	0.5033	1000	AUTUMN	1.08	92	925672.84	0.02
05	11	5	Benzene	0.36	0.5138	1000	SPRING	1.05	91	925672.84	0.02
05	11	5	Benzene	0.55	0.5033	1000	SUMMER	1.15	92	925672.84	0.03
05	11	5	Benzene	0.32	0.5138	1000	WINTER	1.02	90	925672.84	0.02
05	11	6	Benzene	0.39	0.5033	1000	AUTUMN	1.08	92	925672.84	0.02
05	11	6	Benzene	0.36	0.5138	1000	SPRING	1.05	91	925672.84	0.02
05	11	6	Benzene	0.44	0.5033	1000	SUMMER	1.15	92	925672.84	0.02
05	11	6	Benzene	0.28	0.5138	1000	WINTER	1.02	90	925672.84	0.01
05	11	8	Benzene	0.32	0.5033	1000	AUTUMN	1.08	92	925672.84	0.02
05	11	8	Benzene	0.31	0.5138	1000	SPRING	1.05	91	925672.84	0.02
05	11	8	Benzene	0.33	0.5033	1000	SUMMER	1.15	92	925672.84	0.02
05	11	8	Benzene	0.32	0.5138	1000	WINTER	1.02	90	925672.84	0.02

Table 15: Individual Calculations for Benzene from LDGV on Urban Interstate Highways in Cumberland County in 1999

The total annual emissions for benzene from light-duty, gas vehicles on all roadways in Cumberland County in 1999 is the sum of all values in Column L, or 105.82 tons.

V. Comparison to Previous 1999 Air Toxics Inventory

The first quality assurance/quality control check conducted was a comparison to the previous air toxics, on-road inventory developed in 2003 for the MATI process. Thirty pollutants common to both inventories were compared and the values is presented in Table 16.

Pollutant Code	Pollutant Name	Previous 1999 Onroad Emissions (tpy) (Nate's data)	New 1999 Onroad Emissions (tpy)	% Difference
1634044	Methyl Tert Butyl Ether	449.41465	945.5123787	110.39%
110543	n-Hexane	249.253475	363.7291694	45.93%
91203	Napthalene	17.60486	23.34293628	32.59%
83329	Acenaphthene	0.131815	0.17282929	31.12%
56553	Benzo(a)anthracene	0.038	0.049771149	30.98%
193395	Indeno(123cd)pyrene	0.013305	0.017324357	30.21%
108883	Toluene	2285.299855	2975.650456	30.21%
100414	Ethylbenzene	337.25804	436.4411574	29.41%
1330207	Xylene	1299.240115	1672.261012	28.71%
120127	Anthracene	0.16145	0.207567836	28.56%

Pollutant Code	Pollutant Name	Previous 1999 Onroad Emissions (tpy) (Nate's data)	New 1999 Onroad Emissions (tpy)	% Difference
50328	Benzo(a)pyrene	0.02451	0.031285589	27.64%
86737	Fluorene	0.28336	0.360195807	27.12%
100425	Styrene	70.04673	88.96162354	27.00%
208968	Acenaphthylene	0.720345	0.913169798	26.77%
50000	Formaldehyde	401.336365	508.5388044	26.71%
103	Chrysene	0.022215	0.027363038	23.17%
85018	Phenanthrene	0.48358	0.592282816	22.48%
205992	Benzo(b)fluoranthene	0.028295	0.034477463	21.85%
207089	Benzo(k)fluoranthene	0.028295	0.034477463	21.85%
129000	Pyrene	0.25108	0.300405315	19.65%
75070	Acetaldehyde	123.21041	146.4005328	18.82%
206440	Fluoranthene	0.182135	0.215873112	18.52%
540841	2,2,4-Trimethylpentane	882.19782	1034.56719	17.27%
106990	1,3 Butadiene	127.913495	140.5543515	9.88%
107028	Acrolein	18.32974	19.81921161	8.13%
7439965	Manganese	0.02379	0.025602347	7.62%
7440020	Nickel	0.05325	0.05668561	6.45%
18540299	Chromium (Cr6)	0.02819	0.029922676	6.15%
123386	Propionaldehyde	21.14885	22.15757723	4.77%
71432	Benzene	794.474815	824.0921363	3.73%

Table 16: Comparison of 2003 MATI On-road Inventory with New 1999 Onroad Inventory

The new on-road, air toxics inventory shows higher emission levels for all pollutants. There are several explanations for this increase.

1. <u>The new 1999 on-road emissions inventory contains refueling emissions for nine pollutants (all indicated by the [1]).</u> The on-road inventory developed in 2003 did not contain refueling emissions (they were reported previously as an area source). Because current EPA guidance recommends using the MOBILE6.2 model to calculate Stage II emissions, we have decided that they will no longer be reported under the area source sector, but included with the on-road sector emissions.

2. <u>Changes in the model lead to changes in emissions.</u> MOBILE6.2 was the first version of the MOBILE model to include air toxics emissions. In "Technical Description of the Toxics Module for MOBILE6.2 and Guidance on Its Use for Emission Inventory Preparation," (EPA420-R-02-029, November 2002), EPA conducted a comparison between MOBILE6.2 emissions and those calculated using MOBTOX5b, the previous air toxics emissions inventory model and the model used for the 1999 National Emissions Inventory. EPA found that for all compounds, MOBILE6.2 estimates higher emission factors in base years, with a convergence in emission factors by 2020. This trend is primarily a result of changes in the TOG (total organic gases) emission rates used in MOBILE6.2, versus those used in MOBTOX5b.

   EPA also compared results by vehicle class and model year. EPA again found MOBILE6.2 emission factors for early 1980's model years to be about three times greater than in MOBTOX5b, where again, there is a convergence for later model years (2000 and greater). EPA again attributed the difference in TOG emission rates for earlier model years to account for most of the difference in other air toxics emission rates.

3. New seasonal allocation factors from MDOT. Prior to this inventory, annual emissions were calculated assuming consistent VMT across seasons, or by applying a summer adjustment factor, but no winter, spring or autumn adjustment factors. The seasonal allocation factors used by Maine DEP were developed by MDOT expressly for this inventory, using new methodologies. Maine DEP considers this a significant improvement.

4. More accurate inputs lead to a more accurate inventory. Maine DEP has already documented changes from previous model inputs (MIN/MAX TEMPERATURE). Also, we cannot be sure if the previous inventory was developed using actual VMT or projected VMT. These two input parameters are identified in documentation as ones which have a "major" effect on emissions ("Sensitivity Analysis of MOBILE6.0," EPA420-R-02-035, December 2002).

VI. **Uncertainty**

MOBILE6.2 is EPA's approved motor vehicle emission factor model for estimating volatile organic compounds (VOCs), nitrogen oxides (NOx), and carbon monoxide (CO) from on-road, motor vehicles. The Clean Air Act requires that state implementation plan (SIP) inventories and control measures be based on the most current information and applicable models. By Federal Register Notice (69 FR 28830, May 19, 2004), EPA designated MOBILE6.2 as the sole acceptable model to be used by state and local agencies (except California) for SIP development and transportation conformity determinations.

That said, the model and the inputs are not without uncertainty. The description of the input parameters, and how Maine DEP arrived at the inputs, should give the reader pause in assuming that the emission estimates are more than simply a best representation based on available data. Those inputs which come from measured values (MIN/MAX TEMPERATURE and GAS AROMATIC%, for example) will have a lower degree of uncertainty than those inputs derived from generalization, surrogate data, or are simply best guesses (FUEL RVP, DIESEL SULFUR, and AVERAGE SPEED). Where MOBILE6.2 model defaults are used, additional uncertainty, beyond the ability of Maine DEP to quantify, is introduced.

Errors within the MOBILE6.2 model must also be assumed. While the model is certified as acceptable for criteria pollutants, there is additional variability and uncertainty in the algorithms used to calculate air toxics. As an additional QA/QC check, Maine DEP compared the 1999 emission estimates derived from using the All Vehicle (ALL VEH) composite emission factor to the sum of emissions from all 28 individual vehicle classes. Theoretically, these values should be equal, as demonstrated in Equation 3.

$$EF_{ALL\_VEH} = \sum \left(EF_{Vehicle\_Class} \times VMTFraction_{Vehicle\_Class} \right)$$

Equation 3: The ALL VEH emission factor is the sum of the individual vehicle emission factors times the VMT fraction for the vehicle class.

However, as demonstrated in Table 17, Maine DEP did find a discrepancy emission estimates between the ALL VEH emission factor and the sum of the individual vehicle classes. Allowing for rounding errors, Maine DEP set a level for concern of differences greater than 1%. Only two pollutants – dibenz(ah)anthracene and particulate matter from tire wear – showed any significant difference in 1999.

CAS #	Pollutant Name	ALL VEH (SUM)	ALL VEH (EF)	% DIFF
106990	1,3 Butadiene	140.530363	140.5543515	0.0171
540841	2,2,4-Trimethylpentane	1034.578603	1034.56719	-0.0011
83329	Acenaphthene	0.172715796	0.17282929	0.0657
208968	Acenaphthylene	0.9122902	0.913169798	0.0963
75070	Acetaldehyde	146.3453455	146.4005328	0.0377
107028	Acrolein	19.79357979	19.81921161	0.1293
NH3	Ammonia (gaseous)	1437.288256	1437.274239	-0.0010
120127	Anthracene	0.20741385	0.207567836	0.0742
7440382	Arsenic	0.113516817	0.113535804	0.0167
71432	Benzene	824.0601585	824.0921363	0.0039
56553	Benzo(a)anthracene	0.049727339	0.049771149	0.0880
50328	Benzo(a)pyrene	0.031267247	0.031285589	0.0586
205992	Benzo(b)fluoranthene	0.034454023	0.034477463	0.0680
191242	Benzo(ghi)perylene	0.061336938	0.061369356	0.0528
207089	Benzo(k)fluoranthene	0.034454023	0.034477463	0.0680
PM10	Brake PM (Non-exhaust PM)	201.3108057	201.3429758	0.0160
PM25	Brake PM (Non-exhaust PM)	85.35578162	85.36942176	0.0160
CO	Carbon Monoxide	459732.2091	459832.6395	0.0218
7440473	Chromim (Cr3)	0.044875732	0.044886486	0.0240
18540299	Chromim (Cr6)	0.029917154	0.029922676	0.0185
103	Chrysene	0.027350552	0.027363038	0.0456
53703	Dibenz(ah)anthracene	2.49954E-05	2.47011E-05	-1.1916
PM10	Elemental Carbon Portion of Exhaust Particulate (Exhaust PM)	484.3047017	484.8773832	0.1181
PM25	Elemental Carbon Portion of Exhaust Particulate (Exhaust PM)	445.5429828	445.8363275	0.0658
100414	Ethylbenzene	436.4441626	436.4411574	-0.0007
206440	Fluoranthene	0.215807708	0.215873112	0.0303
86737	Fluorene	0.359927854	0.360195807	0.0744
50000	Formaldehyde	508.348808	508.5388044	0.0000
193395	Indeno(123cd)pyrene	0.017309348	0.017324357	0.0866
PB	Lead	0	0	0.0000
7439965	Manganese	0.025598201	0.025602347	0.0162
7439976	Mercury	0.126412998	0.126499774	0.0686
1634044	Methyl Tert Butyl Ether	945.2686469	945.5123787	0.0258
91203	Napthalene	23.31906479	23.34293628	0.1023

CAS #	Pollutant Name	ALL VEH (SUM)	ALL VEH (EF)	% DIFF
110543	n-Hexane	363.7420686	363.7291694	-0.0035
7440020	Nickel	0.056674717	0.05668561	0.0192
NOX	Nitrogen Oxides	54000.7805	54035.06766	0.0635
PM10	Organic Carbon Portion of Exhaust Particulate (Exhaust PM)	240.4490743	240.4039514	-0.0188
PM25	Organic Carbon Portion of Exhaust Particulate (Exhaust PM)	221.1981677	221.1306343	-0.0305
85018	Phenanthrene	0.591805348	0.592282816	0.0806
123386	Propionaldehyde	22.16754436	22.15757723	-0.0450
129000	Pyrene	0.300340912	0.300405315	0.0214
100425	Styrene	88.96546896	88.96162354	-0.0043
PM10	Sulfate Portion of Exhaust Particulate (Exhaust PM)	109.6427716	109.7004568	0.0526
PM25	Sulfate Portion of Exhaust Particulate (Exhaust PM)	109.6427716	109.7004568	0.0526
SO2	Sulfur Dioxide (gaseous)	1659.539828	1660.385986	0.0510
PM10	Tire PM (Non-exhaust PM)	152.5882868	153.0206616	0.2826
PM25	Tire PM (Non-exhaust PM)	38.14707171	38.65785136	1.3213
108883	Toluene	2976.183443	2975.650456	-0.0179
PM10	Total Carbon Portion of Gasoline Exhaust Particulate (Exhaust PM)	140.0165476	139.6143142	-0.2881
PM25	Total Carbon Portion of Gasoline Exhaust Particulate (Exhaust PM)	116.145161	116.3567585	0.1819
VOC	Volatile Organic Compounds (Express HC as VOC)	30320.11873	30327.03022	0.0228
1330207	Xylene	1672.349349	1672.261012	-0.0053

Table 17: Comparison of 1999 Emission Estimates Using the ALL VEH Emission Factor and Sum of the Vehicle Classes

Further attributing the difference in dibenz(ah)anthracene to a rounding error, Maine DEP has tried to determine the source of the PM error and can only attribute it to a slight error in the model. However, only exhaust PM is used to ratio other PM-related air toxics and the discrepancy with the Tire PM should have no effect on air toxics calculations. We have brought this issue to the attention of EPA's Regional Office in Boston and will continue to investigate this problem.

Appendix A
Estimating Emissions of Air Toxics from Vehicle Idling

Task: Maine DEP was asked to estimate emissions of air toxics from vehicle idling to determine the benefit value of pursing anti-idling initiatives as part of the MATI process.

Vehicle Idling Assumption: Not having any data on actual idling practices, Maine DEP assumed all vehicles in the state were idling (engines running while not in motion) a minimum of five minutes per day every day of the year.

Vehicle Registration Data: Vehicle registration data was provided by Jonathan Rubin and Greg Gould, University of Maine.[3] Using VIN numbers, more than 1,080,000 vehicles were placed in one of MOBILE6's 28 vehicle classes.

MOBILE6 Vehicle Class	Number of Vehicles Registered in Maine	MOBILE6 Vehicle Class	Number of Vehicles Registered in Maine
1 – LDGV	499,688	15 – LDDT12	118
2 – LDGT1	10,183	16 – HDDV2b	9,881
3 – LDGT2	298,607	17 – HDDV3	4,168
4 – LDGT3	137,259	18 – HDDV4	1,895
5 – LDGT4	17,695	19 – HDDV5	1,006
6 – HDGV2b	36,462	20 – HDDV6	2,090
7 – HDGV3	5,684	21 – HDDV7	4,667
8 – HDGV4	2,544	22 – HDDV8a	11,310
9 – HDGV5	523	23 – HDDV8b	2,398
10 – HDGV6	652	24 – MC	24,710
11 – HDGV7	697	25 – HDGB	2,517
12 – HDGV8a	81	26 – HDDBT	624
13 – HDGV8b	0	27 – HDDBS	1,938
14 – LDDV	2,698	28 – LDDT34	633

Table 18: 2005 Maine Vehicle Registration Data (Source: University of Maine, 2006)

MOBILE6 Modeling: Idling emission rates are indirectly modeled by MOBILE6.2 by running scenarios using a average speed which assigns all VMT to the 2.5 mph average speed bin and the arterial/collector driving cycle set. The resulting emission rate (in grams per mile) is multiplied by the average speed (2.5 miles per hour) to give the idling emission rate (in grams per hour).[4] MOBILE6.2 emission rates already include vehicle idling in proportion to normal driving.

[3] Data Source: Maine Vehicle Registration Records, snapshot from InforME, March 31, 2005. MOBILE6 categories decoded from VINs by ESP Data Solutions, Inc. Approximately 59,000 vehicles were not decoded (and are not included in the final vehicle count) because they were non-highway vehicles (trailers, ATVs) or had missing VIN information.

[4] U.S. Environmental Protection Agency, *Technical Guidance on the Use of MOBILE6.2 for Emission Inventory Preparation* (EPA420-R-04-013), August 2004, pg. 43.

Other Modeling Assumptions:

- Idling emissions were estimated for Calendar Year 2005, as that was the only year where Maine Vehicle Registration data were available.

- Because registration data was not provided for each individual county, Maine DEP had to select one of the five runs normally used to estimate emissions on a statewide basis. Maine DEP selected the Southern Counties MOBILE6 runs. (As a reminder, the Southern Counties have no Stage II Program, have only a catalytic converter check for their I/M program, and have fuel with a Summer RVP of 7.8.)

- Idling emissions were calculated for each season and summed for annual emissions. This is the same methodology used for the annual emission estimates.

- Only Emission Type Classification "1" (Exhaust Running Emissions) were used to calculate idling emissions. According to EPA guidance:

  > "…most of the effects of an engine start on exhaust emissions will occur in the first minute. For this reason, EPA recommends that the calculation of idling emissions … not include any effects from engine starts."[5]

  All other emission types are evaporative in nature and unrelated to idling.

Calculation Formula:

Annual Idling Emissions = Sum of Seasonal Idling Emissions

Seasonal Idling Emissions = # Vehicles (by class) x Emission Factor (by class, g/mile) x 2.5 miles/hour x Idling time (5 min/day) x hour/60 min x #days in season x 0.000001102 ton/g

Sample Calculation

Summer Idling Emission for Acrolein from LDGV

= 499,688 vehicles x 1.19 mg/mile Acrolein x 1g/1000 mg x 2.5 mile/hour x 5 min/day x 1hour/60 min x 92 days in summer x 0.000001102 ton/g
= 0.0126 tons Acrolein in summer

Findings: On average, vehicle idling emissions account for less than one percent of annual vehicle emissions in Maine (see Table 19). By vehicle class, the most significant impact was found to be with Heavy-Duty Gas Buses (accounting for 10.59% of total annual emissions), while the least impact on Light-Duty Diesel Trucks (accounting for 0.28% of total annual emissions). Although idling emissions have been documented to have localized impacts, when compared to annual vehicle emissions as a whole, they remain negligible.

[5] Ibid, pg. 44.

Poll #	Pollutant Name	ALL VEH (SUM)	IDLING ALL VEH (SUM)	IDLING % OF SUM
106990	1,3 Butadiene	80.5840964	1.712070779	2.12%
540841	2,2,4-Trimethylpentane	631.7245135	10.8052492	1.71%
83329	Acenaphthene	0.100613402	0.000611051	0.61%
208968	Acenaphthylene	0.526427464	0.003377508	0.64%
75070	Acetaldehyde	81.71151968	1.476378965	1.81%
107028	Acrolein	11.48982866	0.254177704	2.21%
NH3	Ammonia (gaseous)	1558.654698	8.416575344	0.54%
120127	Anthracene	0.121054654	0.000719189	0.59%
7440382	Arsenic	0.122853956	0.000432965	0.35%
71432	Benzene	673.7340574	13.04104462	1.94%
56553	Benzo(a)anthracene	0.030453818	0.000119203	0.39%
50328	Benzo(a)pyrene	0.018556052	9.55749E-05	0.52%
205992	Benzo(b)fluoranthene	0.020239948	0.000110766	0.55%
191242	Benzo(ghi)perylene	0.035702337	0.000215919	0.60%
207089	Benzo(k)fluoranthene	0.020239948	0.000110766	0.55%
PM10	Brake PM (Non-exhaust PM as PM10)	212.7089709		
PM25	Brake PM (Non-exhaust PM as PM2.5)	90.18860368		
CO	Carbon Monoxide	336296.2793	5146.208471	1.53%
7440473	Chromim (Cr3)	0.047311022	0.000261044	0.55%
18540299	Chromim (Cr6)	0.031540731	0.000174029	0.55%
103	Chrysene	0.015993647	9.09121E-05	0.57%
53703	Dibenz(ah)anthracene	1.09056E-05	7.89094E-08	0.72%
PM10	Elemental Carbon Portion of Exhaust Particulate (Exhaust PM as PM10)	299.3733865	0.524340429	0.18%
PM25	Elemental Carbon Portion of Exhaust Particulate (Exhaust PM as PM2.5)	275.4665227	0.48244547	0.18%
100414	Ethylbenzene	268.0420005	4.519585011	1.69%
206440	Fluoranthene	0.124484652	0.000773289	0.62%
86737	Fluorene	0.209234012	0.001273419	0.61%
50000	Formaldehyde	229.1105931	4.44765475	1.94%
193395	Indeno(123cd)pyrene	0.009995334	6.354E-05	0.64%
PB	Lead	0	0	0.00%
7439965	Manganese	0.027007134	0.000147288	0.55%
7439976	Mercury	0.138546869	0.000367853	0.27%
1634044	Methyl Tert Butyl Ether	85.89458826	0.281329897	0.33%
91203	Napthalene	14.36723043	0.074154234	0.52%
110543	n-Hexane	259.9687516	2.174454315	0.84%
7440020	Nickel	0.059838905	0.000322536	0.54%
NOX	Nitrogen Oxides	38497.69158	233.3370948	0.61%
PM10	Organic Carbon Portion of Exhaust Particulate (Exhaust PM as PM10)	151.7911918	0.397732499	0.26%
PM25	Organic Carbon Portion of Exhaust Particulate (Exhaust PM as PM2.5)	139.6310048	0.365887939	0.26%
85018	Phenanthrene	0.342116221	0.002132453	0.62%
123386	Propionaldehyde	13.50510365	0.21873946	1.62%
129000	Pyrene	0.173737408	0.001062363	0.61%
100425	Styrene	51.50217781	1.053313564	2.05%

Poll #	Pollutant Name	ALL VEH (SUM)	IDLING ALL VEH (SUM)	IDLING % OF SUM
PM10	Sulfate Portion of Exhaust Particulate (Exhaust PM as PM10)	50.65570138	0.196843637	0.39%
PM25	Sulfate Portion of Exhaust Particulate (Exhaust PM as PM2.5)	50.65570138	0.196843637	0.39%
SO2	Sulfur Dioxide (gaseous)	810.1539383	2.84518362	0.35%
PM10	Tire PM (Non-exhaust PM as PM10)	162.0263394		0.00%
PM25	Tire PM (Non-exhaust PM as PM2.5)	40.50658485		0.00%
108883	Toluene	1802.403034	31.92224376	1.77%
PM10	Total Carbon Portion of Gasoline Exhaust Particulate (Exhaust PM as PM10)	108.4130875	0.698088186	0.64%
PM25	Total Carbon Portion of Gasoline Exhaust Particulate (Exhaust PM as PM2.5)	95.92896791	0.601254214	0.63%
VOC	Volatile Organic Compounds (Express HC as VOC)	19467.22525	733.8424183	3.77%
1330207	Xylene	1011.343219	18.00205993	1.78%

Table 19: 2005 On road Motor Vehicle Emission Comparison with 2005 Emissions from Idling (5 minutes per day)

Appendix B
Estimating Emissions of Air Toxics Using Maine Registration Data

Task: Maine DEP was asked to determine if and how using actual Maine vehicle registration data, rather than the national default registration data in the MOBILE model, would impact emission estimates.

Vehicle Registration Data: Vehicle registration data was provided by Jonathan Rubin and Greg Gould, University of Maine, based on motor vehicle registrations as of March 31, 2005. Using VIN numbers, more than 1,080,000 vehicles were placed in one of MOBILE6's 28 vehicle classes and further segregated by age, from new to more than 25 years old. These 28 vehicle classes were then aggregated into the 16 composite vehicle classes for vehicle registration data. Three assumptions were made during this aggregation:

- All vehicles in LDDT12 (Light-Duty Diesel Trucks, Class 1 and 2) were equally divided between Class 1 and Class 2 trucks;

- All vehicles in LDDT34 (Light-Duty Diesel Trucks, Class 3 and 4) were equally divided between Class 3 and Class 4 trucks; and

- Half of all HDGB (Heavy-Duty Gas Buses) were assumed to be school buses and half were assumed to be transit buses.

See Table 18 for class breakdown and vehicle registrations.

MOBILE6 Modeling: A registration distribution data file (MEREGIS.d) was created using the Maine motor vehicle registration information. The REG DIST (Registration Distribution) command requires an external data file which contains all 16 composite vehicle types followed by 25 age fractions, representing the fraction of vehicles of that age in the composite vehicle class in July. MOBILE 6 uses these fractions directly if a July evaluation date is requested or converts them to January for EVALUATION MONTH = 1.

Because this registration data was current to year 2005, Maine DEP decided to re-run only the 2005 modeling files and reference the external Maine registration data file using the REG DIST command. This file would have produced inaccurate results if used in future years. No other changes were made to the 2005 input files.

Calculations: No changes were made in the calculation methodology.

Findings: Although there were significant differences within certain vehicle classes, the average difference was 2.4% per pollutant, with a standard deviation of 3.4%. Of note, there were increases in elemental and organic carbon particulate matter and a decrease in gasoline particulate matter, indicative of fleet mix with significantly more Heavy-Duty, Diesel Vehicles than the national fleet mix. While there were increases in the air toxics benzene and 1,3-butadiene, there were decreases in acetaldehyde, acrolein, formaldehyde and methyl tert-butyl ether.

Poll #	Pollutant Name	ALL VEH (SUM)	ALL VEH (SUM) ME REGIS DIST	% DIFF
106990	1,3 Butadiene	80.5840964	82.06164473	1.8%
540841	2,2,4-Trimethylpentane	631.7245135	634.0371008	0.4%
83329	Acenaphthene	0.100613402	0.098386004	-2.2%
208968	Acenaphthylene	0.526427464	0.50884351	-3.3%
75070	Acetaldehyde	81.71151968	81.501824	-0.3%
107028	Acrolein	11.48982866	11.27334451	-1.9%
NH3	Ammonia (gaseous)	1558.654698	1567.226895	0.5%
120127	Anthracene	0.121054654	0.118933203	-1.8%
7440382	Arsenic	0.122853956	0.122853956	0.0%
71432	Benzene	673.7340574	703.1962186	4.4%
56553	Benzo(a)anthracene	0.030453818	0.031991414	5.0%
50328	Benzo(a)pyrene	0.018556052	0.018725954	0.9%
205992	Benzo(b)fluoranthene	0.020239948	0.020211696	-0.1%
191242	Benzo(ghi)perylene	0.035702337	0.034944906	-2.1%
207089	Benzo(k)fluoranthene	0.020239948	0.020211696	-0.1%
PM10	Brake PM (Non-exhaust PM as PM10)	212.7089709	212.7089709	0.0%
PM25	Brake PM (Non-exhaust PM as PM2.5)	90.18860368	90.18860368	0.0%
CO	Carbon Monoxide	336296.2793	352107.0176	4.7%
7440473	Chromim (Cr3)	0.047311022	0.047311022	0.0%
18540299	Chromim (Cr6)	0.031540731	0.031540731	0.0%
103	Chrysene	0.015993647	0.015857326	-0.9%
53703	Dibenz(ah)anthracene	1.09056E-05	1.05763E-05	-3.0%
PM10	Elemental Carbon Portion of Exhaust Particulate (Exhaust PM as PM10)	299.3733865	336.2075394	12.3%
PM25	Elemental Carbon Portion of Exhaust Particulate (Exhaust PM as PM2.5)	275.4665227	309.3236151	12.3%
100414	Ethylbenzene	268.0420005	269.735809	0.6%
206440	Fluoranthene	0.124484652	0.121232464	-2.6%
86737	Fluorene	0.209234012	0.204555064	-2.2%
50000	Formaldehyde	229.1105931	220.9892487	-3.5%
193395	Indeno(123cd)pyrene	0.009995334	0.009681382	-3.1%
PB	Lead	0	0	0.0%
7439965	Manganese	0.027007134	0.027007134	0.0%
7439976	Mercury	0.138546869	0.138546869	0.0%
1634044	Methyl Tert Butyl Ether	85.89458826	85.37555956	-0.6%
91203	Napthalene	14.36723043	14.22591347	-1.0%
110543	n-Hexane	259.9687516	271.4641489	4.4%
7440020	Nickel	0.059838905	0.059838905	0.0%
NOX	Nitrogen Oxides	38497.69158	42308.23869	9.9%
PM10	Organic Carbon Portion of Exhaust Particulate (Exhaust PM as PM10)	151.7911918	169.8607468	11.9%
PM25	Organic Carbon Portion of Exhaust Particulate (Exhaust PM as PM2.5)	139.6310048	156.2772619	11.9%
85018	Phenanthrene	0.342116221	0.332865496	-2.7%
123386	Propionaldehyde	13.50510365	13.60496517	0.7%
129000	Pyrene	0.173737408	0.169755115	-2.3%
100425	Styrene	51.50217781	51.00172995	-1.0%

Poll #	Pollutant Name	ALL VEH (SUM)	ALL VEH (SUM) ME REGIS DIST	% DIFF
PM10	Sulfate Portion of Exhaust Particulate (Exhaust PM as PM10)	50.65570138	50.38975326	-0.5%
PM25	Sulfate Portion of Exhaust Particulate (Exhaust PM as PM2.5)	50.65570138	50.38975326	-0.5%
SO2	Sulfur Dioxide (gaseous)	810.1539383	810.0146739	0.0%
PM10	Tire PM (Non-exhaust PM as PM10)	162.0263394	162.0263394	0.0%
PM25	Tire PM (Non-exhaust PM as PM2.5)	40.50658485	40.50658485	0.0%
108883	Toluene	1802.403034	1806.906826	0.2%
PM10	Total Carbon Portion of Gasoline Exhaust Particulate (Exhaust PM as PM10)	108.4130875	103.3278133	-4.7%
PM25	Total Carbon Portion of Gasoline Exhaust Particulate (Exhaust PM as PM2.5)	95.92896791	92.53736148	-3.5%
VOC	Volatile Organic Compounds (Express HC as VOC)	19467.22525	19840.46132	1.9%
1330207	Xylene	1011.343219	1013.490184	0.2%

Table 20: Comparison of Emission Estimates Using Default Registration Distribution in MOBILE Model and 2005 Maine Motor Vehicle Registration Information

The process used by the University of Maine to obtain and categorize this data means than utilizing Maine registration data on a regular basis is unlikely because of the expense and time for data analysis and its limitations in future year modeling. Use of Maine vehicle registration data will remain limited to non-SIP (State Implementation Plan) and non-Transportation Conformity uses, such as National Emissions Inventory and Maine Air Toxics Initiative work.

Appendix C
Estimating Future Emissions of Air Toxics Using Reformulated Gasoline (RFG)

Task: Maine DEP was asked to determine the effect switching to reformulated gasoline (RFG) would have on air toxics emissions in a future year. Switching to RFG is one of the air toxics control options which has been considered by the Mobile Source Subcommittee.

Reformulated Gasoline: RFG was removed from the Maine market in 1999 following issues with the oxygenate MTBE. When requested to characterize a future RFG, Maine DEP looked at characteristics of RFG fuel sold in Hartford, Boston, Portsmouth and Chicago[6], settling eventually on the Hartford fuel. Hartford was chosen because it is the nearest New England fuel with ethanol used as the sole oxygenate. Also, Maine DEP wanted to find an existing fuel that would not lead to the creation of a "boutique" or specialty fuel. Three-year averages (2003 to 2005) of key fuel parameters were used to characterize the Hartford RFG. The following table compares the 2008 fuel parameters for Maine's MOBILE6 runs with the Hartford RFG parameters.

Fuel Parameter	As modeled in 2008	Hartford RFG
RVP (summer)	7.8	6.86
Gas Aromatic (% vol)	28.23	21.63
Gas Benzene (% vol)	0.81	0.73
Gas Olefin (% vol)	10.85	11.34
E200	48.08	52.03
E300	83.43	85.80
Oxygenates		
Ethanol (% vol)	0	10.28
Ethanol (market share)	0	1.00
ETBE (% vol)	0.46	0.00
ETBE (market share)	0.1	0.00
TAME (% vol)	0.54	0.00
TAME (market share)	0	0.00

Table 21: Characteristics of Fuel Used in 2008 MOBILE6 Runs and Hartford, CT Reformulated Gas

MOBILE6 Modeling: Maine DEP chose to re-run the 2008 runs using the RFG parameters, believing that it would be several years, at least, before RFG could be phased into the Maine market. All 2008 input files were edited to include the Hartford RFG fuel parameters. All parameters were employed over all four seasons, except for RVP. The 6.86 RVP was used for Summer scenarios only. RVP values for Winter, Spring and Autumn scenarios remained unchanged.

[6] U.S. Environmental Protection Agency, RFG Properties Survey Data: Information on Reformulated Gasoline (RFG) Properties and Emissions Performance by Area and Season, http://www.epa.gov/otaq/regs/fuels/rfg/properf/rfgperf.htm.

Calculations: No changes were made in the calculation methodology.

Findings: The results are mixed for the impact of RFG on the control of air toxics (see Table 22 below). Less than one-third of the air toxics modeled showed any change due to the RFG fuel parameters. And while most showed a decrease, there was a significant increase in acetaldehyde, which Maine DEP cannot find an explanation.

Poll #	Pollutant Name	ALL VEH (SUM)	ALL VEH RFG (SUM)	% DIFF
106990	1,3 Butadiene	61.96617413	54.6544996	-11.8%
540841	2,2,4-Trimethylpentane	482.6748642	438.9731517	-9.1%
83329	Acenaphthene	0.081277184	0.081277184	0.0%
208968	Acenaphthylene	0.429729471	0.429729471	0.0%
75070	Acetaldehyde	63.18187607	128.2824801	103.0%
107028	Acrolein	8.751872378	7.984769442	-8.8%
NH3	Ammonia (gaseous)	1602.538498	1602.538498	0.0%
120127	Anthracene	0.097125343	0.097125343	0.0%
7440382	Arsenic	0.126513095	0.126513095	0.0%
71432	Benzene	530.3202428	394.8000769	-25.6%
56553	Benzo(a)anthracene	0.022508203	0.022508203	0.0%
50328	Benzo(a)pyrene	0.01439591	0.01439591	0.0%
205992	Benzo(b)fluoranthene	0.015841318	0.015841318	0.0%
191242	Benzo(ghi)perylene	0.028762738	0.028762738	0.0%
207089	Benzo(k)fluoranthene	0.015841318	0.015841318	0.0%
PM10	Brake PM (Non-exhaust PM as PM10)	217.7539663	217.7539663	0.0%
PM25	Brake PM (Non-exhaust PM as PM2.5)	92.3276817	92.3276817	0.0%
CO	Carbon Monoxide	279511.0696	249809.939	-10.6%
7440473	Chromim (Cr3)	0.048408294	0.048408294	0.0%
18540299	Chromim (Cr6)	0.032272247	0.032272247	0.0%
103	Chrysene	0.012633417	0.012633417	0.0%
53703	Dibenz(ah)anthracene	5.40534E-06	5.40534E-06	0.0%
PM10	Elemental Carbon Portion of Exhaust Particulate (Exhaust PM as PM10)	216.9828278	216.9828278	0.0%
PM25	Elemental Carbon Portion of Exhaust Particulate (Exhaust PM as PM2.5)	199.6288073	199.6288073	0.0%
100414	Ethylbenzene	205.1638298	187.0645228	-8.8%
206440	Fluoranthene	0.100173784	0.100173784	0.0%
86737	Fluorene	0.168671195	0.168671195	0.0%
50000	Formaldehyde	169.0843842	172.7560702	2.2%
193395	Indeno(123cd)pyrene	0.008135005	0.008135005	0.0%
PB	Lead	0	0	0.0%
7439965	Manganese	0.027638138	0.027638138	0.0%
7439976	Mercury	0.143088958	0.143088958	0.0%
1634044	Methyl Tert Butyl Ether	0	0	0.0%
91203	Napthalene	11.77015813	11.67072945	-0.8%
110543	n-Hexane	207.8451616	194.319247	-6.5%
7440020	Nickel	0.061247218	0.061247218	0.0%
NOX	Nitrogen Oxides	29727.70439	29717.1728	0.0%
PM10	Organic Carbon Portion of Exhaust Particulate (Exhaust PM as PM10)	110.4478705	110.4478705	0.0%

Poll #	Pollutant Name	ALL VEH (SUM)	ALL VEH RFG (SUM)	% DIFF
PM25	Organic Carbon Portion of Exhaust Particulate (Exhaust PM as PM2.5)	101.6561177	101.6561177	0.0%
85018	Phenanthrene	0.276418999	0.276418999	0.0%
123386	Propionaldehyde	10.45723865	9.796465115	-6.3%
129000	Pyrene	0.139410687	0.139410687	0.0%
100425	Styrene	38.73402189	34.98980199	-9.7%
PM10	Sulfate Portion of Exhaust Particulate (Exhaust PM as PM10)	8.462815233	8.462815233	0.0%
PM25	Sulfate Portion of Exhaust Particulate (Exhaust PM as PM2.5)	8.112893886	8.112893886	0.0%
SO2	Sulfur Dioxide (gaseous)	161.5895009	161.5895009	0.0%
PM10	Tire PM (Non-exhaust PM as PM10)	166.0453877	166.0453877	0.0%
PM25	Tire PM (Non-exhaust PM as PM2.5)	41.51134692	41.51134692	0.0%
108883	Toluene	1373.272236	1248.47214	-9.1%
PM10	Total Carbon Portion of Gasoline Exhaust Particulate (Exhaust PM as PM10)	96.9105783	96.9105783	0.0%
PM25	Total Carbon Portion of Gasoline Exhaust Particulate (Exhaust PM as PM2.5)	86.98471012	86.98471012	0.0%
VOC	Volatile Organic Compounds (Express HC as VOC)	15314.31852	14163.03677	-7.5%
1330207	Xylene	770.2820005	700.2064662	-9.1%

Table 22: Comparison of 2008 Mobile Emissions With and Without the Use of Reformulated Gasoline

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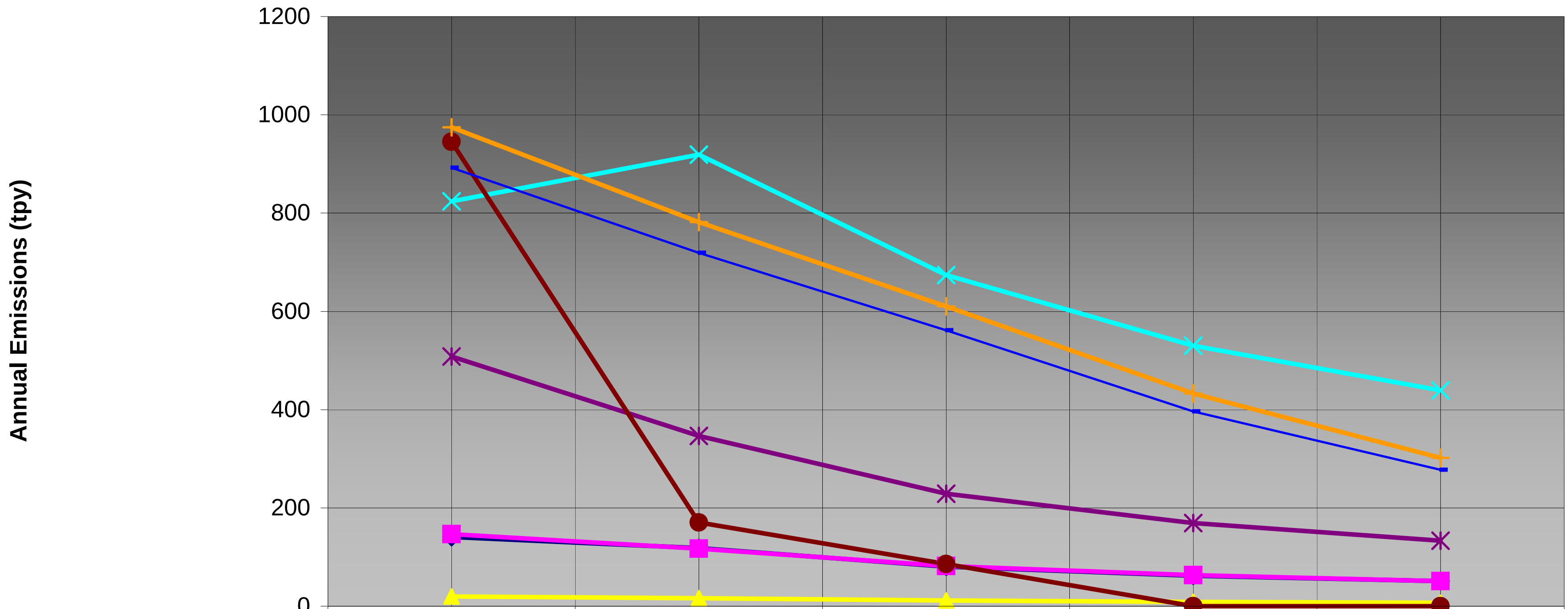
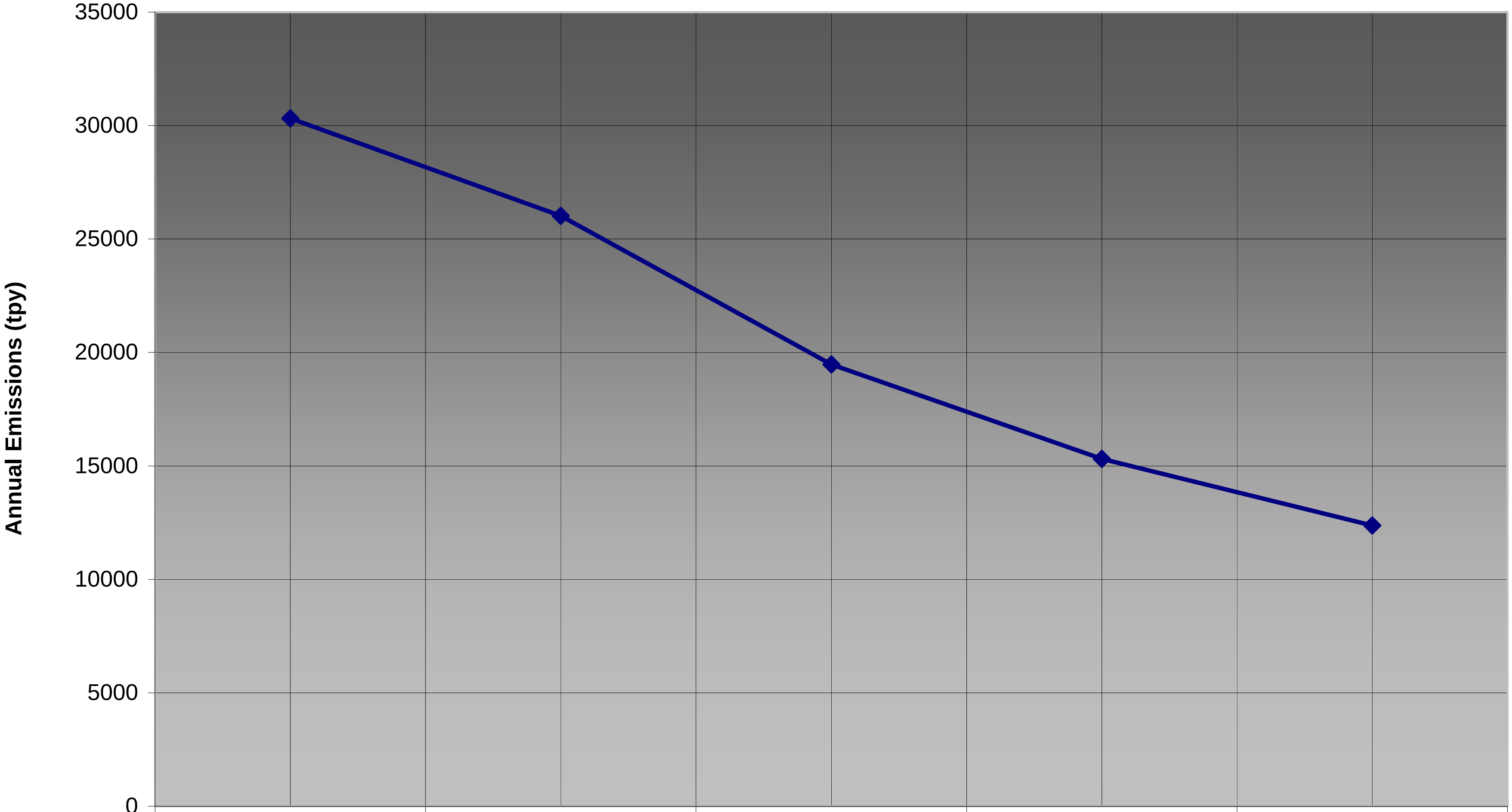
MOBILE6.2 Air Toxics and PM Exhaust Emissions



	1999	2002	2005	2008	2011
1,3 Butadiene	140.530363	118.0559372	80.5840964	61.96617413	50.78731617
Acetaldehyde	146.3453455	116.8192625	81.71151968	63.18187607	51.15396836
Acrolein	19.79357979	16.44077518	11.48982866	8.751872378	6.910101773
Benzene	824.0601585	918.7945456	673.7340574	530.3202428	439.1427215
Formaldehyde	508.348808	346.4784695	229.1105931	169.0843842	133.5361031
Methyl Tert Butyl Ether	945.2686469	170.4184758	85.89458826	0	0
PM10 exhaust only	974.4130953	781.8272707	610.2333671	432.8040919	302.0471228
PM2.5 exhaust only	892.5290831	718.949528	561.6821968	396.3825289	277.3069278

Modeled Years

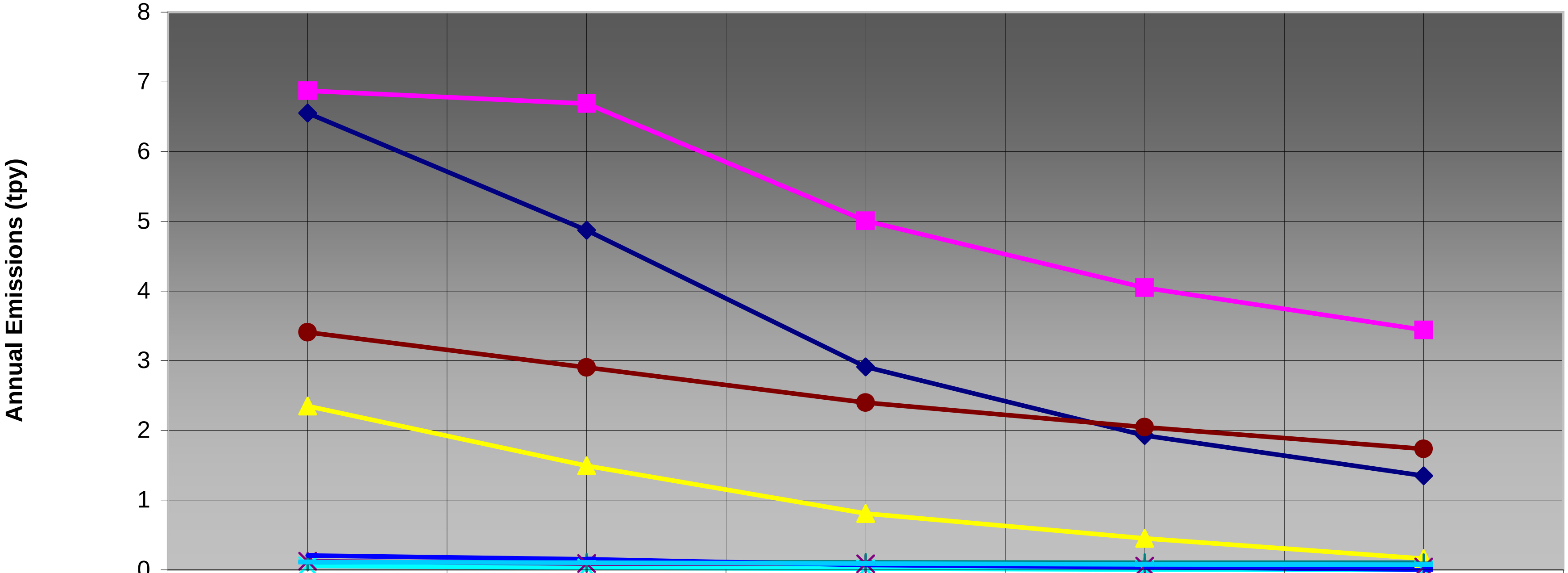
VOC Annual Emissions



	1999	2002	2005	2008	2011
VOC	30320.11873	26021.85314	19467.22525	15314.31852	12378.70968

Modeled Years

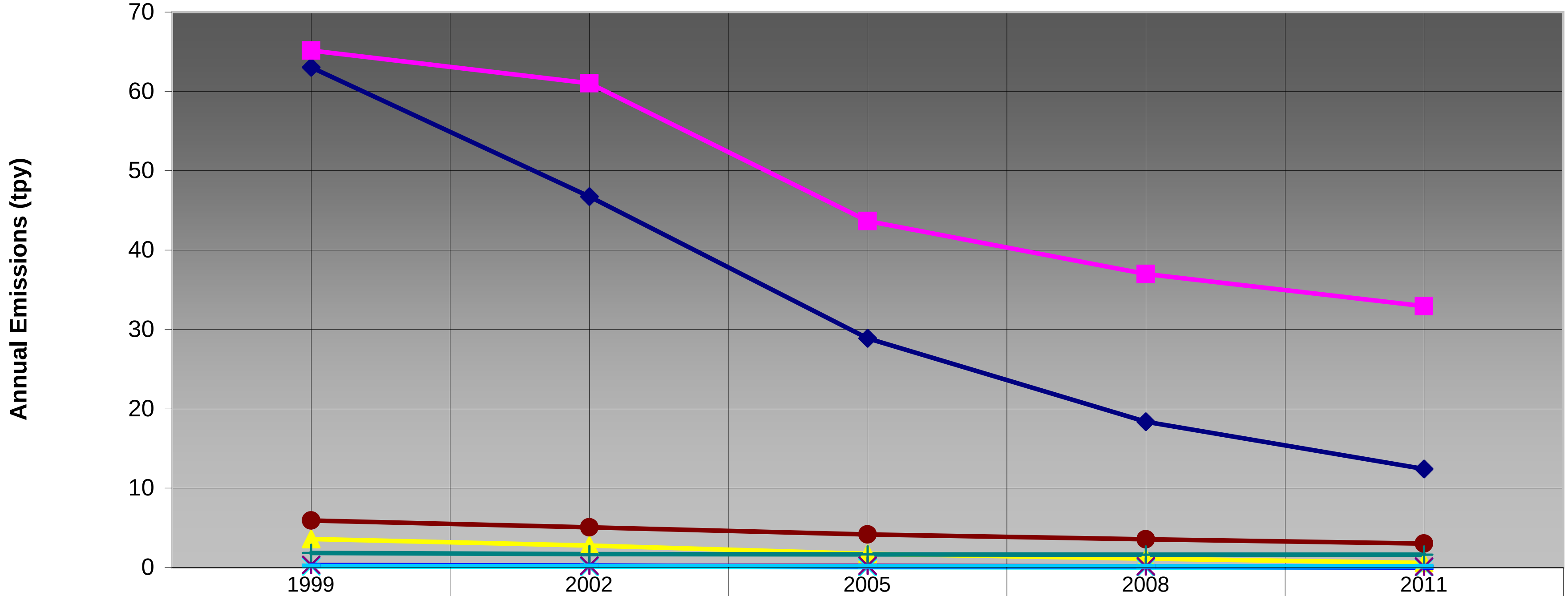
Acrolein Emissions by Source 1999 to 2011



	1999	2002	2005	2008	2011
LDGV	6.552600388	4.870234573	2.909368896	1.9285025	1.349518868
LDGT	6.874223206	6.689628397	5.007600215	4.047888777	3.441797104
HDGV	2.350800012	1.494214692	0.80766357	0.451265541	0.159078045
LDDV	0.058365278	0.030255001	0.017243022	0.005209258	0.002038143
LDDT	0.121926916	0.088911386	0.08463591	0.052238382	0.041992993
HDDV	3.407156452	2.905152142	2.396916445	2.046897657	1.73330598
MC	0.109958822	0.1083174	0.105175278	0.10408259	0.104091934
HDGB	0.206443596	0.151949703	0.070959795	0.036625283	0.004397716
HDDB	0.112105116	0.102111887	0.090265534	0.07916239	0.07388099

Modeled Years

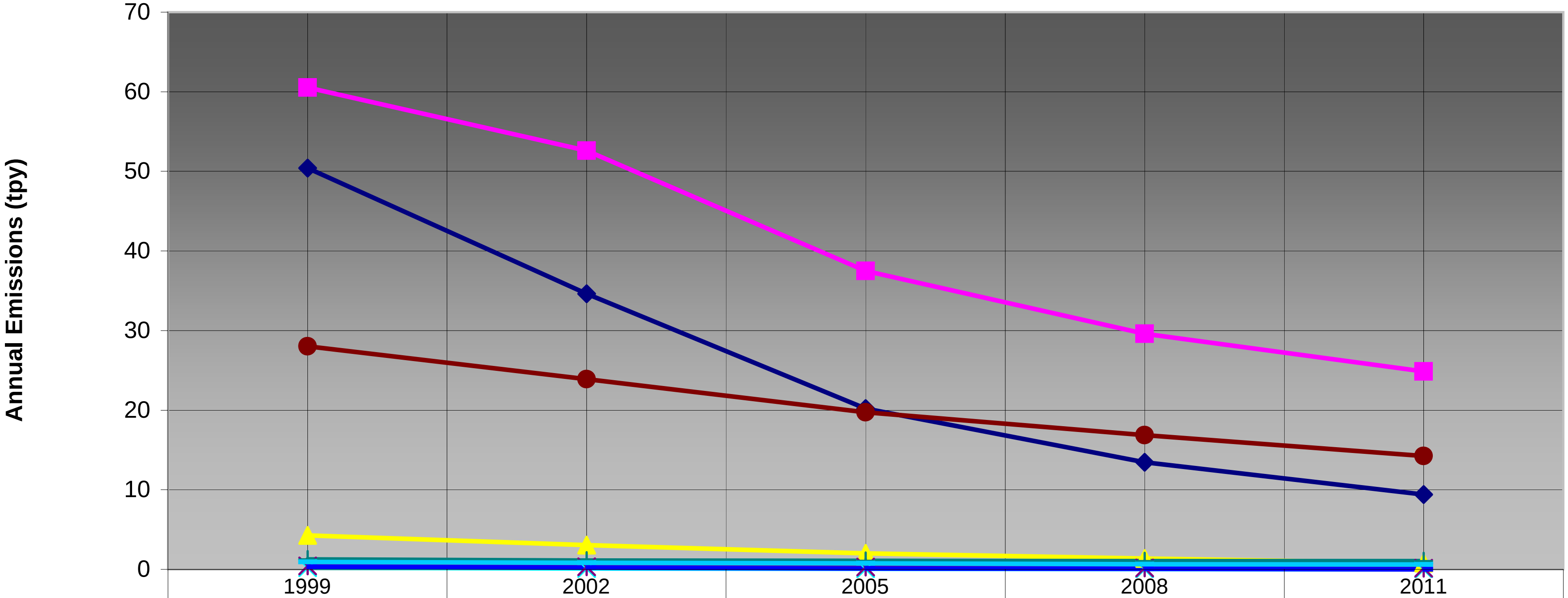
1,3-Butadiene Emissions by Source 1999 to 2011



	1999	2002	2005	2008	2011
LDGV	63.04747622	46.75743065	28.87114027	18.3729318	12.42528138
LDGT	65.14238079	61.03820945	43.65699359	36.98479272	32.93621819
HDGV	3.604185223	2.771239863	1.706346213	1.095762172	0.558727395
LDDV	0.150072384	0.07778414	0.044357179	0.013413682	0.005251895
LDDT	0.31359975	0.228604794	0.217574408	0.134339971	0.107956302
HDDV	5.937390146	5.061772089	4.177632343	3.567912273	3.019605958
MC	1.844681438	1.699193471	1.636370695	1.596898698	1.597040331
HDGB	0.295170327	0.243790265	0.116343292	0.062151047	0.008478573
HDDB	0.195406714	0.177912467	0.157338409	0.137971769	0.128756134

Modeled Years

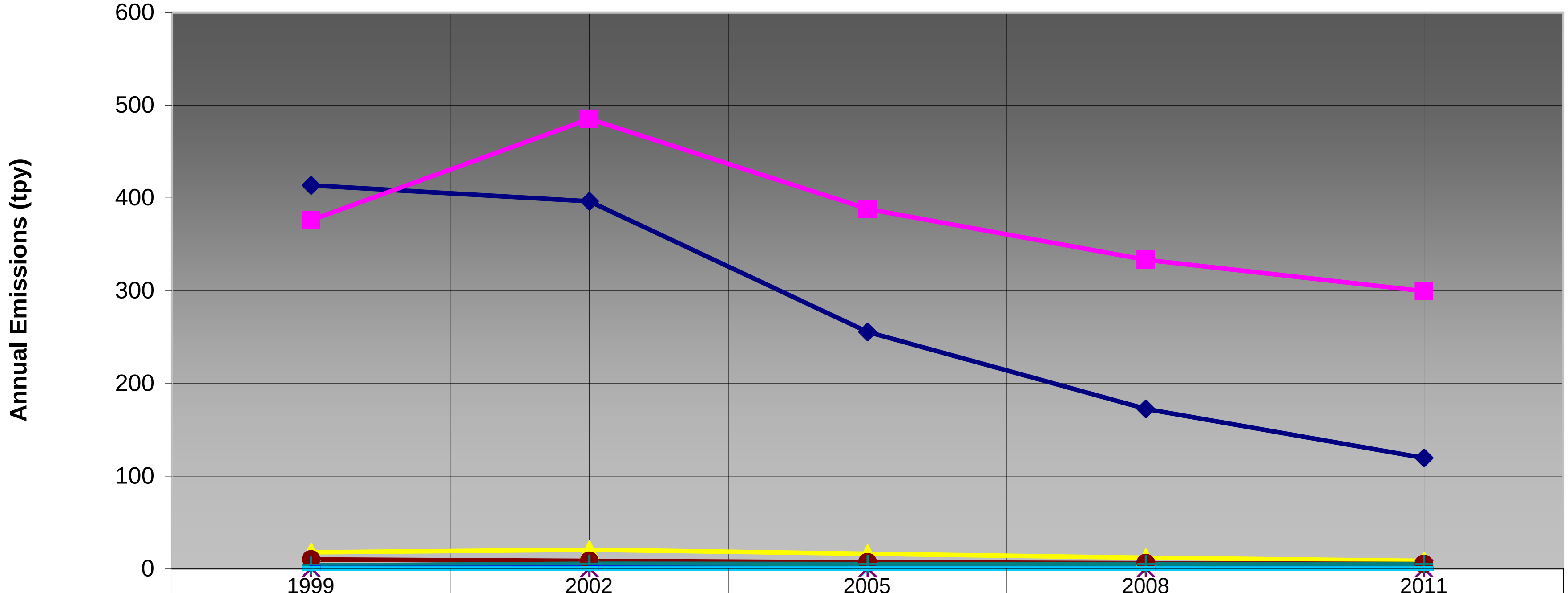
Acetaldehyde Emissions by Source 1999 to 2011



	1999	2002	2005	2008	2011
LDGV	50.39341643	34.63925025	20.19303219	13.44578349	9.416543129
LDGT	60.5280883	52.611248	37.48612972	29.59120608	24.8661364
HDGV	4.267257709	3.058547834	2.02678114	1.346409097	0.802539123
LDDV	0.205133943	0.106300144	0.060619864	0.018322681	0.007171354
LDDT	0.42857333	0.312434406	0.297329111	0.183587272	0.147541837
HDDV	28.03131348	23.89954374	19.71956944	16.84530373	14.25548806
MC	1.256885374	1.121148409	1.075268687	1.041651934	1.041744656
HDGB	0.312163827	0.230778595	0.109905037	0.058200263	0.008921158
HDDB	0.922513074	0.840011132	0.742884491	0.651411532	0.607882647

Modeled Years

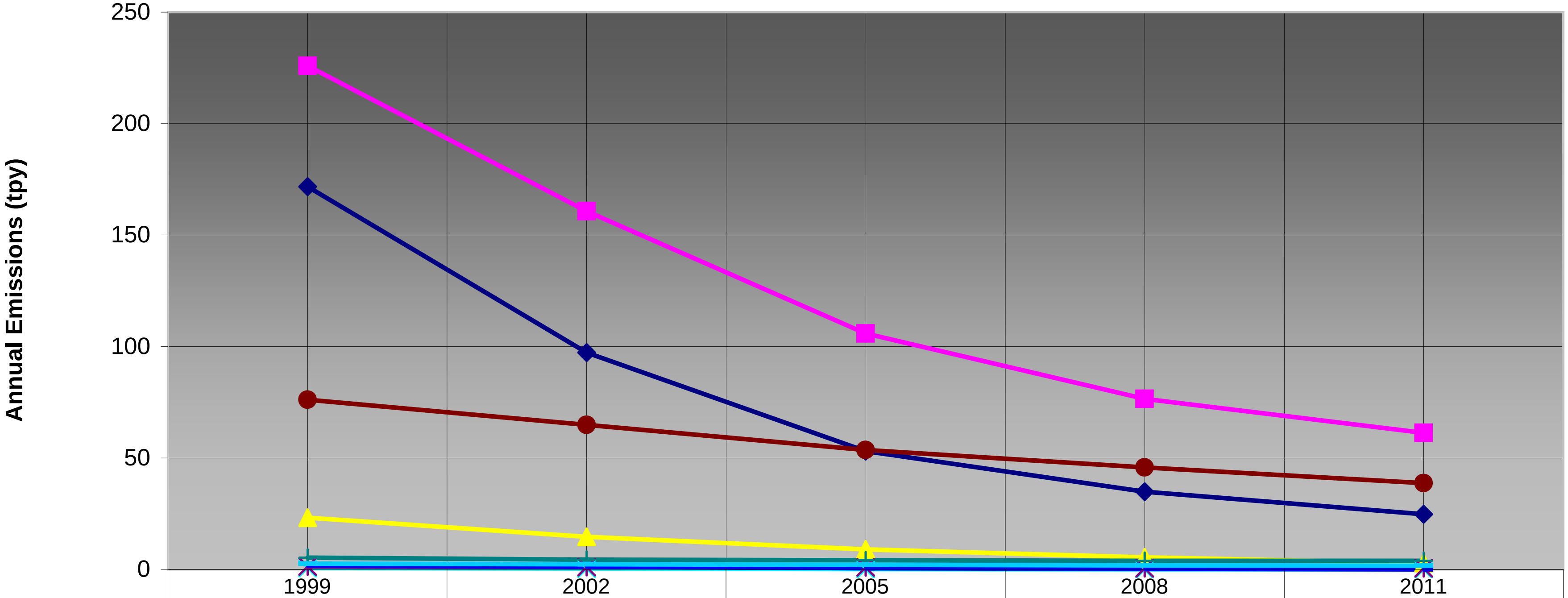
Benzene Emissions by Source 1999 to 2011



	1999	2002	2005	2008	2011
LDGV	413.6213249	396.5360349	255.4811981	172.4352632	119.7634803
LDGT	376.1663011	485.4261429	388.1014646	333.4569972	299.619738
HDGV	17.95893862	20.60524679	16.17665825	12.10664576	8.728997448
LDDV	0.333563451	0.172847166	0.098574332	0.029799406	0.011666308
LDDT	0.696909457	0.50803292	0.483493205	0.298522554	0.239949801
HDDV	10.22009613	8.713956482	7.189358352	6.141939912	5.197497634
MC	3.704159594	5.400101706	5.355975327	5.292166903	5.28860631
HDGB	1.022555563	1.125892034	0.576503757	0.321402001	0.071154432
HDDB	0.336309684	0.306290697	0.270831431	0.237505814	0.221631223

Modeled Years

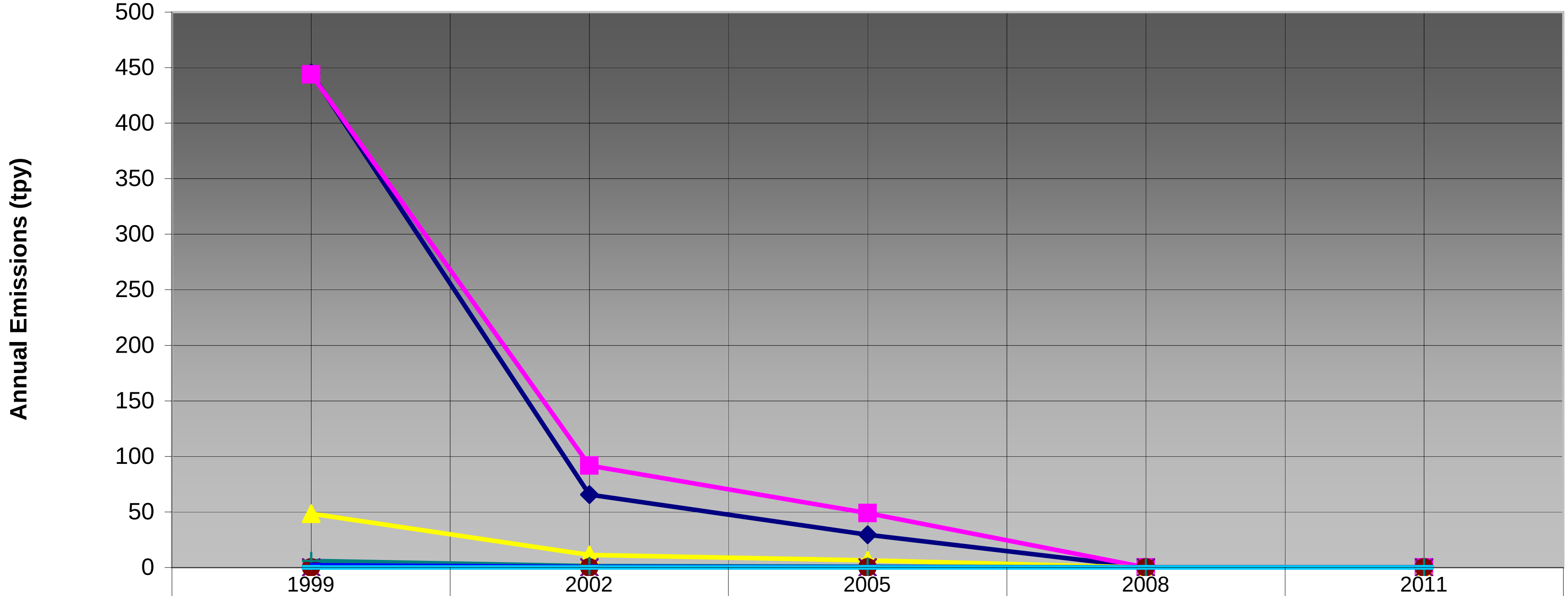
Formaldehyde Emissions by Source 1999 to 2011



	1999	2002	2005	2008	2011
LDGV	171.7490861	97.23776422	53.00804936	34.83773532	24.72647839
LDGT	225.8509948	160.6810321	105.8348375	76.52713878	61.20205695
HDGV	23.18727998	14.55089959	8.923231704	5.396142733	2.834549855
LDDV	0.6437221	0.333577489	0.190246191	0.05751845	0.022516356
LDDT	1.344985968	0.980495601	0.933194304	0.576107462	0.463032853
HDDV	76.11522196	64.89428777	53.54652888	45.74001263	38.70771359
MC	5.212153399	4.310130664	4.090192528	3.888175078	3.88852044
HDGB	1.739513584	1.209361718	0.567241679	0.2928193	0.040657043
HDDB	2.504864656	2.280920248	2.017070995	1.768734488	1.650577573

Modeled Years

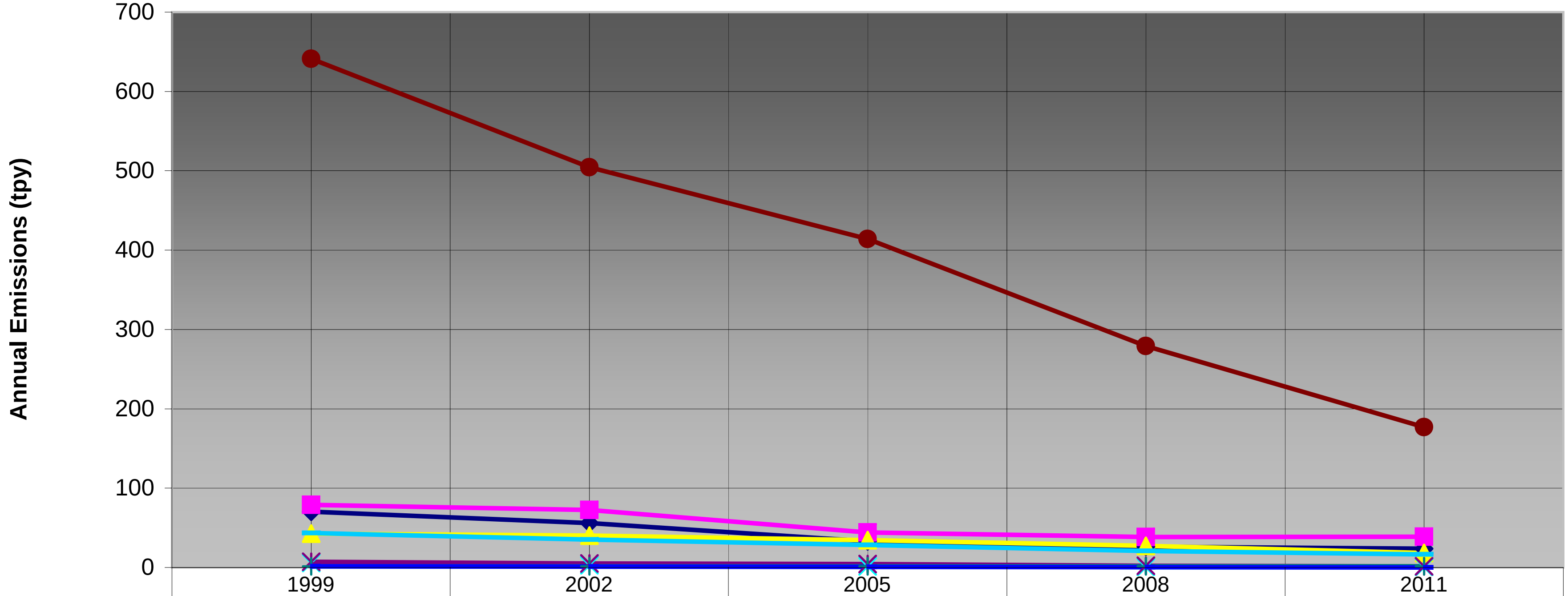
MTBE Emissions by Source 1999 to 2011



	1999	2002	2005	2008	2011
LDGV	445.074054	65.50188032	29.53030294	0	0
LDGT	443.8419921	91.71743584	48.88851141	0	0
HDGV	48.46564424	11.39444489	6.470921761	0	0
LDDV	0	0	0	0	0
LDDT	0	0	0	0	0
HDDV	0	0	0	0	0
MC	5.818158753	1.388724558	0.844292538	0	0
HDGB	2.068797766	0.415990238	0.160559612	0	0
HDDB	0	0	0	0	0

Modeled Years

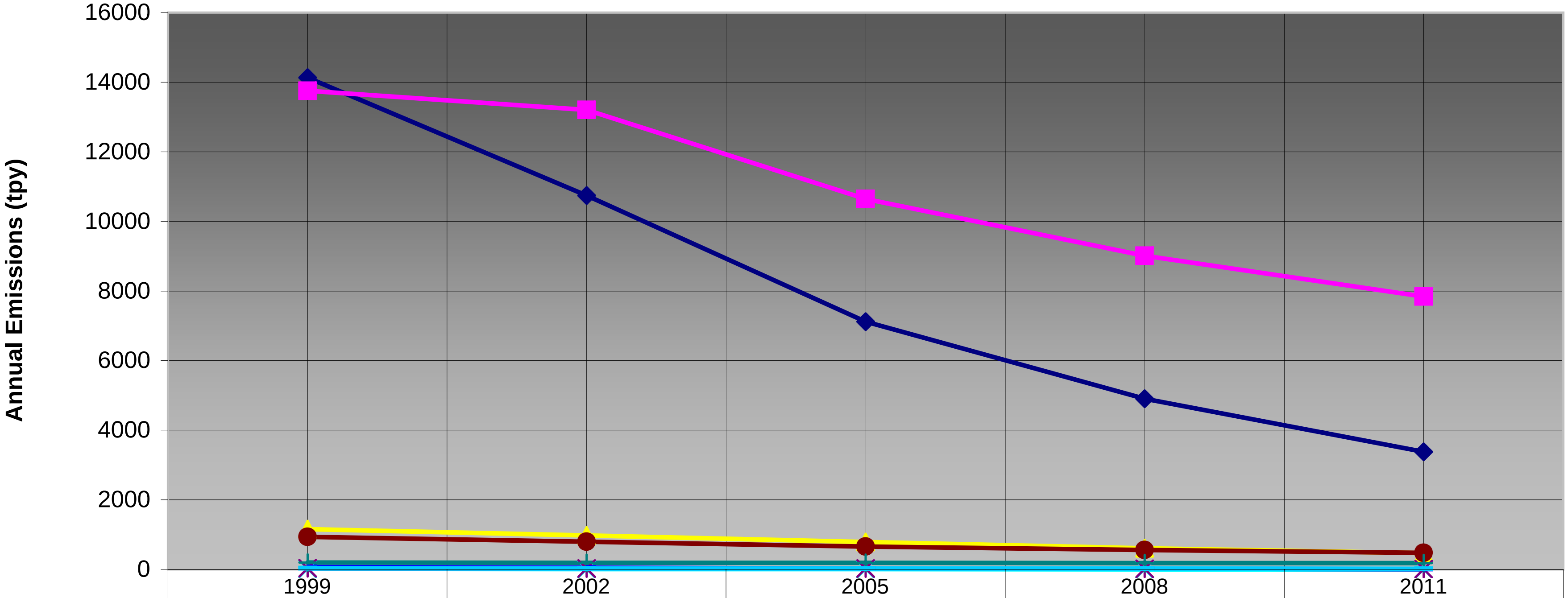
PM2.5 (exhaust only) Emissions by Source 1999 to 2011



	1999	2002	2005	2008	2011
LDGV	70.48482378	55.96510567	33.04759301	26.26479954	23.6921393
LDGT	79.0576444	72.52341865	44.1251787	38.56677407	38.70910523
HDGV	42.64887068	40.19736994	34.44295583	27.12450024	18.33163239
LDDV	5.872524745	2.819685274	1.382085801	0.47112768	0.207129795
LDDT	7.057576429	5.149647571	4.271021443	2.320187406	1.558962427
HDDV	641.0110576	504.4643662	413.9818666	278.9905005	176.7310106
MC	1.562244664	1.510393213	1.398659595	1.365680181	1.366224121
HDGB	1.355377663	1.061707877	0.613796097	0.354774948	0.08326223
HDDB	43.47896317	35.25783359	28.4190397	20.92418442	16.62746173

Modeled Years

VOC Emissions by Source 1999 to 2011



	1999	2002	2005	2008	2011
LDGV	14132.31618	10742.13677	7120.696165	4903.718962	3378.464576
LDGT	13752.69264	13205.78138	10640.8792	9011.231338	7842.939294
HDGV	1156.567666	976.0010035	786.2216853	606.8243887	467.7492114
LDDV	16.52413978	8.571535811	4.892047208	1.4832301	0.582502116
LDDT	34.58453448	25.23753244	24.04466154	14.85597368	11.94980963
HDDV	935.1499438	794.9426592	653.8254187	558.2909823	472.1754946
MC	197.4102128	191.9673699	185.46685	181.1086998	180.3921254
HDGB	64.29175106	49.41876192	26.65179064	15.27059576	4.359237929
HDDB	30.58166244	27.79613878	24.54742776	21.53434635	20.09743318

Modeled Years