United States Environmental Protection Agency
Office of Transportation and Air Quality
EPA420-D-06-004
February 2006

Draft Regulatory Impact Analysis: Control of Hazardous Air Pollutants from Mobile Sources

Chapter 2

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Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

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Chapter 2: Emission Inventories

This chapter describes the methods used to develop inventories for air quality modeling, estimation of emission benefits and calculation of cost-effectiveness for this rule. The chapter also presents and discusses these inventories. MSAT inventories for air quality modeling were developed well in advance of rule proposal, because of the lead time required to conduct air quality, exposure, and risk analyses. Thus, these inventories do not include revised estimates of emissions at cold temperature in vehicles, emissions from portable fuel containers, or revisions in the gasoline distribution inventory to reflect changes made for the 2002 National Emissions Inventory. Therefore, the chapter has separate sections discussing MSAT inventories used for modeling, and revised inventories used to estimate emission benefits of the rule and cost-effectiveness.

2.1 Criteria Pollutants

2.1.1 Methods

2.1.1.1 Highway Vehicles

Highway vehicle hydrocarbon (HC) emission inventories were calculated by using vehicle emission rates produced from the emission model MOBILE6.2 multiplied by vehicle miles traveled (VMT) using the National Mobile Inventory Model (NMIM).[1] MOBILE6.2 uses emission factors obtained through the analysis of emissions data collected from vehicle emission research[2]. The VMT used by NMIM was estimated for base years using historical data from the Federal Highway Administration, allocated to counties using the methodology documented for the National Emissions Inventory, and projected to future years using the Energy Information Administration's National Energy Modeling System (NEMS) Transportation Model. This is the same approach used in the Clean Air Interstate Air Quality (CAIR) rule.[3]

Analysis of vehicle emission certification data submitted to EPA as part of requirements to comply with requirements for cold temperature carbon monoxide (CO) standards by vehicle manufacturers, as well as surveillance testing data from the California Air Resources Board, indicated that MOBILE6.2 was substantially underestimating start emission at cold temperatures for Tier 1 and later vehicles. This data was supplemented with test data collected by the Office of Transportation and Air Quality (OTAQ) at Southwest Research Institute (SwRI)[4] and was then used to adjust the temperature and engine start emission factors in MOBILE6.2 to provide inputs to NMIM which calculates county level national inventories.[5]

EPA cold CO certification data was paired as 20 ºF versus 75 ºF tests per engine family to calculate the additional hydrocarbon (HC) emissions due to lower temperature. The bag emission data where available indicated that at 20 ºF, as in the standard FTP at 75 ºF, the majority of HC emissions occur during vehicle start and that lower vehicle soak and start temperatures result in higher HC emissions. Table 2.1.-1 indicates the trends found in the EPA Cold CO program certification data.

The state of California has a 50 ºF emission standard requirement and that data, also supplied by manufacturers, reflects the same trend over the smaller temperature difference (Table 2.1.-2).

The testing done by OTAQ at SwRI was performed on four Tier 2 vehicles to confirm the effects seen in the certification data and to extend the range of soak temperature to 0 ºF. A summary of the hydrocarbon data is found in Table 2.1.-3.

Table 2.1.-1. FTP HC Data From Federal Certified Vehicles (grams per mile)

		75º		20º	
Emission Standard	Sample Size	Mean	Std. Dev.	Mean	Std. Dev.
Tier 1	410	0.1190	0.0553	0.8630	0.7269
TLEV	64	0.0804	0.0286	0.6996	0.2778
LEV	695	0.0501	0.0209	0.6402	0.3723
ULEV	132	0.0335	0.0214	0.4675	0.2727
LEV2	119	0.0296	0.0123	0.5035	0.2549
2004 Tier 2	172	0.0406	0.0169	0.5641	0.3269
2005 Tier 2	190	0.0415	0.0203	0.5651	0.3247
2006 Tier 2	90	0.0408	0.0239	0.5502	0.3107

Table 2.1.-2. FTP HC Emissions Data from California Certified Vehicles (grams per mile)

		75º		50º		
Emission Standard	Sample Size	Mean	Std. Dev.	Mean	Std. Dev.	Ratio of Averages
LEV	53	0.0397	0.0259	0.0988	0.0631	2.49
ULEV	14	0.0162	0.0043	0.0403	0.0176	2.48
LEV2	21	0.0346	0.0097	0.0843	0.0310	2.44

Table 2.1.-3. SwRI FTP (Bag 1 Only) Emissions from Four Tier 2 Vehicles			
Temperature in ºF	75	20	0
Number of Observations	4	8	4
Average THC (gm/mile)	0.115	1.658	3.752
Standard deviation	0.072	0.780	2.117
Ratio to 75 ºF	1	14.446	32.699

MOBILE6.2 currently has engine start emission factors based on 75º emission test data on 1981 and newer vehicles. These engine start emissions are the difference, in grams, between the emissions from phase 1 of the FTP after a 12 hour engine soak and the emissions of the same driving fully warm and without the engine start. Temperature effects on HC emissions are estimated using a multiplier that depends on ambient temperature. This process is described in the MOBILE6.2 documentation[6]. The current engine start adjustments in MOBILE6.2 are not as large for Tier 1 and later vehicles as what is indicated in the certification and SwRI test data. A method of correcting the emission factors was developed using the test data. Those methods are covered in detail in EPA technical report no. EPA420-D-06-001, "Cold Temperature Effects on Vehicle HC Emissions."

Based on our analysis from Tier 1 and newer vehicles, it was decided that additive values would be applied to 75 ºF start emission factors based on temperature and vehicle technology (i.e., Tier 1, NLEV, Tier 2, etc). Additive values can more closely approximate the additional hydrocarbon emissions caused strictly by the start and warm-up of the engine and/or the exhaust aftertreatment at the different temperatures than multiplicative values. These values were obtained from subtracting the FTP emissions at 0, 20, and 50 ºF from the FTP emissions at 75 ºF using the certification and SwRI test data. For emissions at temperature points where data was not available (i.e., 50 ºF for Tier 2 vehicles), linear interpolation between the 20 and 75 ºF test data was used. All of the difference in emissions is attributed to the increase in engine start emissions. The values used for inputs for start adjustments are found in Table 2.1.-4.

It is not clear what impact this phenomenon has on HC emissions in malfunctioning or deteriorated vehicles. Emissions could go up proportionally to properly operating vehicles or could go up at a lower rate. Properly operating vehicles are very clean due to their emissions technology. Vehicle starts represent a period of operation where the vehicle's emissions equipment is not fully operational and the oxidation of fuel to carbon dioxide and water is not optimal. This situation is similar to the conditions found in a deteriorated or improperly maintained vehicle except that the condition is temporary in a normal vehicle. While MOBILE currently uses a multiplier to account for temperature effects, doing so in the case results in extremely high and unrealistic emission rates. Therefore we have used the MOBILE6.2 estimate of FTP emissions at 20 ºF for model year 2005 high-emitting vehicles in calendar year 2005 as the additive factor for all Tier 2 high-emitting vehicles. Those values are found in Table 2.1.-5. We are not changing high-emitting vehicle emission factors for Tier 1 and older vehicles.

Table 2.1.-4. Increase in Engine Start Hydrocarbon Emissions Over the 75 ºF Baseline at Low Temperatures (grams per engine start after a 12 hour soak)

		ºF		
Index	**Description**	**0**	**20**	**50**
1	Tier 0 (not used)	25.96	12.98	3.09
2	Intermediate Tier 1	25.96	12.98	3.09
3	Tier 1	25.96	12.98	3.09
4	Tier 2 (not used)	18.26	9.13	3.27
5	Intermediate Transitional Low Emission Vehicle	21.60	10.80	2.09
6	Transitional Low Emission Vehicle	21.60	10.80	2.09
7	Intermediate Low Emission Vehicle	20.59	10.29	1.30
8	Low Emission Vehicle (LEV)	20.59	10.29	1.30
9	Transitional Ultra Low Emission Vehicle	15.14	7.57	0.87
10	Ultra Low Emission Vehicle (ULEV)	15.14	7.57	0.87
11	Zero Emission Vehicle (ZEV) (not used)	0.00	0.00	0.00
Index	**Tier 2 (All Cars & Trucks) By Model Year**	**0**	**20**	**50**
1	2004	18.26	9.13	3.27
2	2005	18.27	9.13	3.27
3	2006	17.77	8.88	3.27
4	2007	17.77	8.88	3.27
5	2008	17.77	8.88	3.27
6	2009	17.77	8.88	3.27
7	2010	17.77	8.88	3.27
8	2011	17.77	8.88	3.27
9	2012	17.77	8.88	3.27
10	2013	17.77	8.88	3.27
11	2014	17.77	8.88	3.27
12	2015	17.77	8.88	3.27

Table 2.1.-5. Tier 2 High Emitter HC Adjustment Based on 2005 Model Year MOBILE6.2 Results in Calendar Year 2005

Temperature ºF	0	20	50	75
Engine start grams without adjustment	63.335	41.360	21.821	12.813
Additional grams	50.522	28.547	9.008	N/A

The above tables and the new emission standard were used to determine the effects of the proposed emission standard on start emission factors. The predicted reductions were applied to Tier 2 vehicles over the phase-in period of the standards. Those values are found in Table 2.1.-6. No reductions beyond those found for normally-emitting Tier 2 vehicles are applied for Tier 2 high-emitting vehicles.

With the appropriate HC start emission temperature adjustment factors, we can provide the necessary emission factors required as inputs to NMIM to project pre-control and control inventories for this rule. No modification to any other components of NMIM is needed to calculate these inventories.

Table 2.1.-6. Adjustments to Engine Start Hydrocarbon Emissions Over the 75 ºF Baseline at Low Temperatures For MSAT Rule (grams per engine start after a 12 hour soak)

		ºF			Phase In Fraction
Index	**Tier 2 Cars & Light Trucks <6,000 lbs GVWR By Model Year**	**0**	**20**	**50**	
1	2004	18.26	9.13	3.27	0
2	2005	18.27	9.13	3.27	0
3	2006	17.77	8.88	3.27	0
4	2007	17.77	8.88	3.27	0
5	2008	17.77	8.88	3.27	0
6	2009	17.77	8.88	3.27	0
7	2010	6.66	3.3	1.215	0.25
8	2011	6.66	3.3	1.215	0.50
9	2012	6.66	3.3	1.215	0.75
10	2013	6.66	3.3	1.215	1.00
11	2014	6.66	3.3	1.215	1.00
12	2015	6.66	3.3	1.215	1.00
		ºF			Phase In Fraction
Index	**Tier 2 Light Trucks >6,000 lbs GVWR By Model Year**	**0**	**20**	**50**	
1	2004	18.26	9.13	3.27	0
2	2005	18.27	9.13	3.27	0
3	2006	17.77	8.88	3.27	0
4	2007	17.77	8.88	3.27	0
5	2008	17.77	8.88	3.27	0
6	2009	17.77	8.88	3.27	0
7	2010	17.77	8.88	3.27	0
8	2011	17.77	8.88	3.27	0
9	2012	11.0	5.5	2.025	0.25
10	2013	11.0	5.5	2.025	0.50
11	2014	11.0	5.5	2.025	0.75
12	2015	11.0	5.5	2.025	1.00

2.1.1.2 Portable Fuel Containers

In 1999, California's Air Resources Board (ARB) proposed a methodology to estimate annual emissions from portable fuel containers (PFCs) within California. Their approach relied on survey data to first estimate the number of PFCs, and then to combine those estimates with results from testing PFCs to develop a statewide annual inventory.

EPA has modified California's approach. We first used our NONROAD emissions model to estimate (for each month of the year and for each state) the quantity of gasoline dispensed from PFCs that was used to fuel nonroad equipment. Then using some of the California survey data on the amount of gasoline in stored in each PFC, EPA estimated the number of PFCs in use (each season) in each state. These estimated counts of PFCs were similar (but not identical) to the California estimates. EPA also adjusted the California emission estimates to account for daily temperature variations and seasonal RVP variations. EPA then combined its state-by-state estimates of PFC usage with its adjusted emission rates to obtain seasonal VOC inventory estimates for each state.[7]

For each of the 50 states plus the District of Columbia, this EPA approach produced the estimates for calendar year 1990 given in Table 2.1.-7. Assuming no changes (i.e., no controls), each of these estimates will increase by approximately 1.21 percent annually due to the increase in gasoline consumption predicted by the NONROAD model.

Six states (California, Delaware, Maine, Maryland, New York, and Pennsylvania) have implemented controls on the design of PFCs that will reduce HC emissions. The California program began in 2001. The other states started their programs in 2005. Additionally, seven other states plus the District of Columbia (Connecticut, Massachusetts, New Jersey, Rhode Island, Texas, Vermont, Virginia, and Washington DC) are also planning to adopt the California PFC program.

Additionally, California has begun to adopt more stringent emission standards that will require each PFC to emit (permeation plus evaporation) no more than 0.3 grams of VOC per day for each gallon of capacity. This requirement will be effective July 1, 2007. Assuming that PFCs have a typical life of about five years on average, the "new" versions of the PFCs should replace virtually all of the earlier versions by 2013. As these state programs result in replacing the existing PFCs with lower-emitting PFCs, the estimated national inventory of VOCs associated with PFCs will drop by about 20 percent.

To estimate the VOC emissions from gas cans assuming the proposed rules are implemented, we made to following three changes to our inventory estimates:

1. Since the proposed rule makes it unlikely for a newly designed gas can to be left in the "open" position, we altered the distribution of the cans (from the California survey) to 100 percent "closed." This change reduced the VOC emissions from both evaporation as well as spillage during transport. (Note, the 13 states plus the District of Columbia that

are adopting the California gas can rules already had this change applied. So, this affected the VOC emissions from only gas cans in the other 37 states.)

2. This proposed rule also produces changes (to the design of the individual gas cans) that are expected to reduce the spillage by 50 percent (when these gas cans are used to refuel individual pieces of equipment). Again, this emission reduction was already included in the base case for those states that are adopting the California rules. Therefore, only the gas cans in the remaining 37 states contributed to our estimated reductions of spillage.

3. Finally, the proposed rule includes a maximum emission rate of 0.3 grams per gallon per day for the new gas cans. We used this emission standard to estimate the total permeation plus evaporative emissions from each newly designed gas can. Only California has adopted (or plans to adopt) this requirement. Thus, the effect of this proposed national requirement applies to the remaining 49 states.

The change in VOC emissions was then calculated by subtracting the emissions (on a state-by-state basis) estimated using these preceding three changes from our base estimates. The national estimate was simply the sum of the 50 individual state (plus DC) estimates.

2.1.2 Emission Reductions of Proposed Controls

Light-Duty Gasoline Vehicles -- We are proposing a 20° F FTP emission standard for non-methane hydrocarbon (NMHC) emissions from spark ignition vehicles of 0.3 grams per mile for light duty vehicles and trucks that weigh 6000 pounds or less and a 0.5 gram per mile standard for vehicles that weigh more than 6000 pounds. The standard will be applied to a manufacturer on a sales-weighted fleet-wide basis. Furthermore, the standards will be phased in over a period of time following the schedule found in Table 2.1.-8.

The resulting reductions were modeled based upon the above standard and the phase-in period. This was done as outlined in Section 2.1.1.1 with an external data file provided as input to MOBILE6.2 that altered MOBILE6.2 start emission factors for Tier 2 vehicles only. MOBILE6.2 was then used with NMIM to generate county and nationwide inventories of the control case. When the standard is fully phased in we expect a 60 % reduction in start emissions in gasoline fuel vehicles that have a gross vehicle weight rating (GVWR) of less than or equal to 6000 lbs and a 30 % in gasoline-fueled vehicles that have a GVWR greater than 6000 lbs. The impact on future nationwide VOC inventories is found in Table 2.1.-9.

Table 2.1-7. PFC Emissions (Tons per Year) by Source Type (for 1990)

	Refilling PFC at Pump			Refueling Equipment			
State	Vapor Displ	Spillage	Spillage During Transport	Vapor Displ	Spillage	Permeation Plus Evaporation	Totals by State
AL	159.6	13.2	395.5	159.6	871.3	3,572.3	5,171.4
AK	17.5	1.4	46.8	17.5	83.3	548.0	714.6
AZ	273.4	23.5	655.2	273.4	1,665.4	2,910.4	5,801.2
AR	88.3	7.0	218.5	88.3	428.9	2,467.9	3,299.0
CA	1,602.2	136.0	3,815.5	1,602.2	9,452.1	21,553.8	38,161.8
CO	209.9	17.0	485.9	209.9	1,174.2	3,025.9	5,123.0
CT	148.9	12.8	367.9	148.9	884.4	2,230.0	3,793.0
DE	33.6	3.0	87.8	33.6	210.5	450.8	819.5
DC	5.7	0.5	18.2	5.7	37.1	176.1	243.3
FL	817.5	72.2	2,026.0	817.5	4,998.5	10,172.5	18,904.2
GA	305.6	29.2	838.6	305.6	1,971.4	4,107.6	7,558.0
HI	51.9	3.9	110.6	51.9	273.4	972.6	1,464.3
ID	43.6	4.6	135.9	43.6	301.8	663.6	1,193.0
IL	383.4	39.7	1,148.0	383.4	2,673.0	4,385.3	9,012.8
IN	213.7	20.7	606.1	213.7	1,406.0	2,981.2	5,441.4
IA	105.7	9.5	283.9	105.7	625.7	1,876.5	3,007.0
KS	93.7	9.2	269.7	93.7	614.6	1,620.4	2,701.3
KY	107.4	10.2	311.8	107.4	656.2	2,233.4	3,426.3
LA	132.1	11.0	339.7	132.1	694.8	3,697.3	5,006.9
ME	47.7	4.1	125.6	47.7	285.5	979.6	1,490.3
MD	248.2	21.5	604.5	248.2	1,521.8	2,950.2	5,594.5
MA	230.9	20.1	584.2	230.9	1,372.7	3,390.3	5,829.1
MI	452.7	33.4	993.3	452.7	2,253.8	10,004.8	14,190.8
MN	155.6	14.8	444.2	155.6	940.8	2,657.3	4,368.2
MS	70.3	6.5	204.2	70.3	412.9	1,852.0	2,616.3
MO	193.4	18.0	536.6	193.4	1,182.5	3,161.3	5,285.1
MT	23.7	2.3	72.7	23.7	143.5	511.9	777.7
NE	53.9	5.6	166.4	53.9	367.6	786.8	1,434.1
NV	81.0	7.8	217.1	81.0	550.7	709.2	1,646.8
NH	51.4	4.2	125.7	51.4	283.1	939.0	1,454.8
NJ	351.5	31.0	889.5	351.5	2,093.1	5,136.2	8,852.8
NM	56.3	5.0	147.9	56.3	338.8	1,019.5	1,623.8
NY	479.6	45.6	1,339.2	479.6	2,918.2	7,196.1	12,458.3
NC	368.1	28.6	828.9	368.1	1,937.1	6,327.8	9,858.5
ND	17.7	1.8	53.6	17.7	105.1	355.5	551.3
OH	523.5	42.1	1,223.4	523.5	2,886.9	8,553.9	13,753.4
OK	124.9	10.0	304.0	124.9	669.3	3,094.2	4,327.4
OR	165.0	13.3	383.2	165.0	915.1	2,601.9	4,243.4
PA	396.8	39.1	1,164.9	396.8	2,670.4	6,988.9	11,656.9
RI	29.9	3.2	92.9	29.9	217.2	367.6	740.6

	Refilling PFC at Pump		Refueling Equipment	Refueling Equipment			
State	Vapor Displ	Spillage	Spillage During Transport	Vapor Displ	Spillage	Permeation Plus Evaporation	Totals by State
SC	161.1	14.1	407.3	161.1	974.5	2,519.7	4,237.8
SD	18.8	1.9	59.4	18.8	118.3	359.8	577.1
TN	181.5	16.6	496.5	181.5	1,086.4	3,789.5	5,751.9
TX	743.1	68.1	1,968.7	743.1	4,654.3	11,008.5	19,185.9
UT	63.6	6.5	192.0	63.6	419.2	941.6	1,686.4
VT	21.8	2.0	60.7	21.8	134.2	380.2	620.7
VA	295.4	26.2	752.9	295.4	1,845.0	4,211.6	7,426.5
WA	245.8	20.5	595.4	245.8	1,411.9	3,627.0	6,146.4
WV	51.8	4.4	141.9	51.8	279.8	1,502.9	2,032.6
WI	190.2	16.9	505.2	190.2	1,118.3	3,547.8	5,568.4
WY	14.5	1.4	44.3	14.5	90.5	269.1	434.4
50-State	10,903.6	961.1	27,887.6	10,903.6	65,221.2	171,387.4	287,264.5

Table 2.1.-8. Proposed Phase-in Schedule for 20°F Standard by Model Year

Vehicle GVWR (Category)	2010	2011	2012	2013	2014	2015
≤ 6000 lbs (LDV/LLDT)	25%	50%	75%	100%		
> 6000lbs HLDT (and MDPV)			25%	50%	75%	100%

Table 2.1.-9. Impact on Nationwide VOC Emissions from Light Duty Vehicles and Trucks of a 20 ºF FTP Emission Standard for Non-Methane Hydrocarbons.

Year	Tons Without Standard	Tons With Standard	Reduction
1999	4,899,891	N. A.	N.A.
2010	2,936,905	2,790,971	145,934
2015	2,625,076	2,305,203	319,874
2020	2,556,751	2,020,267	536,484
2030	2,889,269	1,985,830	913,439

These benefits are primarily realized in regions of the country with colder winter temperatures. Table 2.1.-10 shows the impacts on a State by State basis in year 2030.

Test data show that the proposed controls on cold temperature hydrocarbon emissions will have the ancillary benefit of reducing PM emissions as well. Emissions generated during cold temperature starts tend to be elevated due to a combination of a cold catalyst and excess fuel in the combustion chamber. These factors increase emissions of benzene and other hydrocarbons, and at the same time allow for unburned or pyrolized fuel to be emitted.

A number of source apportionment studies have indicated previously that emissions from vehicles starting at cold temperatures contribute disproportionately to ambient $PM_{2.5}$. For instance, the Northern Front Range Air Quality study conducted in the Denver, CO area during the winter of 1997 estimated that, on average, 12% of ambient $PM_{2.5}$ could be attributed to cold start light-duty gasoline vehicle emissions.[8]

At this point, the PM emission factors in MOBILE6.2 for PM from light-duty gasoline vehicles are not sensitive to temperatures. However, as outlined above, the emission factors for hydrocarbons and gaseous toxics are temperature-dependent.

In order to estimate the expected emission reductions in PM as a result of the cold temperature standards in this proposal, we evaluated the relationship between PM and NMHC in Tier 2 vehicles operating at different temperatures. All emissions benefits of the cold temperature standard are expected to affect only the cold temperature starting emissions. As such, all analyses were restricted to Bag 1. However, similar results were obtained when using full weighted FTP results.

First, data from the only extant testing program of Tier 2 vehicles at multiple temperatures was obtained from Southwest Research Institute.[9] Figure 2.1.-1 shows the PM emission factors as a function of temperature. Like NMHC, PM emission factors increase exponentially with lower temperatures through the entire range of testing.

Table 2.1.-10. Impacts on State Light Duty Vehice and Truck VOC Emissions of 20 ºF FTP Emission Standard for Non-Methane Hydrocarbons in 2030.

	Reference Case Tons	Control Case Tons	Reduction in Tons	Percent Reduction
AL	49,848	38,155	11,692	23
AK	11,377	6,130	5,247	46
AZ	50,563	38,008	12,556	25
AR	28,603	21,104	7,499	26
CA	249,670	178,119	71,552	29
CO	59,856	38,363	21,493	36
CT	28,578	17,443	11,135	39
DE	7,573	4,883	2,690	36
DC	3,462	2,329	1,133	33
FL	110,729	100,275	10,454	9
GA	99,741	75,155	24,586	25
HI	6,979	6,820	158	2
ID	20,716	13,068	7,648	37
IL	117,780	73,217	44,563	38
IN	87,191	57,078	30,113	35
IA	36,930	23,614	13,315	36
KS	34,192	22,590	11,602	34
KY	49,849	33,028	16,821	34
LA	35,684	28,657	7,026	20
ME	17,412	10,288	7,124	41
MD	49,383	31,758	17,625	36
MA	49,937	30,477	19,460	39
MI	141,535	88,464	53,072	37
MN	87,180	52,242	34,938	40
MS	23,418	17,721	5,697	24
MO	73,449	49,197	24,252	33
MT	17,728	10,506	7,222	41
NE	23,655	15,038	8,617	36
NV	26,445	18,852	7,593	29
NH	18,650	11,440	7,210	39
NJ	57,554	36,810	20,744	36
NM	27,037	19,911	7,126	26
NY	155,448	97,923	57,525	37
NC	89,150	64,947	24,202	27
ND	12,087	7,041	5,045	42
OH	119,496	77,175	42,321	35
OK	44,642	32,578	12,064	27
OR	53,308	34,494	18,814	35
PA	116,128	74,186	41,942	36
RI	7,615	4,729	2,886	38
SC	46,158	33,346	12,812	28
SD	12,261	7,441	4,820	39
TN	67,115	47,317	19,799	29

	Reference Case Tons	Control Case Tons	Reduction in Tons	Percent Reduction
TX	176,753	146,569	30,184	17
UT	28,151	17,576	10,575	38
VT	11,451	6,993	4,458	39
VI	79,427	54,082	25,345	32
WA	72,891	44,616	28,275	39
WV	16,139	10,259	5,881	36
WI	77,447	47,205	30,242	39
WY	10,900	6,614	4,286	39

Figure 2.1.-1. FTP Bag 1 PM Emissions vs. Temperature, Tier 2 Vehicles

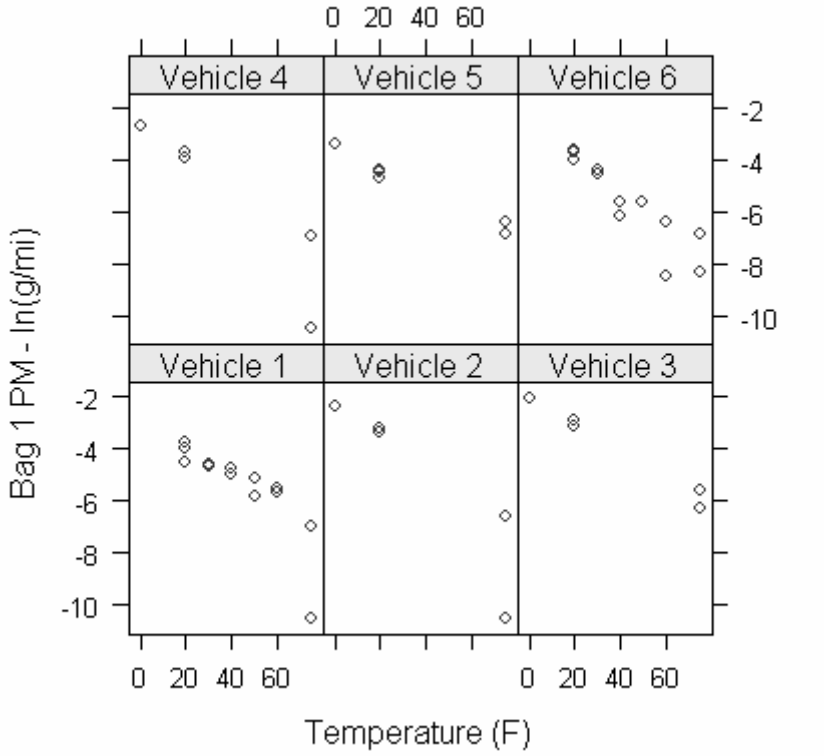
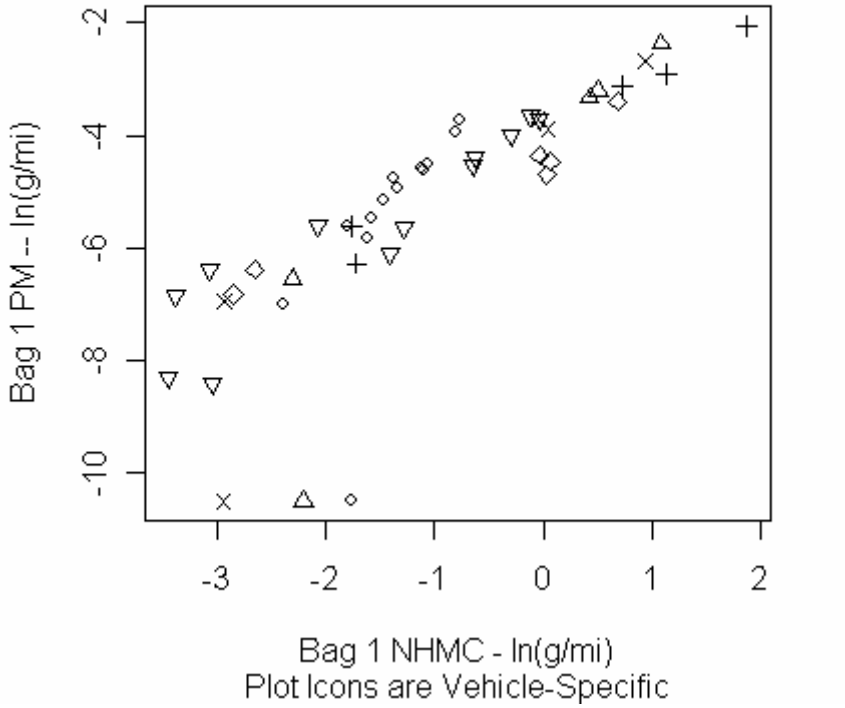


Figure 2.1.-2 illustrates the relationship between FTP Bag 1 NMHC and PM emission factors in this test program. Lower temperature tests are found to the upper right corner, corresponding to elevated emissions of both NMHC and PM. The symbol used for each data point represents the different vehicles in the test program. As shown, there is a clear, linear association. Thus, we concluded that estimated reductions in PM as a result of the hydrocarbon emission controls in this rule could be estimated by applying a PM to NMHC ratio to the estimated reduction in NMHC.

Figure 2.1.-2. FTP Bag 1 PM and FTP Bag 1 NMHC for Various Tier 2 Vehicles



In order to determine an appropriate PM/NMHC ratio for calculating PM reductions from NMHC reductions during cold start conditions, we employed mixed models with random vehicle terms.[10] We fit several models to the data, treating the PM/NMHC ratio as a dependent variable. In summary, the model fit to the data was:

$$\mathbf{Y} = \mu + \tau + \mathbf{b} + \mathbf{e}$$

Here, **Y** is a matrix of dependent variables (emission factors);

μ is the intercept term or "grand mean";

b is the change in emission factor associated with discrete testing temperatures;

τ is the vehicle effect, normally distributed around zero;

e is the random error term (normally distributed).

Tests in which temperature was treated as a continuous variable were also employed. Overall, the **b** term was found to be significant only at 75º testing, and this may have been due to random measurement errors in the PM/NMHC ratio as a result of very low emissions at 75º. The **b** term became insignificant when it was allowed to vary randomly by vehicle. In addition, because the proposed standards apply only to cold starting conditions, the effect on the ratio at 75º is not relevant to changes in overall emissions. Therefore, we used the mean PM/NMHC ratio of 0.022 to calculate the expected ancillary reductions in PM. The 95% confidence interval for the mean was 0.020 – 0.024.

Using this number, the expected reductions in PM from this rule are estimated to be 7,037 tons in 2015, 11,803 tons in 2020 and 20,096 tons in 2030. These calculations provide initial evidence that the potential public health impacts of this proposal are substantial.

In a subsequent test program in which the feasibility of the NMHC standards in today's proposal was demonstrated, the test vehicle exhibited substantial reductions in PM emission as well. These PM emission reductions at 20º F were of similar magnitude as those predicted by the above calculation. However, in that test program, the average PM/NHMC ratio was slightly smaller than in the SwRI test program. The vehicle tested in the feasibility program reflected a unique control technology that requires careful coordination among the engine air-fuel ratio and secondary air injection timing and air volume to provide the maximum emission benefits. The feasibility program was a "proof of concept" type study that did not have the ability to fully explore ideal control coordination and sizing of the emission control system. PM reductions would very likely have been even greater if this coordination was possible. The six current unmodified production vehicles tested in the SwRI test program are considered to be more representative of emission control technologies found throughout the fleet.

Several factors are not accounted for in the emission reduction estimation procedures, which adds uncertainty to the level of emission reductions reported here. First, if manufacturers employ control technologies that differ substantially from those in the SwRI test program, actual emission reductions could differ from the estimates here. Second, actual PM reductions may be affected by the extent to which different vehicle or engine technologies penetrate into the vehicle market (such as hybrid electric drivetrains and direct injection gasoline engines).

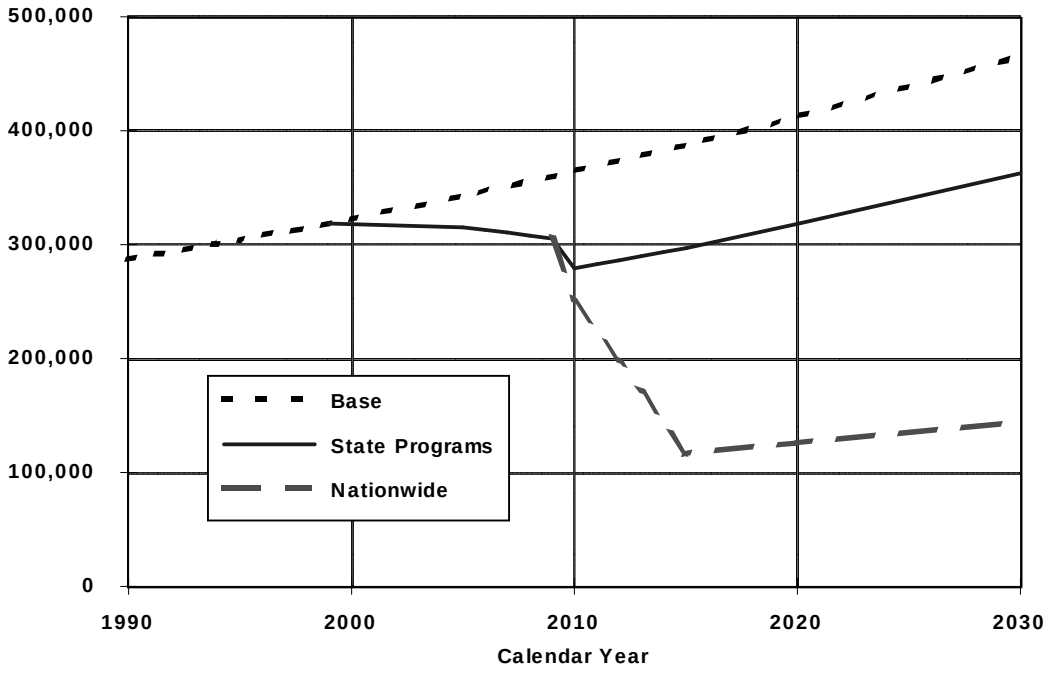
Portable Fuel Containers -- The portable fuel container controls proposed in this rule will also reduce emissions of hydrocarbons. As noted in Section 2.1.1.2, thirteen states plus the District of Columbia have adopted controls on PFCs independent of the controls proposed in this RIA. In Figure 2.1.-3, we have graphed the estimated annual national VOC emissions (in tons) associated with PFCs for the following three scenarios:

-- a base scenario in which no PFC controls are used illustrated with the dotted (black) line,

-- a scenario in which only those 13 states plus DC have implemented PFC controls illustrated with the solid (blue) line, and

-- a scenario in which the PFC controls proposed in this RIA are implemented nationwide illustrated with the dashed (red) line

Figure 2.1-3. Comparison of PFC Control Scenarios
Annual Nationwide VOC Emissions (Tons) from PFCs by Calendar Year



As noted in Section 2.1.1.2, the estimates of the VOC inventory in the basic scenario are increasing (annually) at a rate of about 1.21 percent. The scenario containing just the state programs has the estimated VOC inventory increasing at an annual rate of about 1.33 percent once all of the programs are phased in. Similarly, the scenario in which nationwide requirements (of this RIA) are phased in exhibit an annual increase in the VOC inventory of about 1.44 percent after phase-in.

Table 2.1.-11 compares the estimated national (annual) inventory of PFC-related VOC with the proposed control program to a reference case scenario that includes only State level controls.

Table 2.1.-11. Nationwide Annual Gas Can VOC Emissions (tons)

Calendar Year	With NO EPA PFC Controls	With EPA PFC Controls	Reduction
1999	318,596	NA	NA
2007	310,744	NA	NA
2010	279,374	250,990	28,384
2015	296,927	116,431	180,496
2020	318,384	125,702	192,683
2030	362,715	144,634	218,080

2.1.3 Strengths and Limitations of Criteria Pollutant Inventories

Light-Duty Gasoline Vehicles -- Emission factors for hydrocarbons in the MOBILE model are based on tens of thousands of tests under a wide variety of conditions, and account for leaking fuel systems, aggressive driving, air conditioner use and a variety of other parameters. These data are supported by over 50 technical reports, and many of them received extensive scientific peer review. The strengths and limitations of the MOBILE model have been evaluated by the Coordinating Research Council and the National Research Council.[11,12]

There are significant uncertainties in emission inventories resulting from the use of national default data rather than local inputs, as well as "top-down" allocation schemes in estimating toxic emissions. Examples include use of national default vehicle registration distributions, default average speed distributions, and use of county level population data to allocate State or urban level VMT.

Also, it should be noted that there are greater uncertainties in projection year estimates. Estimates of emissions from advanced technology vehicles and engines that will comply with planned future emission standards include assumptions regarding levels of emission deterioration and performance under various conditions. Also, vehicle miles traveled are estimated using economic projections with similar inherent limitations.

The revised estimates of cold start VOC emissions are based on a robust dataset at temperatures of 20ºF and above. At lower temperatures, however, data are more limited and the magnitude of cold temperature effects is not as certain. Similarly, the estimate of PM reductions from NMHC cold temperature controls are based on limited data, although PM shows a very strong correlation with NMHC. Future control strategies may also employ mechanisms that result in different PM/NMHC ratios than found in existing vehicles.

Portable Fuel Containers -- To estimate PFC inventories we were able to build on survey and test data collected by the California Air Resources Board. We also developed inventories using a "bottom up" approach which provides flexibility and permits very detailed fine-tuning of the various scenarios. However, the inventory involved many assumptions, including refueling activity and temperature effects. Spillage occurring when non-road equipment is refueled is a significant source of VOC emissions. We are assuming (from EPA's NONROAD model) that spillage is a constant 17 grams for each refueling event. We are also assuming that each refueling event occurs when the fuel tank on that piece of equipment is empty. However, if the user "tops off" the fuel tank prior to each use, then we are underestimating the total VOC emissions.

Another assumption relates to whether inactive PFCs are stored with fuel. For example, we assumed that a residence that uses a PFC to only fuel a lawn mower (perhaps six months of the year) will have that PFC empty the remainder of the year (i.e., no permeation or evaporative emissions). However, if that PFC were to contain a small amount of gasoline for those non-mowing months, then we are underestimating the total inventory.

Uncertainty in the characterization of the population of PFCs (i.e., commercial versus residential usage, open versus closed, metal versus plastic) is the major source of uncertainty in our estimates of the inventory of VOCs from PFCs. Our characterization of the population of PFCs is based on surveys performed by the Air Resources Board (ARB) of California. We used the same distribution of open versus closed PFCs determined by ARB. Since the rest of the country might not be exactly like California (relative to PFCs), we performed a sensitivity analysis to determine the effects of varying that distribution. We found that even relatively large changes in that distribution produced changes in estimated total VOC of less than 13 percent.[13] Other source of uncertainty include estimates of the frequency of refilling of containers, estimates of effects of ambient temperature on vapor displacement and spillage estimates of effects of RVP on vapor displacement, impacts of temperature of the fuel itself on emissions, and estimates of the amount of spillage during refilling.

2.2 Air Toxics

2.2.1 Emission Inventories Used in Air Quality Modeling

The data and methods employed to develop the county-level air toxics inventories used for air quality, exposure and risk modeling to support this rule are discussed in detail in the EPA Technical Report, "National Scale Modeling of Air Toxics for the Mobile Source Air Toxics Rule; Technical Support Document," Report Number EPA-454/R-06-002. In addition, the reference case emissions modeling (i.e., emissions modeling without proposed controls) has been externally peer-reviewed in a journal article currently in press.[14] All underlying data and summary statistics are included in the docket for this rule. The following sections summarize the methods used to develop these inventories and present results. While air quality, exposure, and risk modeling was done for years 1999, 2015, 2020, and 2030 (with modeling for 1999 done as the National Scale Air Toxics Assessment), reference case inventories were also developed for 2007 and 2010 in order to better assess emission trends over time. Inventories for 1990 and 1996 which are methodologically consistent with later year inventories are also discussed to put emission trends for later years into perspective. Control case modeling was done for proposed fuel benzene standards in 2015, 2020 and 2030. Inventories which included revised estimates of cold temperature hydrocarbon and air toxics emissions and portable fuel container emissions were not completed in time to be included in this modeling. For the reference case, we modeled all air toxic compounds listed in section 112 of the Clean Air Act for which we had adequate data to estimate emissions. Table 2.2.-1 lists the pollutants included in these inventories which were used in subsequent modeling of air quality, exposure, and risk. For the control case, we modeled a smaller subset of pollutants as discussed below. Emission inventories included stationary sources, highway vehicles, and nonroad equipment.

2.2.1.1 Methods Used to Develop Air Toxics Inventories for Air Quality Modeling

2.2.1.1.1 Highway Vehicles

For modeling calendar year 1999, we used the 1999 National Emissions Inventory (NEI), final version 3.[15] This inventory was also used in the 1999 National-Scale Air Toxics Assessment. This inventory estimated highway vehicle emissions using the MOBILE6.2 emission factor model.[16, 17] The 1999 NEI includes vehicle refueling emissions as part of the stationary source inventory; thus, in developing inventories for air quality, exposure and risk modeling these emissions were treated as stationary sources.

Within the MOBILE6.2 model, six MSATs (benzene, formaldehyde, acetaldehyde, 1,3 butadiene, acrolein, and methyl tertiary butyl ether [MTBE]) can be calculated directly by including detailed fuel parameters within the MOBILE6.2 scenario descriptions. These fuel parameters are: sulfur content, olefins content, aromatics content, benzene content, E200 value, E300 value, oxygenate content by type, and oxygenate sales fraction by type.[A] Since these fuel parameters are area-specific, EPA developed county-level inputs for each of these parameters by season. Fuel parameters were collected for winter and summer seasons using a number of different data sources. These sources include the Alliance of Automobile Manufacturers, Northrop Grumman Mission Systems (formerly TRW Petroleum Technologies), and EPA reformulated gasoline surveys. Documentation for the NEI describes the development of the fuel parameter database used with MOBILE6.2 in detail. The fuel parameter data through 1999 are posted at the following website:

ftp://ftp.epa.gov/EmisInventory/finalnei99ver3/haps/datafiles/onroad/auxiliary/

MOBILE6.2 also has a command (ADDITIONAL HAPS) which allows the user to enter emission factors or air toxic ratios for additional air toxic pollutants. Emission factors for the other HAPs in Table 2.2.-1 were calculated by MOBILE6.2 through the use of external data files specifying emission factors for these pollutants in one of three ways: as fractions of volatile organic compounds (VOC), fractions of PM, or by supplying the basic emission factors. The ratios used with this command must be expressed as milligrams of HAP per gram of VOC or PM. Gaseous hydrocarbons were estimated as fractions of VOC. Polycyclic aromatics hydrocarbons (PAHs) were calculated as fractions of PM, although the data used to calculate mass ratios included both gas and particle phase PAH emissions.

[A] E200 and E300, represent the percentage of vapor that gasoline produces at 200 and 300 ºF, respectively.

Table 2.2.-1. Air Toxics Included in Emission Inventories and Used for Air Quality, Exposure, and Risk Modeling.

1,3-Butadiene	Ethyl Benzene
2,2,4-Trimethylpentane	Fluoranthene
Acenaphthene	Fluorene
Acenaphthylene	Formaldehyde
Acetaldehyde	n-Hexane
Acrolein	Indeno(1,2,3,c,d)-pyrene
Anthracene	Manganese
Benzene	Methyl tert-butyl ether (MTBE)
Benz(a)anthracene	Naphthalene
Benzo(a)pyrene	Nickel
Benzo(b)fluoranthene	Phenanthrene
Benzo(g,h,i)perylene	Propionaldehyde
Benzo(k)fluoranthene	Pyrene
Chromium	Styrene
Chrysene	Toluene
Dibenzo(a,h)anthracene	Xylenes

Metals were estimated using basic emission factors. Evaporative emissions (e.g., toluene, xylenes) can only be estimated as fractions of VOC. Because toxic to VOC ratios for several gaseous HAPs vary between baseline gasoline and gasoline oxygenated with MTBE or ethanol, separate ADDITIONAL HAPS input files were developed for: 1) baseline gasoline; 2) gasoline oxygenated with 2% MTBE by weight (e.g., Federal reformulated gasoline); 3) gasoline oxygenated with 2.7% MTBE by weight (e.g., winter oxygenated gasoline); and 4) gasoline oxygenated with 3.5% ethanol by weight (gasohol). The documentation for the NEI provides more information on the development of HAP inventories using this command. ADDITIONAL HAPs inputs (including PAHs) for the 1999 NEI, final version 3 can be obtained at the same link given above for the final 1999 NEI fuel parameter files.

Although fuel parameter data were prepared for only two seasons (summer and winter), four seasonal scenarios were developed. The months corresponding to each season were selected to best coincide with seasonal fuel requirements. Summer fuel parameters were applied in the fall scenarios and winter fuel parameters were applied in the spring scenarios.

The number of MOBILE6.2 input files required to model all counties in a State were determined based on unique combinations of control programs and fuel parameters.

For counties where there was more than one fuel type sold, such as reformulated gasolines with MTBE and ethanol, two sets of MOBILE6.2 input files were developed, and resulting emission factors were weighted by gasoline market shares to derive overall county-level emission factors. The county level emission factors were multiplied by VMT from the Highway Performance Monitoring System (HPMS), as described in the documentation for the 1999 NEI. It should also be noted that California provided its own air toxic emissions estimates for 1999, which replaced those generated by EPA.

To develop projection year inventories for highway vehicles, we used NMIM.[18, 19] NMIM develops inventories using EPA's MOBILE6.2 emission factor model for highway vehicles, EPA's NONROAD emissions inventory model for nonroad equipment, and model inputs stored in data files. Model inputs include data such as temperatures, fuel properties, vehicle registration distributions, inspection and maintenance programs, vehicle miles traveled, and toxics inputs in the form of toxic to volatile organic compound (VOC) ratios, toxic to particulate matter (PM) ratios, or toxic emission factors. The toxics inputs were developed from a variety of emissions testing programs conducted by EPA, States, and industry over many years (see Section 2.2.1.1.6 for more information). Details on data sources can be found in the documentation for the National Emissions Inventory. Projection year fuel parameters were developed using results of several refinery modeling analyses conducted to assess impacts of fuel control programs on fuel properties.[20, 21, 22]

The projection year fuel parameters were calculated by applying adjustment factors to the base year parameters.[23] In addition, NMIM uses monthly rather than seasonal fuel parameters, and parameters for spring and fall months are estimated by interpolating from summer and winter data. Documentation of the fuel parameters used in NMIM was compiled in 2003 (Eastern Research Group, 2003), and subsequently, a number of changes were made, based on comments from States. These changes are documented in the change log for NMIM, dated May, 14, 2004. This change log is included in the docket for this rule, along with the original documentation. In general, multiplicative adjustment factors were used to calculate future year gasoline parameters (i.e., future year parameter = base year parameter x adjustment factor). However, additive adjustment factors were used to calculate future year parameters for E200, E300, and oxygenate market shares (i.e., future year parameter = base year parameter + adjustment factor). The database used for this assessment assumes no Federal ban on MTBE, but does include State bans. Also, it did not include the renewable fuels mandate in the recent Energy Policy Act. Vehicle miles traveled used in this assessment were those developed for the Clean Air Interstate Air Quality Rule (CAIR).[24]

NMIM outputs for 1999, 2007, 2010, 2015 and 2020 were used to develop ratios of future year to 1999 air toxic inventories. These were then applied to 1999 NEI inventory estimates by SCC, county and HAP:

$$PF_{20XX} = \frac{E_{NMIM,20XX}}{E_{NMIM,1999}} \qquad (1)$$

where PF_{20XX} is the projection factor for 2007, 2010, 2015, 2020, or 2030, E_{20XX} is the emissions for the corresponding year and E_{1999} is the 1999 emissions. NMIM results were provided for the following emission types – exhaust, non-refueling evaporative and refueling evaporative. E_{NMIM} was computed as the sum of non-refueling evaporative and exhaust emissions for pollutants with both an exhaust and evaporative emissions component (benzene, 2,2,4-trimethylpentane, naphthalene, toluene, xylenes, n-hexane, and ethylbenzene). Separate ratios were developed for each vehicle class, pollutant and county combination. In addition, separate ratios were developed for vehicle refueling, and these ratios were used to project refueling emissions in the stationary source inventory.

In cases where the 1999 NEI included aggregated or different categories other than those in NMIM, we aggregated NMIM results prior to applying ratios. For example, California reported heavy duty diesel vehicle (HDDV) emissions in the 1999 NEI as an aggregated HDDV "total" vehicle type rather than the specific HDDV classes (e.g., Class 2B, Class 3, 4, and 5). Thus, we aggregated NMIM HDDV results for California in order to apply a projection ratio to the HDDV "total" emissions. In the event that the NEI had HAPs not covered by NMIM (resulting from a state or local agency inventory submission), we developed ratios based on NMIM PM or VOC results.

For years 2015, 2020, and 2030, inventories were developed that reflected the impacts of the fuel benzene standard proposed in this rule. These control case inventories included the following pollutants: benzene, 1,3-butadiene, formaldehyde, acetaldehyde and acrolein. In MOBILE6.2, emissions of other pollutants are not affected by changes in fuel benzene or aromatics levels.

To develop these inventories, NMIM was rerun with revised gasoline fuel parameter inputs for fuel benzene and aromatics levels. These inputs were revised based on refinery modeling done for the rule. As part of the refinery modeling, average fuel properties under the new standards were estimated for each Petroleum Administration for Defense District (PADD). Average fuel benzene levels for conventional gasoline and reformulated gasoline in each PADD before and after implementation of the proposed standards were used to develop multiplicative factors which were applied to the reference case fuel benzene levels for each county in the NMIM database. These multiplicative factors are summarized in Table 2.2.-2. Although California is part of PADD5, it was treated separately, since California has its own reformulated gasoline program. The refinery modeling also indicated that the reduction in fuel benzene levels would result in small decreases in aromatics levels as well.[25] Thus aromatics levels were adjusted using the additive factors calculated as follows:

$$\text{Additive Factor} = 0.77*(BZ(\text{control}) - BZ(\text{ref})) \qquad (2)$$

Where BZ = benzene

An Excel workbook, designated "fuel changes.xls", summarizes the control and reference case fuel benzene and aromatics levels used for 2015, 2020, and 2030. This file is

included in the docket for the rule. We also checked the control case fuel benzene levels to make sure the nationwide average level was close to the proposed standard. We did this by weighting county fuel benzene level by VMT as a surrogate for fuel sales. The resulting nationwide average level was a little under 0.63%, very close to the standard. The refinery modeling methodology is discussed in Chapter 9 of the Regulatory Impact Analysis. Since the reduction in fuel benzene changes well below one percent of the gasoline, the level of uncertainty in the impacts on other fuel parameters and emissions is quite small.

Once fuel parameters were developed for the control case, NMIM was rerun with the same data files used in original reference case runs. Output included total exhaust and non-refueling evaporative emissions, exhaust emissions, non-refueling evaporative emissions, and refueling evaporative emissions. Projection factors for each emissions type, by gasoline vehicle class, county and pollutant, were calculated as follows:

$$PF_{20XX} = \frac{E_{NMIM\ Control20XX}}{E_{NMIM\ Reference20XX}} \qquad (3)$$

Table 2.2.-2. Average Fuel Benzene Level (Volume Percent) by PADD with Implementation of Proposed Fuel Benzene Standard (CG – Conventional Gasoline; RFG – Reformulated Gasoline)

		PADD 1	**PADD 2**	**PADD 3**	**PADD 4**	**PADD 5**	**Calif.**
Reference Case	CG	0.91 %	1.26%	0.95%	1.47%	1.42%	0.62%
	RFG	0.59%	0.80%	0.57%	1.05%	0.65%	0.62%
Control Case	CG	0.55%	0.68%	0.54%	0.93%	0.85%	0.61%
	RFG	0.54%	0.71%	0.55%	0.62%	0.60%	0.61%
Multiplicative Factor	CG	0.60	0.54	0.57	0.63	0.60	0.98
	RFG	0.92	0.89	0.96	0.59	0.92	0.98

PF_{20XX} is the projection factor for 2015, 2020, or 2030, and $E_{NMIM\ Control20XX}$ is the NMIM emissions for the control scenario. It includes exhaust and non-refueling evaporative emissions, but not refueling emissions. $E_{NMIMReference20XX}$ is the NMIM reference case MSAT emissions, and includes exhaust and non-refueling evaporative emissions, but not refueling emissions. Although vehicle refueling was estimated as part of the stationary source inventory, changes in MOBILE6.2 vehicle refueling emissions with fuel benzene

control were used to adjust the reference case refueling inventory to obtain the control case inventory.

2.2.1.1.2 Nonroad Equipment in the Nonroad Model

Nonroad equipment in the NONROAD model includes such sources as recreational, construction, industrial, lawn and garden, farm, light commercial, logging, airport service, railway maintenance, recreational marine vessels. For modeling calendar year 1999, we used the 1999 National Emissions Inventory (NEI), final version 3. This inventory used NONROAD2004, which was also used in the recent Clean Air Nonroad Diesel Rule.[26] As with highway vehicles, exhaust gaseous hydrocarbons were estimated as fractions of VOC, PAHs were calculated as fractions of PM, and metals were estimated using basic emission factors. Evaporative emissions were estimated as fractions of VOC. The projection of the portion of the nonroad inventory included in the NONROAD model followed a similar methodology as for the on-road. Projection factors were developed using the 1999 and future year NMIM runs and were applied to nonroad categories in the 1999 NEI. Retrospective inventories for nonroad equipment in1990 and 1996 are available at the same link given for the 1990 and 1996 highway inventories and are described in the documentation for the 1999 NEI.

Changes in fuel benzene and aromatics levels are expected to result in similar emission changes for nonroad gasoline equipment as for gasoline highway vehicles. However, NMIM does not have the capability to model impacts of these fuel changes on nonroad equipment emissions. Thus, we assumed that changes in county level exhaust emissions of nonroad gasoline equipment were proportional to changes in highway light duty gasoline vehicle exhaust emissions, and changes in county level evaporative emissions of nonroad gasoline equipment were proportional to changes in highway light duty gasoline vehicle evaporative (refueling and non-refueling) emissions:

$$PF\ nonroad\ exhaust_{20XX} = \frac{E_{LDGVexhaust\ NMIM\ Control\ 20XX}}{E_{LDGVExhaust\ NMIM\ Reference\ 20XX}} \quad (4)$$

$$PF\ nonroad\ evap_{20XX} = \frac{E_{LDGVevap\ NMIMControl20XX}}{E_{LDGVEvap\ NMIMReference20XX}} \quad (5)$$

2.2.1.1.3 Commercial Marine Vessels, Locomotives and Aircraft

These source sectors will not be impacted by the fuel benzene standards being proposed in this rule.

Emissions for these source sectors in 1999 were obtained from the 1999 National Emissions Inventory, Final Version 3. Gaseous air toxic and PAH emissions for turbine engine aircraft were estimated by applying toxic to VOC ratios obtained from detailed characterization of turbine engine emissions. Since no emissions data were available for

piston engine aircraft, a speciation profile from a non-catalyst light-duty gasoline vehicle was used as a surrogate. Metal emissions were not estimated for aircraft. No speciated emissions data were available for commercial marine vessels. For diesel marine vessels, profiles from heavy-duty diesel highway vehicles were used; for steamships, a profile for stationary and industrial boilers was used. Locomotive air toxic emissions were estimated using speciation data from a year 2000 study done by the California Air Resources Board.[27] More detailed information on methods used to develop air toxic inventories for these sectors can be found in the documentation for the 1999 NEI.[28] This documentation also describes methods used to develop inventories for 1990 and 1996.

The following approaches were used to project emissions for these source categories:

Locomotives and commercial marine vessels – For gaseous HAPs, inventories were developed by applying ratios of future year to 1999 national level 50 state VOC inventory estimates (from the recent Clean Air Nonroad Diesel rule) by SCC code. For polycyclic aromatic hydrocarbons, PM ratios were used. Metal inventory estimates were projected to future years based on activity. Locomotive activity was projected using fuel consumption data from the Energy Information Administration, as discussed in the Regulatory Impact Analysis for Clean Air Nonroad Diesel Rule. For commercial marine vessels, projected equipment populations from 1998 Power Systems Research (PSR) data were used to develop factors. The future year inventories do not account for potential reductions of additional locomotive or commercial marine vessel emission controls currently under consideration.

Aircraft – To project emissions from aircraft and from aviation gas distribution emissions, we developed and applied growth factors (in EMS-HAP) to 1999 emissions based on landing and take off data. The Federal Aviation Administration's Terminal Area Forecast System provided landing and take off data for future years up to 2020, associated with commercial aircraft, general aviation, air taxi and military aircraft.[29] These four categories map directly to the inventory categories for aircraft emissions. The landing and take off data were summed across airports to create growth factors at the national level. The general aviation growth factors were used for aviation gas distribution emissions. After 2020, activity was assumed to increase at the same rate as the increase from 2015 to 2020.

2.2.1.1.4 Stationary Sources

Stationary source estimates for 1990, 1996, and 1999 were obtained from the National Emissions Inventories for those years.[30,31, 32, 33]

For nearly all stationary sources (point and non-point source inventories), we used the Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP), Version 3.0 to apply growth and control factors to the 1999 NEI, source type by source type.[34] EMS-HAP has the capability of projecting emissions to 2020. After 2020, stationary source emissions were assumed to remain constant.

The general methodology for projecting stationary source emissions using EMS-HAP is as follows:

Future Year Emissions = Base Year Emissions * Growth Factor * (100% - % Reduction)/100

The actual equations used by EMS-HAP also allow the application of a "new source" reduction to a fraction of the emissions to allow for a different level of emission reduction to be applied to a portion of the emissions. In addition, if the source is already controlled, and the value of the overall control efficiency is provided in the emission inventory, EMS-HAP adjusts the percent reduction (% Reduction) based on the overall control efficiency value provided in the inventory. The actual projection equations are provided in Chapter 6 (PtGrowCntl) of the EMS-HAP User's Guide (U. S. EPA, 2004b, pp. 6-15 – 6-17).

Stationary source growth -- EMS-HAP allows growth factors to be applied to the inventory on either a national, state or county level basis, based on one of the following inventory codes that describe the source: (1) MACT, which identifies an emission source as a belonging to a particular regulatory category or subcategory; (2) Standard Industrial Classification (SIC), which classifies establishments by their primary type of activity, as defined by the U.S. Census Bureau; (3) Source Category Code (SCC), which defines the source using EPA's coding system for the NEI. The MACT and SCC code definitions are contained in the code tables supplied with the NEI. Note that even though the code is called "MACT", it is also used for other regulations besides MACT such as section 129 rules. The hierarchy built into EMS-HAP is to use a MACT-based growth factor first, followed by an SIC-based and lastly, an SCC-based growth factor. The most detailed geographic level is used first (e.g., a state-specific growth factor replaces a national growth factor). EMS-HAP does not have the capability to apply growth factors to specific point source facilities, nor can they be applied differently for the different pollutants for a particular source category.

For stationary sources, growth factors were developed using three primary sources of information:

- Regional Economic Models, Inc. (REMI) Policy Insight® model, version 5.5;[35, 36]
- Regional and National fuel-use forecast data from the Energy Information Administration, U.S. Department of Energy, Annual Energy Outlook (AEO)[37]
- Rule development leads or economists who had obtained economic information in the process of rule development.

The first two sources of information were also used in projecting criteria pollutant emissions for EPA's 2005 Clean Air Interstate Rule.[38]

More details on how these sources were used can be found in the EPA technical report, "National Scale Modeling of Mobile Source Air Toxic Emissions, Air Quality, Exposure and Risk for the Mobile Source Air Toxics Rule," cited previously.

For refueling emissions, which are related to mobile sources but inventoried as stationary sources, we developed SCC-based growth factors based on changes in refueling emissions predicted using MOBILE6.2.

Stationary source reductions -- Emission reductions were applied to the grown emissions to account for regulatory efforts which are expected to reduce HAPs from 1999 levels. The percent reductions we determined were primarily based on estimates of national average reductions for specific HAPs or for groups of HAPs from a source category or subcategory as a result of regulatory efforts. These efforts are primarily the MACT and section 129 standards, mandated in Title III of the 1990 Clean Air Act Amendments. We determined percent reductions, and whether they apply to major only or both major and area sources, for the various rules from rule preambles, fact sheets and through the project leads (questionnaire and phone calls). A major source is defined as any stationary source or group of stationary sources located within a contiguous area and under common control that has the potential to emit considering controls, in the aggregate, 10 tons per year or more of any hazardous air pollutant or 25 tons per year or more of any combination of hazardous air pollutants. For some rules, percent reductions were provided for specific HAPs or groups of HAPs (e.g., all metals, or all volatiles) rather than a single number for all HAPs in the categories. After 2010, stationary source emissions are based only on economic growth. They do not account for reductions from ongoing toxics programs such as the urban air toxics program, residual risk standards and area source program, which are expected to further reduce toxics.

Impact of Fuel Benzene Controls – The fuel benzene controls in this rule will reduce emission from vehicle refueling, and also emissions from gasoline distribution. Gasoline distribution emissions include emissions at bulk terminals, bulk plants, and service stations, and emissions during transport by trucks, marine vessels, and rail. Reductions in emissions from all these sources were assumed to be proportional to reductions in vehicle refueling emissions.

2.2.1.1.5 Precursor Emissions

In addition to the air toxics in Table 2.2.-1, emissions of a number of other compounds were estimated because they are precursor emissions which are atmospherically transformed into air toxics. These pollutants are listed in Table 2.2.-3, along with air toxic pollutants included in the inventory which can be transformed into other air toxics. Precursor emissions in 1999 were estimated by applying speciation profiles from SPECIATE to VOC estimates from version 2 of the 1999 NEI.[39] For mobile sources, precursor emissions were projected to future years using ratios of VOCs for future years versus 1999. Stationary source precursor emissions were assumed to remain at 1999 levels since the impact of growth and control is unknown.

2.2.1.1.6 Strengths and Limitations

Highway Vehicles – Limitations in the VOC and PM emission estimates which are the basis for calculating air toxic emissions are discussed in Section 2.1.3. MOBILE6.2 toxic to VOC ratios for key toxics from gasoline vehicles, such as benzene, 1,3-butadiene, formaldehyde and acetaldehyde, are based on almost 900 vehicle tests on a wide variety of fuels. These data account for impacts of emissions control technology, normal vs. high emitters, and impacts of a variety of fuel properties, including benzene. level, aromatics levels, olefin level, sulfur level, RVP, E200, E300, and oxygenate content.

However, there are a number of significant uncertainties in our highway vehicle air toxic inventories for air quality modeling. Among the uncertainties are:

- The Agency has limited emissions data for advanced technology highway vehicles, including hybrid and alternative technology vehicles. The toxic to VOC ratios in MOBILE6.2 are all based on Tier 0 and earlier vehicles. EPA has recently evaluated data on more recent technology vehicles and what might be the potential impacts of these data on inventories. The result of this analysis is discussed in Section 2.3.1.
- MOBILE6.2 uses the same toxic to VOC ratios for cold starts and hot running operation even though these ratios for benzene and 1,3-butadiene are higher during cold starts than hot running.
- We have a limited understanding of the impact of off-cycle operation on highway vehicle air toxic emissions.
- Data are limited for certain sources and pollutants not significant to this rule. For heavy-duty highway vehicles (both gasoline and diesel engines) the toxic to VOC ratios used in MOBILE6.2 to develop inventory estimates are based on very limited data. Moreover, we lack data on how diesel fuel properties impact air toxic emissions, and we have very little data on mobile source metal emissions.

There are also significant uncertainties resulting from the use of national default data rather than local inputs, as well as "top-down" allocation schemes in estimating toxic emissions. Examples include use of national default vehicle registration distributions, default average speed distributions, and use of county level population data to allocate State or urban level VMT. A recent paper evaluated the impacts of these default inputs and allocation schemes on local level inventories.[40]

Table 2.2.-3. Precursor Pollutants.

Pollutant	Precursor for	Pollutant	Precursor for
Acetaldehyde	Formaldehyde (reactive and inert)	Isoprene	Formaldehyde (reactive and inert)
1,3-Butadiene	Formaldehyde (reactive and inert), Acrolein (reactive and inert)	MTBE	Formaldehyde (reactive and inert)
1-Butene	Formaldehyde (reactive and inert), Propionaldehyde (reactive and inert)	Methanol	Formaldehyde (reactive and inert)
1-2,3-Dimethyl butene	Formaldehyde (reactive and inert)	1-Nonene	Formaldehyde (reactive and inert)
1-2-Ethyl butene	Formaldehyde (reactive and inert)	2-Nonene	Acetaldehyde (reactive and inert)
1-2-Methyl butene	Formaldehyde (reactive and inert)	1-Octene	Formaldehyde (reactive and inert)
1-3-Methyl butene	Formaldehyde (reactive and inert)	2-Octene	Acetaldehyde (reactive and inert)
2-Butene	Acetaldehyde (reactive and inert)	1-Pentene	Formaldehyde (reactive and inert)
2-2-Methyl butene	Acetaldehyde (reactive and inert)	1-2,4,4-Trimethyl pentene	Formaldehyde (reactive and inert)
1-Decene	Formaldehyde (reactive and inert)	1-2-Methyl pentene	Formaldehyde (reactive and inert)
Ethanol	Acetaldehyde (reactive and inert)	1-3-Methyl pentene	Formaldehyde (reactive and inert)
Ethene	Formaldehyde (reactive and inert)	1-4-Methyl pentene	Formaldehyde (reactive and inert)
1-Heptene	Formaldehyde (reactive and inert)	2-Pentene	Acetaldehyde (reactive and inert), Propionaldehyde (reactive and inert)
2-Heptene	Acetaldehyde (reactive and inert)	2-3-Methyl pentene	Acetaldehyde (reactive and inert)
1-Hexene	Formaldehyde (reactive and inert)	2-4-Methyl pentene	Acetaldehyde (reactive and inert)
2-Hexene	Acetaldehyde (reactive and inert)	Propene	Acetaldehyde (reactive), Acetaldehyde (inert), Formaldehyde (reactive and inert)
3-Hexene	Propionaldehyde (reactive and inert)	2-Methylpropene	Formaldehyde (reactive and inert)

Finally, as discussed in Section 2.1.3, there are greater uncertainties in projection year estimates.

Nonroad Equipment – The toxic to VOC ratios in NMIM for lawn and garden equipment, which makes the single largest contribution of any nonroad sector to the air toxics inventory, is supported by a large amount of test data. The VOC estimates for uncontrolled engines in the NONROAD model are based on a large amount of in-use test data and peer reviewed methodologies. Estimates for controlled engines are based on certification test data and emission standards. However, for a number of source categories—in particular heavy-duty diesel engines and aircraft engines--the toxic to VOC ratios used to develop inventory estimates are based on very limited data. In addition, the Agency has limited emissions data for nonroad equipment with emission controls. The Agency has been doing test data to address some of the limitations. This work is discussed in Sections 2.3.3 and 2.3.4. There are also significant uncertainties associated with allocating nonroad equipment emissions from the national to the local level. As with highway sources, future year inventories are more uncertain. Finally, the relationship between fuel parameters and emission rates for gasoline nonroad equipment is much more poorly understood than the relationship for highway gasoline vehicles. In our modeling, we assumed that the impacts of fuel control on emissions from nonroad equipment would be proportional to the impact on highway vehicle emissions, as discussed above.

Stationary Sources -- For the 1999 NEI, there are a number of known or suspected issues for stationary source emissions listed on the emission inventory website (U. S. EPA, 2004a). The issues listed are generally limited to specific geographic areas and are not expected to influence national-level results. Of these, it is expected that issues related to acrolein are most likely to affect the results for assessment of noncancer effects. Another uncertainty concerning the base year inventory is the proper identification of sources using the inventory codes. These codes are utilized for applying growth and reduction factors.

There are several uncertainties associated with the growth and reduction information. The growth information is uncertain for a number of reasons. For most sources, activity growth is used as a surrogate for emissions growth, which may not be appropriate for some industry sectors. In addition the growth information available is from economic models, is typically specific to broad industry categories, and is not resolved geographically for all categories. The stationary source reductions are uncertain because they are generally based on national-average reductions (although we have used facility-specific reductions where available). We do not expect this uncertainty to have an impact on national-level results.

As previously mentioned, after 2010, stationary source emissions are based only on economic growth. They do not account for reductions from ongoing toxics programs such as the urban air toxics program, residual risk standards and area source program, which are expected to further reduce toxics. Furthermore, the 2030 stationary source

inventory estimates are equal to the 2020 estimates, because of additional uncertainties in the available growth data past 2020 and the lack of knowledge of the effect of stationary source control programs that far into the future.

2.2.1.2 Trends in Air Toxic Emissions

2.2.1.2.1 Emission Trends Without Proposed Controls

In 1999, based on the National Emissions Inventory (NEI), mobile sources accounted for 44% of total emissions of 188 hazardous air pollutants (see Figure 2.2.-1). Diesel particulate matter is not included in this list of 188 pollutants. Sixty-five percent of the mobile source tons in this inventory were attributable to highway mobile sources, and the remainder to nonroad sources. Furthermore, over 90% of mobile source air toxic emissions are attributable to gasoline vehicles and equipment.

Overall, air toxic emissions are projected to decrease from 5,030,000 tons in 1999 to 4,010,000 tons in 2020, as a result of existing and planned emission controls on major, area, and mobile sources. In the absence of Clean Air Act emission controls currently in place, EPA estimates air toxic emissions would total 11,590,000 tons in 2020 (Figure 2.2-1). As indicated in Figure 2.2.-1, mobile source air toxic emissions will be reduced 60% between 1999 and 2020 without the controls in this proposal, from 2.2 million to 880,000 tons. This reduction will occur despite a projected 57% increase in vehicle miles traveled, and a 63% projected increase in nonroad activity (See Figures 2.2.-2 and 2.2.-3). It should be noted, however, that EPA anticipates mobile source air toxic emissions will begin to increase after 2020, from about 880,000 tons in 2020 to 920,000 tons in 2030. Benzene emissions from all sources decrease from about 347,000 tons in 1999 to 222,000 tons in 2020, and as is the case with total air toxic emissions, begin to increase slightly between 2020 and 2030 (Figure 2.2.-4).

None of the inventory trends data presented in this section includes revised estimates of emissions at cold temperature in vehicles, addition of emissions from portable fuel containers, and revisions in the gasoline distribution inventory used to estimate emission benefits of the rule and cost-effectiveness. These revisions are discussed in Section 2.2.2.

Figure 2.2.-1. Contribution of Source Categories to Air Toxic Emissions, 1990 to 2020 (not Including Diesel Particulate Matter). Dashed Line Represents Projected Emissions without Clean Air Act Controls.

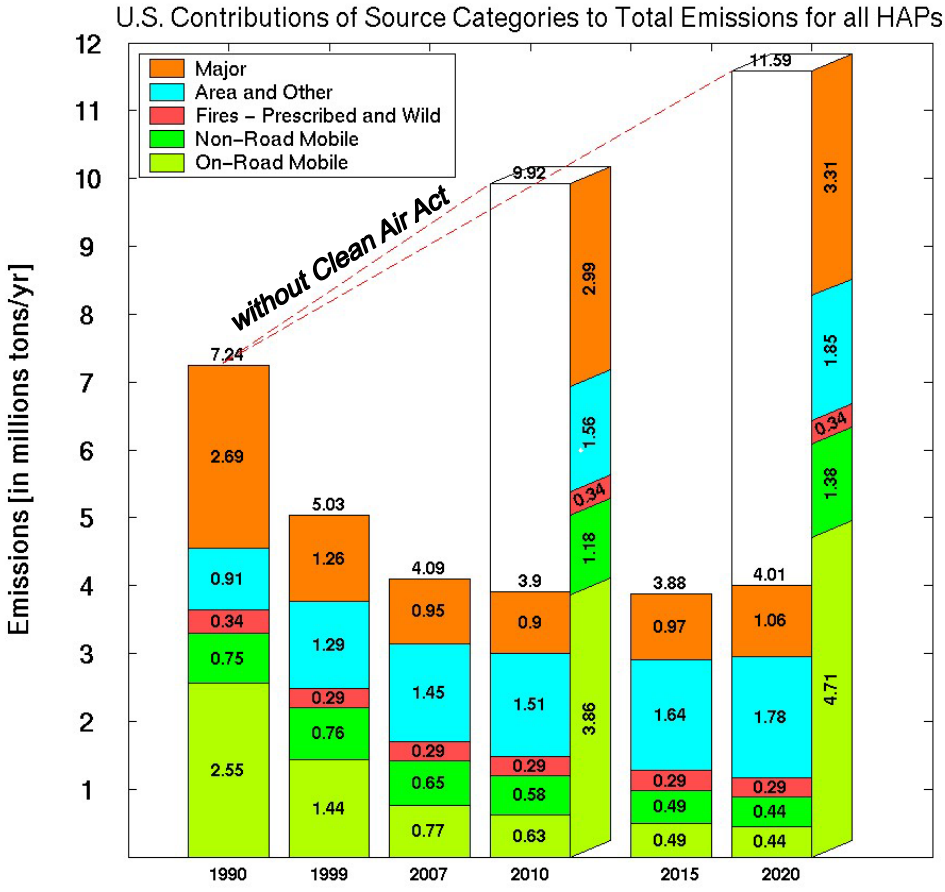


Figure 2.2.-2. Trend in Highway Vehicle Air Toxic Emissions Versus VMT, 1990 to 2030.

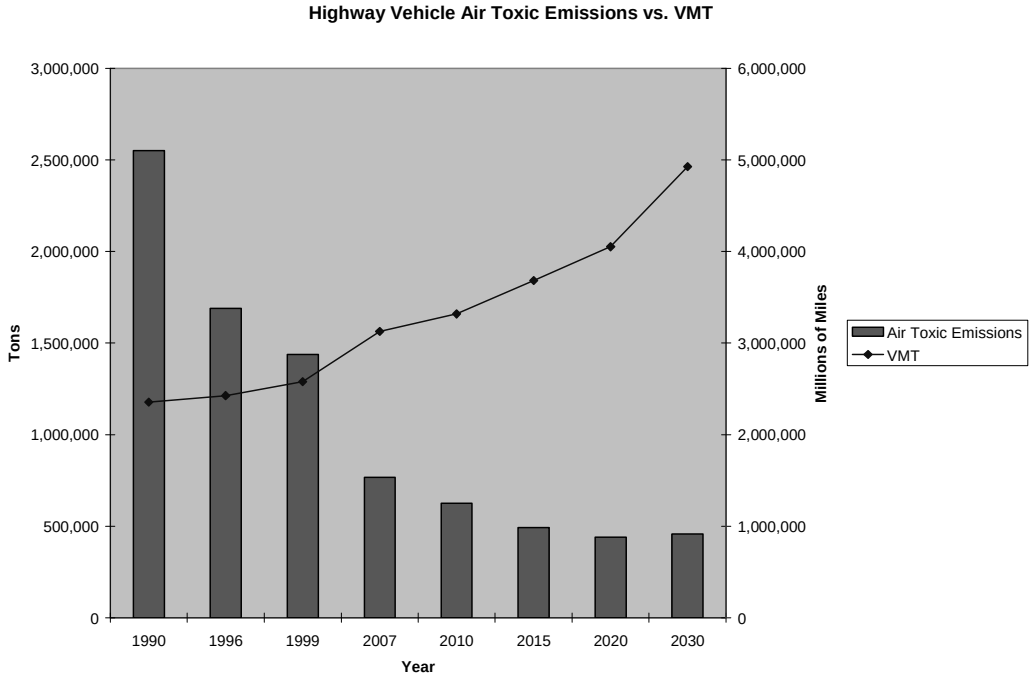


Figure 2.2.-3. Trend in Emissions of Nonroad Equipment Air Toxic Emissions (Excluding Commercial Marine Vessels, Locomotives and Aircraft) versus Activity, 1990 to 2030.

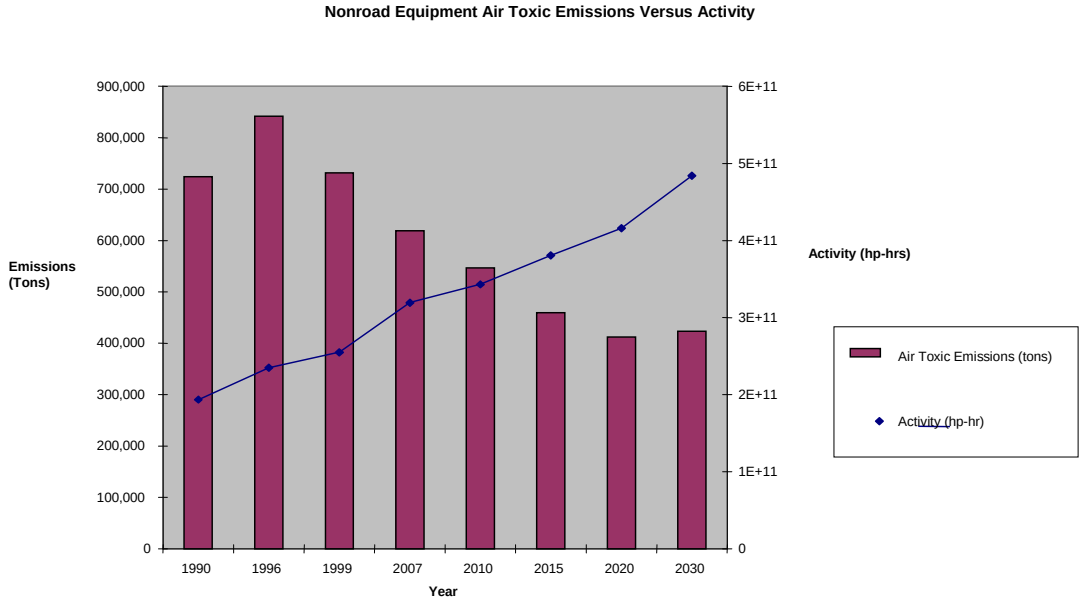
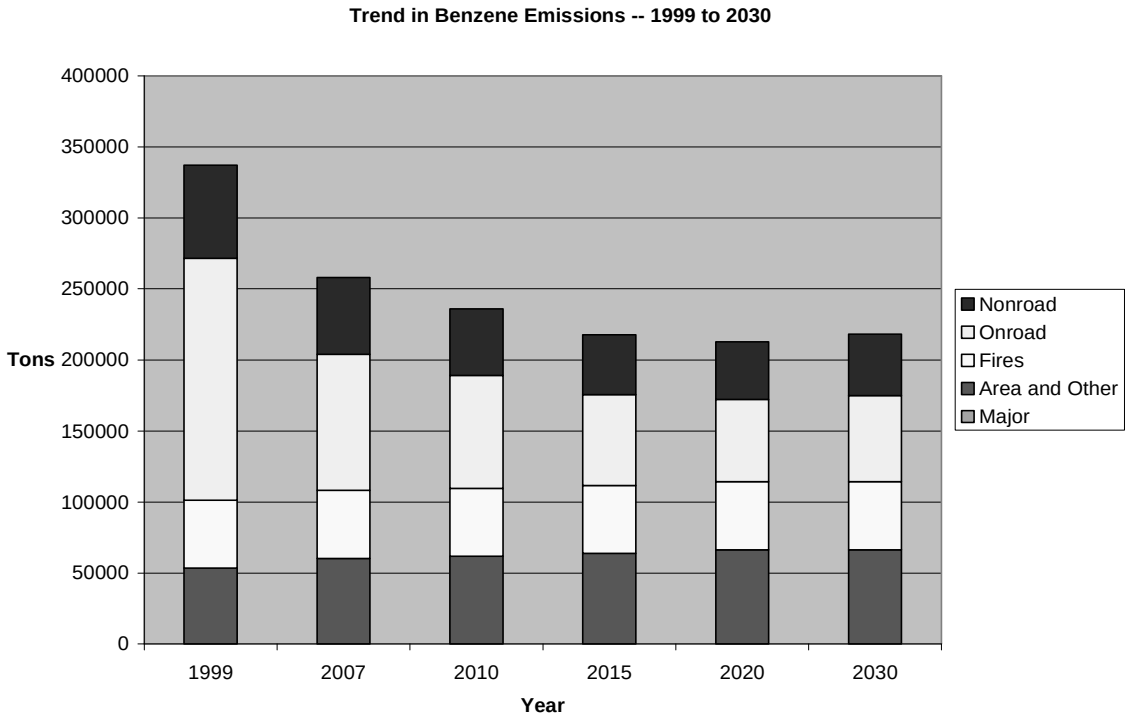


Figure 2.2.-4



Highway Vehicle Trends – Table 2.2.-3 summarizes nationwide emissions of individual air toxics from highway vehicles from 1999 to 2030. Fifteen POM compounds listed in Table 2.2.-1 (except for naphthalene) are grouped together as POM. For mobile sources, eighteen percent of the chromium was assumed to be the highly toxic hexavalent form, based on combustion data from stationary combustion turbines that burn diesel fuel.[41]

Table 2.2.-3. Nationwide Emissions (Tons) of Individual Air Toxic Pollutants from Highway Vehicles.

Pollutant	1999	2007	2010	2015	2020	2030
1,3-Butadiene	23623	10876	8807	6913	6468	6864
2,2,4-Trimethylpentane	166208	90621	73768	58013	51820	53786
Acetaldehyde	29928	17049	13909	11317	10721	11651
Acrolein	3993	1974	1570	1242	1170	1263
Benzene	170355	95766	79550	63920	58109	60660
Chromium VI	4	5	5	6	6	8
Ethyl Benzene	69480	37951	30838	24165	21472	22229
Formaldehyde	80677	40168	32240	26150	24879	27188
n-Hexane	65164	43107	35832	27727	23087	23292
MTBE	82570	33458	28026	21124	16117	15225
Manganese	16	20	22	25	28	36
Naphthalene	3978	2490	2229	2007	1976	2255
Nickel	16	19	20	23	26	32
POM	460	256	228	208	211	243
Propionaldehyde	4209	2343	1953	1621	1553	1693
Styrene	13168	6570	5284	4200	3910	4132
Toluene	456344	242800	196528	154225	138365	143714
Xylenes	267324	142123	115004	90182	80799	83948

Table 2.2.-4 summarizes total tons of air toxic emissions from highway vehicles by vehicle class in 1999, 2007, 2010, 2015, 2020, and 2030. Table 2.2.-5 provides the percentage of total highway vehicle emissions associated with each vehicle class. In 1999, 54% of air toxic emissions from highway vehicles were emitted by light duty gasoline vehicles (LDGVs) and 37% by light duty trucks (LDGTs). EPA projects that in 2020, only 27% of highway vehicle HAP emissions will be from LDGVs and 63% will be from LDGTs. More detailed summaries of emissions by individual pollutant, by State, and for urban versus rural area can be found in Excel workbooks included in the docket for this rule.

Table 2.2.-4. Tons of Air Toxic Emissions from Highway Vehicle Classes, 1999 to 2030 (Not Including Diesel Particulate Matter).

Vehicle Type	Emissions (tons/yr)					
	1999	2007	2010	2015	2020	2030
HDDV	38,534	26,923	23,707	20,570	20,435	23,336
HDGV	80,227	35,096	24,838	17,342	13,666	12,023
LDDT	1,279	766	617	552	491	402
LDDV	977	139	60	34	23	22
LDGT1	342,839	239,534	208,636	177,486	170,855	179,122
LDGT2	186,078	139,447	126,396	114,204	105,843	102,085
LDGV	778,772	317,021	232,547	153,050	118,762	128,305
MC	8,826	8,691	9,035	9,854	10,673	12,957
Total Highway	**1,437,532**	**767,617**	**625,836**	**493,092**	**440,748**	**458,252**

HDDV: Heavy Duty Diesel Vehicles
HDGV: Heavy Duty Gasoline Vehicles
LDDT: Light Duty Diesel Trucks
LDDV: Light Duty Diesel Vehicles
LDGT1: Light Duty Gasoline Trucks 1
LDGT2: Light Duty Gasoline Trucks 2
LDGV: Light Duty Gasoline Vehicles
MC: Motorcycles

Table 2.2.-5. Percent Contribution of Vehicle Classes to Highway Vehicle Air Toxic Emissions, 1999 to 2020 (Not Including Diesel Particulate Matter).

Vehicle	1999	2007	2010	2015	2020	2030
LDGV	54%	41%	37%	31%	27%	28%
LDGT1 and 2	37%	49%	53%	59%	63%	61%
HDGV	6%	5%	4%	4%	3%	3%
HDDV	3%	4%	4%	4%	5%	5%
Other (motorcycles and light duty diesel vehicles and trucks)	1%	1%	1%	2%	2%	3%

Tables 2.2.-6 through 2.2.-11 summarize total tons of emissions nationwide for benzene, 1,3-butadiene, formaldehyde, acetaldehyde, naphthalene, and acrolein from highway vehicles. About 87% of benzene emissions from gasoline vehicles were in exhaust, with the remainder in evaporative and refueling emissions. Benzene emissions from diesel vehicles were all exhaust. There are no evaporative emissions of 1,3-butadiene, formaldehyde, acetaldehyde, and acrolein.

Table 2.2.-6. Tons of Benzene Emissions from Highway Vehicle Classes, 1999 to 2030.

	Emissions (tons/yr)					
Vehicle Type	**1999**	**2007**	**2010**	**2015**	**2020**	**2030**
HDGV	7967	4041	2970	2152	1760	1539
HDDV	2674	1872	1650	1434	1426	1628
LDDT	167	100	82	74	67	57
LDDV	120	17	7	4	3	3
LDGT1	42433	30773	27498	23835	23346	24856
LDGT2	20638	17701	16805	15694	14897	14505
LDGV	95591	40478	29722	19835	15643	16895
MC	764	784	817	892	967	1177
Total Highway	170355	95766	79550	63920	58109	60660

Table 2.2.-7. Tons of 1,3-Butadiene Emissions from Highway Vehicle Classes, 1999 to 2030.

	Emissions (tons/yr)					
Vehicle Type	**1999**	**2007**	**2010**	**2015**	**2020**	**2030**
HDGV	1507	483	260	130	103	84
HDDV	1430	995	877	760	755	859
LDDT	64	38	31	29	26	23
LDDV	44	6	3	1	1	1
LDGT1	5132	3218	2801	2307	2291	2447
LDGT2	3483	1919	1735	1524	1503	1486
LDGV	11743	3983	2855	1895	1500	1614
MC	220	234	244	266	288	350
Total Highway	23623	10876	8807	6913	6468	6864

Table 2.2.-8. Tons of Formaldehyde Emissions from Highway Vehicle Classes, 1999 to 2030.

	Emissions (tons/yr)					
Vehicle Type	**1999**	**2007**	**2010**	**2015**	**2020**	**2030**
HDGV	6648	2242	1309	741	599	498
HDDV	19887	13921	12272	10663	10601	12109
LDDT	495	297	238	211	186	148
LDDV	391	56	24	14	9	9
LDGT1	14907	8540	6787	5572	5516	5975
LDGT2	9809	5264	4164	3628	3513	3509
LDGV	27957	9239	6811	4628	3705	4028
MC	582	609	635	693	751	912
Total Highway	80677	40168	32240	26150	24879	27188

Table 2.2.-9. Tons of Acetaldehyde Emissions from Highway Vehicle Classes, 1999 to 2030.

	Emissions (tons/yr)					
Vehicle Type	**1999**	**2007**	**2010**	**2015**	**2020**	**2030**
HDGV	1569	722	465	297	245	209
HDDV	7568	5310	4682	4071	4049	4633
LDDT	200	120	96	84	73	57
LDDV	164	24	10	6	4	4
LDGT1	5766	3947	3265	2714	2682	2899
LDGT2	3433	2411	2023	1789	1726	1710
LDGV	11057	4311	3155	2123	1690	1831
MC	171	204	214	233	253	309
Total Highway	29928	17049	13909	11317	10721	11651

Table 2.2.-10. Tons of Acrolein Emissions from Highway Vehicle Classes, 1999 to 2030.

	Emissions (tons/yr)					
Vehicle Type	**1999**	**2007**	**2010**	**2015**	**2020**	**2030**
HDGV	714	177	79	25	18	12
HDDV	807	561	494	429	425	483
LDDT	24	14	12	11	10	9
LDDV	16	2	1	1	0	0
LDGT1	661	434	368	306	302	326
LDGT2	357	255	222	198	191	188
LDGV	1396	511	374	251	199	215
MC	18	19	20	22	24	29
Total Highway	3993	1974	1570	1242	1170	1263

Table 2.2.-11. Tons of Naphthalene Emissions from Highway Vehicle Classes, 1999 to 2030.

	Emissions (tons/yr)					
Vehicle Type	**1999**	**2007**	**2010**	**2015**	**2020**	**2030**
HDGV	752	540	388	241	189	170
HDDV	172	98	67	33	20	16
LDDT	6	3	2	1	1	1
LDDV	7	1	0	0	0	0
LDGT1	766	612	645	702	774	906
LDGT2	491	260	268	274	281	316
LDGV	1758	950	831	726	678	807
MC	26	27	28	30	33	40
Total Highway	3978	2490	2229	2007	1976	2255

Nonroad Equipment Trends -- Table 2.2.-12 summarizes nationwide emissions of individual air toxics from nonroad equipment, from 1999 to 2030. The lead emissions in the table are from piston engine aircraft, which use leaded gasoline. Table 2.2.-13 summarizes total tons of air toxic emissions from categories of nonroad equipment by equipment type in 1999, 2007, 2010, 2015, 2020, and 2030. Table 2.2.-14 provides the percentage of total nonroad equipment emissions associated with each equipment type. Air toxic emissions from nonroad equipment are dominated by lawn and garden equipment, recreational equipment, and pleasure craft, which collectively account for almost 80% of nonroad HAP emissions in all years. More detailed summaries of emissions by individual pollutant, by State, and for urban versus rural area can be found in Excel workbooks included in the docket for this rule.

Table 2.2.-12. Nationwide Emissions of Individual Air Toxics from Nonroad Equipment, from 1999 to 2030.

	Annual Total Nonroad Emissions (tons)					
Pollutant	**1999**	**2007**	**2010**	**2015**	**2020**	**2030**
1,3-Butadiene	9718	7906	6799	6298	6237	6765
2,2,4-Trimethylpentane	94546	81056	71985	59516	51944	51957
Acetaldehyde	23479	19333	17390	15425	14516	14988
Acrolein	3083	2655	2496	2360	2330	2505
Benzene	65360	54232	46951	42031	40444	43252
Chromium VI	4	4	4	4	4	5
Ethyl Benzene	42731	36719	32395	27587	25260	26660
Formaldehyde	56254	45526	41214	36911	34979	36320
n-Hexane	28765	25230	22784	19872	18451	19464
Lead	550	551	565	587	609	654
MTBE	24338	10922	9569	8819	8664	9459
Manganese	5	6	6	7	7	8
Naphthalene	1254	1236	1214	1258	1318	1465
Nickel	34	36	38	39	41	45
POM	356	320	302	290	284	300
Propionaldehyde	4735	3792	3358	2956	2765	2827
Styrene	4254	3604	3091	2735	2606	2802
Toluene	205186	192855	173428	143943	125562	127370
Xylenes	193016	160347	140968	118662	107495	112660

Table 2.2.-13. Tons of Air Toxic Emissions from Nonroad Equipment Types, 1999 to 2030 (Not Including Diesel Particulate Matter).

	Emissions (tons/yr)					
Equipment type	**1999**	**2007**	**2010**	**2015**	**2020**	**2030**
Agriculture	23,098	15,954	13,476	10,546	8,530	7,129
Aircraft	14,276	14,315	14,965	16,081	17,256	19,603
Airport Support	421	311	251	206	191	205
Commercial	46,990	33,732	27,281	29,004	31,451	36,981
Commercial Marine Vessel	8,736	9,557	9,742	10,213	10,973	13,354
Construction	39,675	25,138	21,702	17,937	15,609	14,303
Industrial	14,559	7,456	5,114	3,157	2,573	2,382
Lawn/Garden	196,257	115,652	99,485	101,535	109,328	125,823
Logging	3,816	2,325	2,339	2,394	2,562	3,054
Pleasure Craft	258,190	172,930	144,245	122,057	111,936	108,260
Railroad	4,416	4,143	3,984	3,896	3,758	3,531
Recreational	146,526	244,129	231,291	171,593	128,661	124,142
Underground Mining	176	155	138	112	100	104
Total Nonroad	759,565	647,754	575,831	490,454	444625	460,627

Table 2.2.-14. Contribution of Equipment Types to Nonroad Air Toxic Emissions, 1999 to 2020 (not Including Diesel Particulate Matter).

Equipment Type	1999	2007	2010	2015	2020	2030
Lawn and Garden	26%	18%	17%	21%	25%	27%
Pleasure Craft	34%	27%	25%	25%	25%	24%
Recreational	19%	38%	40%	35%	29%	27%
All Others	21%	17%	18%	19%	21%	22%

Almost 90% of nonroad toxic emissions are from 2-stroke and 4-stroke gasoline engines, with the remainder from diesel engines and turbine engine aircraft. Similarly, almost 90% of benzene emissions from nonroad equipment are from gasoline engines, and these emissions would be reduced by a fuel benzene standard.

Tables 2.2.-15 through 2.2.-20 summarize total tons of emissions nationwide for benzene, 1,3-butadiene, formaldehyde, acetaldehyde, naphthalene, and acrolein from nonroad equipment types.

Table 2.2.-15. Tons of Benzene Emissions from Nonroad Equipment Types, 1999 to 2030.

	Emissions (tons/yr)					
Equipment Type	**1999**	**2007**	**2010**	**2015**	**2020**	**2030**
Agriculture	2203	1569	1323	1058	877	744
Aircraft	1102	1114	1163	1247	1335	1511
Airport Support	44	33	26	21	20	22
Commercial	6809	5323	4206	4529	4964	5906
Commercial Marine Vessel	644	705	719	753	809	982
Construction	3601	2310	1957	1639	1450	1348
Industrial	1976	986	633	368	291	258
Lawn/Garden	20451	14729	12112	12039	12960	14941
Logging	267	185	180	177	187	221
Pleasure Craft	20304	14177	12113	10507	9787	9598
Railroad	162	150	144	140	134	125
Recreational	7781	12938	12365	9544	7622	7587
Underground Mining	15	13	12	10	9	9
Total Nonroad	65360	54232	46951	42031	40444	43252

Table 2.2.-16. Tons of 1,3-Butadiene Emissions from Nonroad Equipment Types, 1999 to 2030.

	Emissions (tons/yr)					
Equipment Type	**1999**	**2007**	**2010**	**2015**	**2020**	**2030**
Agriculture	243	176	148	120	101	85
Aircraft	824	821	859	924	993	1131
Airport Support	7	5	3	3	3	3
Commercial	1140	892	683	738	813	972
Commercial Marine Vessel	6	6	6	6	6	7
Construction	407	259	214	182	165	156
Industrial	302	143	88	50	39	33
Lawn/Garden	3423	2445	1933	1887	2030	2342
Logging	44	29	29	29	31	36
Pleasure Craft	2071	1423	1201	1018	928	895
Railroad	114	107	104	102	99	94
Recreational	1136	1600	1530	1238	1029	1009
Underground Mining	1	1	1	1	1	1
Total Nonroad	9718	7906	6799	6298	6237	6765

Table 2.2.-17. Tons of Formaldehyde Emissions from Nonroad Equipment Types, 1999 to 2030.

	Emissions (tons/yr)					
Equipment Type	**1999**	**2007**	**2010**	**2015**	**2020**	**2030**
Agriculture	9816	6671	5630	4288	3363	2749
Aircraft	6549	6505	6809	7333	7885	8990
Airport Support	139	105	90	71	63	65
Commercial	3418	2907	2435	2236	2131	2128
Commercial Marine Vessel	4715	5153	5252	5499	5899	7152
Construction	12417	8958	7742	5937	4779	4074
Industrial	3046	1790	1404	963	832	837
Lawn/Garden	6867	4727	3830	3678	3856	4371
Logging	432	248	214	167	155	163
Pleasure Craft	4136	2848	2447	2105	1932	1879
Railroad	1901	1793	1730	1690	1629	1529
Recreational	2731	3743	3562	2890	2404	2333
Underground Mining	87	77	68	55	50	51
Total Nonroad	56254	45526	41214	36911	34979	36320

Table 2.2.-18. Tons of Acetaldehyde Emissions from Nonroad Equipment Types, 1999 to 2030.

Equipment Type	Emissions (tons/yr)					
	1999	2007	2010	2015	2020	2030
Agriculture	4493	3058	2581	1966	1542	1260
Aircraft	2019	2004	2098	2259	2430	2770
Airport Support	63	49	42	33	29	30
Commercial	1400	1270	1071	975	920	906
Commercial Marine Vessel	2364	2588	2639	2768	2974	3619
Construction	5723	4138	3578	2745	2210	1883
Industrial	1350	857	676	459	389	381
Lawn/Garden	2478	1920	1548	1480	1546	1748
Logging	176	102	85	62	55	55
Pleasure Craft	1703	1179	1002	854	782	757
Railroad	853	805	776	758	731	686
Recreational	820	1330	1264	1041	886	870
Underground Mining	39	34	31	25	22	23
Total Nonroad	23479	19333	17390	15425	14516	14988

Table 2.2.-19. Tons of Acrolein Emissions from Nonroad Equipment Types, 1999 to 2030.

Equipment Type	Emissions (tons/yr)					
	1999	2007	2010	2015	2020	2030
Agriculture	285	194	164	125	98	81
Aircraft	968	960	1005	1083	1165	1329
Airport Support	6	4	4	3	3	3
Commercial	156	127	105	99	98	102
Commercial Marine Vessel	98	109	112	118	129	161
Construction	392	280	241	186	151	130
Industrial	119	71	55	38	33	34
Lawn/Garden	388	252	207	201	212	241
Logging	16	9	8	7	7	8
Pleasure Craft	316	212	179	152	139	134
Railroad	131	124	120	117	113	107
Recreational	206	312	295	228	180	176
Underground Mining	2	2	2	1	1	1
Total Nonroad	3083	2655	2496	2360	2330	2505

Table 2.2.-20. Tons of Naphthalene Emissions from Nonroad Equipment Types, 1999 to 2030.

Equipment Type	Emissions (tons/yr)					
	1999	2007	2010	2015	2020	2030
Agriculture	49	36	32	26	21	15
Aircraft	456	475	496	530	566	638
Airport Support	1	1	1	1	1	1
Commercial	98	106	98	108	119	142
Commercial Marine Vessel	65	69	68	72	79	102
Construction	61	46	42	32	23	16
Industrial	30	18	15	9	6	4
Lawn/Garden	261	245	224	232	251	289
Logging	4	4	4	4	4	5
Pleasure Craft	112	103	100	101	104	110
Railroad	61	51	44	42	40	35
Recreational	56	81	90	101	105	109
Underground Mining	0	0	0	0	0	0
Total Nonroad	1254	1236	1214	1258	1318	1465

Diesel Particulate Matter -- If diesel particulate matter emissions were added to the mobile source total mass of air toxic emissions, mobile sources would account for 48% of a total 5,398,000 tons in 1999. Table 2.2.-21 summarizes the trend in diesel particulate matter between 1999 and 2030, by source category. As controls on highway diesel engines and nonroad diesel engines phase in, diesel-powered locomotives and commercial marine vessels increase from 11% of the inventory in 1999 to 27% in 2020.

Table 2.2.-21. Percent Contribution of Mobile Source Categories to Diesel Particulate Matter Emissions, 1999 to 2020 in Tons Per Year (Percent of Total).

Source	1999	2007	2010	2015	2020
Highway Vehicles	144,000 (39%)	85,000 (33%)	63,000 (30%)	38,000 (25%)	30,000 (26%)
Commercial Marine Vessels	20,000 (5%)	19,000 (7%)	18,000 (8%)	17,000 (11%)	17,000 (15%)
Locomotives	21,000 (6%)	18,000 (7%)	15,000 (7%)	14,000 (9%)	14,000 (12%)
Other Nonroad Equipment	183,000 (50%)	134,000 (52%)	118,000 (55%)	83,000 (55%)	53,000 (46%)

2.2.1.2.2 Impact on Inventory of Proposed Fuel Benzene Control

The fuel benzene control proposed in this rule would reduce benzene emissions from highway gasoline vehicles, nonroad gasoline equipment, gasoline distribution and portable fuel containers. The total benzene emissions reduced in the inventories used for

air quality modeling for these sectors are 12,800 tons, or 6 percent of the national benzene inventory from all sources. It should be emphasized that the air quality, exposure and risk modeling inventory underestimates the total emissions benefit since it does not account for portable fuel container emissions and underestimates cold temperature emissions for highway vehicles. For inventories which include these emissions, see Section 2.2.2.2.

Table 2.2.-22 summarizes the nationwide impact of the proposed benzene standard on emissions of key air toxics from highway vehicles in 2015, 2020, and 2030. Although EPA's MOBILE emissions model estimates very small increases in emissions of 1,3-butadiene, formaldehyde, and acetaldehyde, the reductions in benzene emissions are dramatic, roughly 11 to 12%. Similar impacts are projected for nonroad equipment (Tables 2.2.-23 and 2.2.-24). In addition, fuel benzene controls would reduce emissions within the gasoline distribution sector, and during vehicle refueling. Table 2.2.-25 presents estimated reductions for these sources in 2015 and 2020, which total over 2000 tons per year. These vehicle refueling and gasoline distribution reductions are also based on inventory projections from the 1999 NEI, as discussed above. However, subsequent to the air quality, exposure and risk modeling for this rule, new emission estimates for this sector were released as part of the 2002 NEI[42]. These revisions are discussed in Section 2.2.2, and were used in developing estimates of emission benefits for this rule. More detailed summaries of emissions by individual pollutant, by State, and for urban versus rural area can be found in Excel workbooks included in the docket for this rule.

Table 2.2.-22. Nationwide Impact of the Proposed Benzene Control on Emissions of Key Air Toxics from Highway Vehicles in 2015, 2020, and 2030.

	Annual Emissions (tons) by Vehicle Type								
Pollutant	**2015 Reference Case**	**2015 Control Case**	**2015 Reduction**	**2020 Reference Case**	**2020 Control Case**	**2020 Reduction**	**2030 Reference Case**	**2030 Control Case**	**2030 Reduction**
1,3-Butadiene	6913	6926	-14	6468	6480	-13	6864	6877	-13
Acetaldehyde	11317	11336	-19	10721	10738	-17	11651	11669	-18
Acrolein	1242	1242	0	1170	1170	0	1263	1263	0
Benzene	63920	56596	7324	58109	51711	6398	60660	54154	6506
Formaldehyde	26150	26195	-45	24879	24921	-41	27188	27231	-43
5 MSAT Total	**109542**	**102295**	**7247**	**101347**	**95020**	**6327**	**107626**	**101194**	**6433**

Table 2.2.-23. Nationwide Impact of the Proposed Benzene Control on Emissions of Key Air Toxics from all Nonroad Equipment in 2015, 2020, and 2030.

	Annual Emissions (tons) by Vehicle Type								
Pollutant	**2015 Reference Case**	**2015 Control Case**	**2015 Reduction**	**2020 Reference Case**	**2020 Control Case**	**2020 Reduction**	**2030 Reference Case**	**2030 Control Case**	**2030 Reduction**
1,3-Butadiene	6298	6310	-12	6237	6249	-12	6765	6778	-13
Acetaldehyde	15425	15435	-10	14516	14525	-9	14988	14998	-10
Acrolein	2360	2360	0	2330	2330	0	2505	2505	0
Benzene	42031	37531	4500	40444	36022	4422	43252	38489	4763
Formaldehyde	36911	36940	-29	34979	35007	-28	36320	36350	30
5 MSAT Total	**103025**	**98576**	**4449**	**98505**	**94132**	**4373**	**103830**	**99120**	**4710**

Table 2.2.-24. Nationwide Impact of the Proposed Benzene Control on Emissions of Key Air Toxics from Gasoline Nonroad Equipment in 2015, 2020, and 2030.

Annual Emissions (tons) for Gasoline Nonroad Equipment									
Pollutant	**2015 Reference Case**	**2015 Control Case**	**2015 Reduction**	**2020 Reference Case**	**2020 Control Case**	**2020 Reduction**	**2030 Reference Case**	**2030 Control Case**	**2030 Reduction**
1,3-Butadiene	5071	5083	-12	4982	4994	-12	5401	5413	-13
Acetaldehyde	3663	3672	-10	3558	3567	-9	3807	3817	-10
Acrolein	632	632	0	591	591	0	625	625	0
Benzene	37747	33247	4500	36440	32018	4422	39163	34399	4763
Formaldehyde	9423	9452	-29	9103	9131	-28	9740	9770	-30
5 MSAT Total	**56535**	**52087**	**4448**	**54675**	**50302**	**4373**	**58736**	**54025**	**4711**

Table 2.2.-25. Nationwide Impact of the Proposed Controls on Emissions of Benzene from Vehicle Refueling and Gasoline Distribution in 2015 and 2020 (2030 Assumed to be the Same as 2020).

	2015 Reference Case	2015 Control Case	2015 Reduction	2020 Reference Case	2020 Control Case	2020 Reduction
Vehicle Refueling	724	459	265	720	459	261
Gasoline Distribution	5419	3663	1756	5606	3804	1802

2.2.2 Emission Reductions from Proposed Controls

Section 2.2.2 describes revisions made to emission inventories subsequent to development of MSAT inventories for air quality modeling. These include revised estimates of emissions at cold temperature in vehicles, addition of emissions from portable fuel containers, and revisions in the gasoline distribution inventory to reflect changes made for the 2002 National Emissions Inventory. The revised inventories were used to estimate emission benefits of the rule and cost-effectiveness.

2.2.2.1 Methodology Changes from Air Quality Inventories

2.2.2.1.1 Highway Vehicles

Section 2.1.1.1 describes the changes made to hydrocarbon emission rates in MOBILE6.2 to reflect the higher measured emissions during cold starts at cold temperature for Tier 1 and later vehicles. Since the algorithms used to calculate toxic to hydrocarbon emission ratios in MOBILE6.2 do not vary with temperature, reductions in hydrocarbon emissions result in proportional reductions in air toxic emissions.

The assumption in MOBILE6.2 that reductions in air toxic emissions are proportional to hydrocarbon emission reductions was based on testing done at temperatures ranging from -20 to 75 ºF in EPA's Office of Research and Development in the late 1980's.[43, 44] These studies found that, overall, the composition of hydrocarbon emissions did not vary appreciably with temperature, although fractions of formaldehyde increased somewhat with lower temperature in port fuel injected vehicles. The validity of the assumption was re-evaluated for later model vehicles.

EPA's Office of Research and Development recently tested several later model vehicles as the same temperature ranges cited above.[45,46,47] The results of the test program are unpublished, but are included in the docket for the rule. Vehicles included in the test program were a 1993 Chevrolet Cavalier, a 1987 and 1993 Ford Taurus, a 1996 Chrysler Concord, a 2001 Ford Focus, a 1993 Buick Regal, and a 2001 Dodge Intrepid. This test program found increasing emissions of individual air toxics at lower temperatures. Benzene and 1,3-butadiene emissions increased proportionally with hydrocarbon emissions, with a very strong correlation. However,

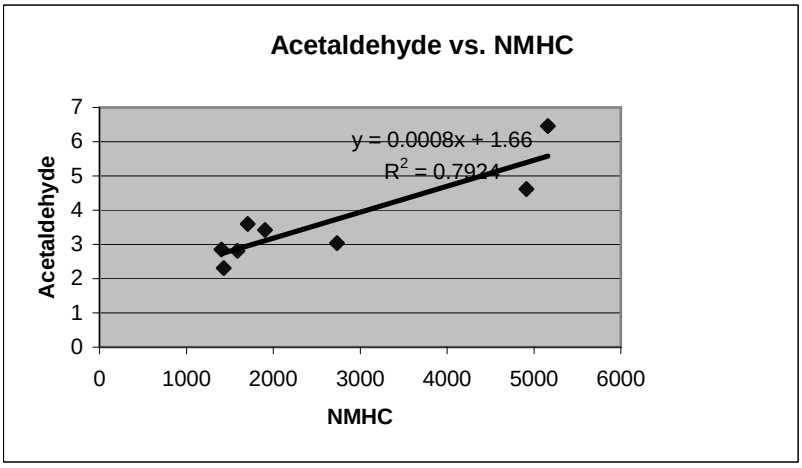
correlations were not as strong with aldehydes. Results from the 1993 Cavalier and 1993 Taurus found a statistically significant correlation for acetaldehyde but not for formaldehyde, whereas analysis of data from the other vehicles found a correlation for formaldehyde but not acetaldehyde.

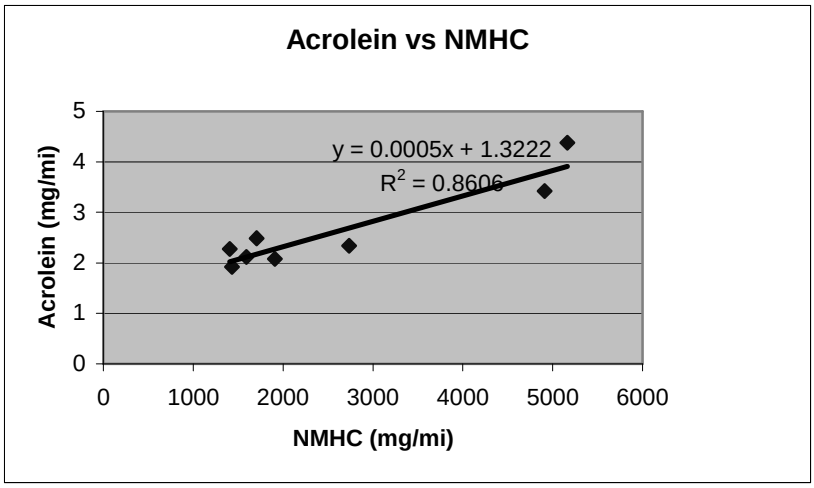
A major vehicle manufacturer also recently tested two Tier 2 compliant vehicles at 75 and 20 ºF. Although the data are confidential, they show emission of air toxics increase at the same rate as hydrocarbons, with a very high correlation.

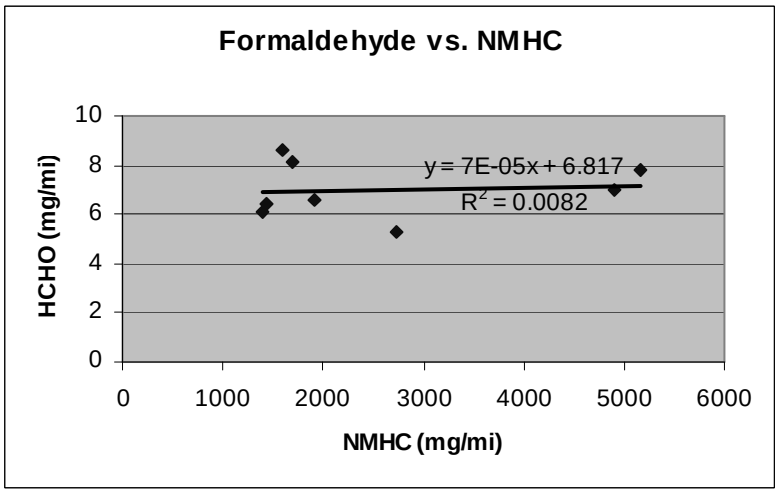
A third source of data is testing done by Southwest Research Institute for U. S. EPA, Office of Transportation and Air Quality on four model year 2005 vehicles – a Ford F-150, a Mazda 3, a Honda Odyssey and a Chevrolet Equinox.[48] The four vehicles were tested at 0, 20 and 75 ºF. Benzene and 1,3-butadiene correlated very strongly with hydrocarbon emissions, with r-square values above 0.9. Benzene accounted for about 3.6 percent of exhaust non-methane hydrocarbon emissions at all temperatures, while 1,3-butadiene accounted for about 0.3%. However, formaldehyde and acetaldehyde fractions appeared to decrease with decreasing temperature. When data for the largest vehicle, the Ford F-150, were removed, there seemed to a stronger correlation between aldehyde emissions and non-methane hydrocarbons. This could be because this larger engine is running richer during cold starts than the other vehicles, and not enough oxygen is available for aldehyde formation.

Recent EPA testing of a Chevrolet Trailblazer, with its engine recalibrated to meet the proposed cold temperature standard, showed reductions in acetaldehyde and acrolein proportional to the reduction in VOC. Formaldehyde was also reduced, but was not reduced as much as acetaldehyde and acrolein. Other air toxic compounds, including benzene, were not included in this testing. Figure 2.2.-5 depicts the relationship between carbonyl compounds and NMHC.

Figure 2.2.-5. Regressions of Carbonyl Emissions Versus NMHC for Chevrolet Trailblazer Recalibrated to Meet Cold Temperature Standard.







Given available data, we have concluded it is reasonable to retain the assumption that ratios of toxic emissions to hydrocarbon emission do not vary with temperature. However, as more data become available, this assumption should be reevaluated, particularly for aldehydes.

2.2.2.1.2 Nonroad Equipment

No changes were made from the inventory estimates of nonroad equipment that were developed for air quality modeling. In estimating the emission reductions from proposed controls, no changes were made from the inventory estimates, with and without the proposed fuel benzene control, developed for air quality modeling. It should be noted, however, that EPA recently released newer versions of NONROAD and NMIM, NONROAD2005 and NMIM2005 that include a number of significant revisions.[49,50] Most importantly, there are new evaporative categories for tank permeation, hose permeation, hot soak, and running loss emissions. If these revisions were included in the estimation of emission reductions from the proposed fuel benzene control, the estimated reductions would be larger.

2.2.2.1.3 Portable Fuel Containers

Any MSATs contained in the liquid gasoline will be present as a component of the VOCs associated with the PFCs. Specifically, the VOC emissions (estimated in Sections 2.1.1.2 and 2.1.3) will contain the following eight MSATs:

-- benzene
-- MTBE
-- n-hexane
-- toluene
-- xylenes
-- ethylbenzene
-- naphthalene
-- 2,2,4-trimethylpentane

We estimated only nationwide emission totals for all MSATs except benzene, where State level totals were estimated.

For all compounds except benzene and MTBE, the fraction of total PFC emissions that is composed of each of those HAPs is assumed to be directly proportional to the ratio of each of those HAPs in total evaporative emissions from light-duty gasoline vehicles. These ratios were obtained from the database of toxic to VOC ratios in the NMIM model, discussed in previous sections. NMIM has ratios that vary by fuel type (conventional or baseline gasoline, ethanol oxygenated gasoline, and MTBE oxygenated gasoline). Based on the sales of the various gasoline blends, we generated the ratios given in Table 2.2.-26.

Table 2.2.-26. Ratios of Pollutants to Total Evaporative VOC Emissions.

Pollutant Name	Baseline	10% Gasohol	MTBE Gasoline	Weighted Ratios
Naphthalene	0.0004	0.0004	0.0004	0.0004
Ethyl Benzene	0.0077	0.0045	0.0063	0.0067
Toluene	0.0413	0.0195	0.0276	0.0337
n-Hexane	0.0234	0.0096	0.0087	0.0175
2,2,4-Trimethylpentane	0.0158	0.0158	0.0158	0.0158
Xylenes	0.0223	0.0119	0.0188	0.0192

In this table, the weighted ratios are based on the estimate that the nationwide distribution of gasoline is 58.3 percent baseline, 23.5 percent gasohol (i.e., E10), and the

remainder (18.2 percent) oxygenated with MTBE. This estimate is based on 2003 sales data for ethanol oxygenated gasoline compiled by the Federal Highway Administration, estimates of reformulated gasoline sales from the Energy Information Administration, and estimates of the amount of MTBE oxygenated gasoline sold as part of the Federal Reformulated Gasoline Program from Federal Reformulated Gasoline surveys.[51, 52]

Because of the localized use of MTBE in gasoline, we used a different approach to estimate nationwide emissions of this pollutant. The nationwide quantity of MTBE emitted by PFCs by permeation or evaporation was estimated based on the ratio of nationwide MTBE refueling emissions in the 2002 NEI to total VOC refueling emissions. The resulting ratio was 0.024. Since several States have eliminated the use of MTBE in reformulated gasoline, and further reductions in the use of MTBE are anticipated in the future, this approach likely overestimates MTBE emissions from PFCs in future years.

Another approach was used to estimate emissions of benzene with and without PFC control, and also with and without the fuel benzene standard proposed in this rule. We assumed that the fraction of PFC emissions that is benzene is proportional to the benzene fraction in refueling emissions. First, we divided State-level benzene refueling emissions by State-level VOC refueling emissions estimated by NMIM, for both reference and control case scenarios. The resultant ratios were multiplied by VOC emissions from evaporation, vapor displacement, and spillage.

A separate ratio was used for permeation emissions since recent research suggests that the ratio of benzene from permeation is higher than for evaporation, vapor displacement or spillage. Thus, we also needed to split the "permeation plus evaporation" estimates in Table 2.1.-1. Analyses (referenced in Section 2.1.1.2) suggest that the permeation emissions account for 33.87 percent of the combined permeation plus evaporation for the sealed PFCs. As noted, a recent study[53] suggests that the ratio of benzene from permeation to total VOC from permeation is about 1.7727 times higher than the ratio associated with evaporation. Thus, we multiplied the benzene refueling ratios for each state by 1.7727 to obtain the benzene to VOC ratios for permeation.

It should be noted that because the PFC inventories for air toxics include emissions spillage while refueling nonroad equipment, and because estimates of nonroad equipment evaporative emissions in NONROAD also include this source of emissions, there is some double counting of overall air toxics emissions and emission benefits from fuel benzene control (This is not an issue for estimates of VOCs). However, the spillage component of evaporative emissions in NONROAD is significantly smaller than the estimates in the PFC inventory, and the double counting accounts for well under 1% of the total emission benefits of fuel benzene control.

2.2.2.1.4 Gasoline Distribution

Subsequent to the development of the gasoline distribution inventories used in the modeling of air quality, exposure, and risk from mobile source air toxics, EPA improved its methodology for estimating gasoline distribution emissions in the 2002 National Emissions Inventory (NEI). The key changes were:

1) Vehicle refueling emissions were estimated as part of the highway vehicle inventory using NMIM. Details of how the modeling was done can be found in the documentation for the mobile source 2002 NEI.[54] The previous methodology is described in the nonpoint 1999 NEI documentation.[55] IN this older method, national VOC emissions were calculated using fuel sales data and estimates of emissions per fuel volume in areas with and without Stage 2 vapor recovery systems. Air toxic emissions were estimated from VOC by applying speciation profiles for different fuel types, such as baseline gasoline, MTBE oxygenated gasoline, and ethanol oxygenated gasoline. Total emissions for each combination of vapor recovery system and fuel type were allocated to individual counties using vehicle miles traveled.

2) For all other source categories in the gasoline distribution sector, EPA used an improved set of methods. These improvements include: (a) for source categories where activity-based emission factors were available (all except bulk terminals and pipelines), EPA established methods that maintain mass balance for storage and transfer activities, such that there is agreement with the activity estimates used for each of the different distribution sectors; (b) EPA developed criteria pollutant and air toxic emission estimates using the same activity data and a consistent set of speciation profiles; and (c) EPA accounted for local differences in fuel properties for downstream emissions (e.g. bulk plants, transit, unloading, storage, Stage 1 evaporative losses). More details on these improvements can be found in a technical memorandum on the website for the 2002 NEI.[56]

The results of these changes were a significant increase in the air toxic inventory estimates for vehicle refueling and a small increase nationwide for other sources of gasoline distribution emissions. County-level estimates for some gasoline distribution sources changed considerably since local differences in fuel properties were accounted for. Table 2.2.-27 compares benzene estimates in the 1999 NEI, final version 3, and the final 2002 NEI.

Table 2.2.-27. Vehicle Refueling and Gasoline Distribution Benzene Emissions (Tons), 1999 and 2002 NEI.

	1999 NEI	2002 NEI	% Difference
Vehicle Refueling	1558	2129	+36
Gasoline Distribution	4978	5119	+3

In order to develop better estimates of the emission benefits of the proposed fuel benzene control in this rule, EPA developed updated air toxic inventories for vehicle refueling and gasoline distribution to reflect the changes made in the 2002 NEI. The changes were made as follows:

1) Vehicle refueling emissions were estimated using NMIM projections. Refueling emissions were estimated for reference case inventories in 1999, 2007, 2010, 2015, 2020 and 2030. Control case inventories were estimated for 2015, 2020 and 2030.

2) For other gasoline distribution emissions, for each air toxic pollutant, EPA estimated a national-scale adjustment factor as follows:

   Adjustment factor = 2002 NEI national emissions/2002 national emissions estimated from interpolation of the 1999 NEI and the 2007 projection for air quality, exposure and risk modeling

3) EPA developed new county level reference case inventories for these pollutants by applying these adjustment factors to county-level gasoline distribution emissions. Revised inventories were developed for years 1999, 2007, 2010, 2015, 2020, and 2030.

4) EPA developed new control case inventories for gasoline distribution, for benzene, for years 2015, 2020, and 2030. These revised county level inventories were estimated by applying the following ratios:

   emissions original control scenario/emissions original reference case

2.2.2.2 Estimated Reductions for Air Toxic Pollutants of Greatest Concern

2.2.2.2.1 Fuel Benzene Standard

Highway Gasoline Vehicles – The proposed fuel benzene standard will reduce emissions from light-duty gasoline vehicles and trucks, motorcycles, and heavy-duty gasoline trucks. Tables 2.2-28, 2.2.-29, and 2.2.-30 present nationwide benzene emissions for these vehicle classes with and without the proposed fuel standard in 2015, 2020, and 2030. Total benzene emissions from these vehicle classes were 178,000 tons in 1999. Since impacts of fuel benzene control on emissions of other MSATs are negligible (see Section 2.2.1.2), they are not presented here, although they are available in the docket for the rule.

Table 2.2.-28. Impact of Fuel Benzene Control on Benzene Emissions from Highway Vehicle Classes, 2015.

Vehicle Class	Reference Case Tons	Control Case Tons	Reduction
LDGV	39,485	35,253	4,232
LDGT1	41,796	37,296	4,500
LDGT2	20,074	17,834	2,240
MC	728	626	102
HDGV	1,715	1,503	212

Table 2.2.-29. Impact of Fuel Benzene Control on Benzene Emissions from Highway Vehicle Classes, 2020.

Vehicle Class	Reference Case Tons	Control Case Tons	Reduction
LDGV	37,635	33,730	3,905
LDGT1	47,352	42,391	4,961
LDGT2	21,083	18,822	2,261
MC	787	677	110
HDGV	1,399	1234	165

Table 2.2.-30. Impact of Fuel Benzene Control on Benzene Emissions from Highway Vehicle Classes, 2030.

Vehicle Class	Reference Case Tons	Control Case Tons	Reduction
LDGV	44,871	40,271	4,600
LDGT1	56,290	50,520	5,770
LDGT2	23,737	21,245	2,492
MC	947	816	131
HDGV	1,213	1067	146

Reductions from the proposed fuel benzene control vary significantly across the U.S., depending on the average level of benzene in gasoline sold, as discussed in Section 2.2.1.2 on air quality modeling inventories. Table 2.2.-31 summarizes impacts of fuel benzene control on the benzene emission inventory for gasoline vehicles in each State in 2030.

Table 2.2.-31. Impacts of Fuel Control on Gasoline Vehicle Benzene by State in 2030.

State	2030 Reference Case Tons	2030 Control Case Tons	2030 Tons Reduced	% Change
ALABAMA	2183	1961	222	10
ALASKA	1270	879	390	31
ARIZONA	1936	1783	153	8
ARKANSAS	1275	1137	138	11
CALIFORNIA	9115	8489	625	7
COLORADO	2870	2503	367	13
CONNECTICUT	1023	1009	13	1
DELAWARE	281	277	4	1
DISTRICT OF COLUMBIA	122	120	2	1
FLORIDA	4220	3754	466	11
GEORGIA	4210	3821	389	9
HAWAII	194	193	1	0
IDAHO	1224	1039	185	15
ILLINOIS	4744	4359	385	8
INDIANA	3895	3426	469	12
IOWA	1704	1471	233	14
KANSAS	1833	1548	285	16
KENTUCKY	2351	2083	268	11
LOUISIANA	1543	1364	179	12
MAINE	765	731	34	4
MARYLAND	1860	1809	51	3
MASSACHUSETTS	1874	1849	25	1
MICHIGAN	6974	6030	944	14
MINNESOTA	4129	3480	649	16
MISSISSIPPI	1000	890	110	11
MISSOURI	3439	3018	421	12
MONTANA	1057	904	153	14
NEBRASKA	1195	1022	174	15
NEVADA	1086	1034	51	5
NEW HAMPSHIRE	797	769	27	3
NEW JERSEY	2068	2041	27	1
NEW MEXICO	1402	1169	234	17
NEW YORK	6601	6236	365	6
NORTH CAROLINA	3738	3363	375	10
NORTH DAKOTA	656	553	103	16
OHIO	5263	4597	666	13
OKLAHOMA	1942	1740	202	10
OREGON	3190	2684	507	16
PENNSYLVANIA	5023	4685	338	7
RHODE ISLAND	271	268	3	1
SOUTH CAROLINA	2034	1837	197	10
SOUTH DAKOTA	619	534	85	14
TENNESSEE	2896	2612	284	10
TEXAS	6544	5949	595	9
UTAH	1473	1276	197	13
VERMONT	541	500	41	8
VIRGINIA	3061	2891	170	6
WASHINGTON	4450	3709	741	17
WEST VIRGINIA	792	700	92	12
WISCONSIN	3657	3253	404	11
WYOMING	671	571	100	15

Gasoline Nonroad Equipment – Table 2.2.-24 summarizes the nationwide impact of the proposed fuel benzene control on benzene emissions from gasoline nonroad equipment. As with highway gasoline vehicles, emission benefits vary across the U. S. As can be seen in Table 2.2.-32, these benefits vary from 1 to 32% by State in 2030.

Portable Fuel Containers –Table 2.2.-33 summarizes MSAT emissions from PFCs with no fuel benzene or Federal PFC control (but including State control programs). The proposed fuel benzene control will reduce benzene emissions from portable fuel containers. Table 2.2.-34 summarizes the nationwide impact of fuel benzene control on PFC benzene emissions. Again, emission benefits vary across the U. S., as seen in Table 2.2.-35.

Gasoline Distribution – Table 2.2.-36 presents revised national reference case inventory estimates for gasoline distribution. Vehicle refueling emissions are included in the highway vehicle inventory. Table 2.2.-37 presents the benzene inventory from gasoline distribution (not including refueling) in 2015 and 2020 with and without the proposed fuel benzene control. Table 2.2.-38 presents the inventory for 2020 at the State level with and without proposed fuel benzene control. More detailed inventory estimates by county are available in the docket for the rule.

Table 2.2.-32. Gasoline Nonroad Equipment Emission Reductions (Tons) from Proposed Fuel Control by State, 2030.

State	2030 Reference Case	2030 Control Case	2030 Reductions	% Change
ALABAMA	707	605	102	14
ALASKA	160	109	51	32
ARIZONA	631	561	70	11
ARKANSAS	443	375	68	15
CALIFORNIA	3018	2705	314	10
COLORADO	578	493	85	15
CONNECTICUT	468	459	8	2
DELAWARE	132	130	3	2
DISTRICT OF COLUMBIA	20	19	0	2
FLORIDA	3085	2662	424	14
GEORGIA	1136	987	148	13
HAWAII	102	102	1	1
IDAHO	279	229	49	18
ILLINOIS	1371	1266	104	8
INDIANA	763	653	110	14
IOWA	452	375	77	17
KANSAS	364	298	66	18
KENTUCKY	514	441	73	14
LOUISIANA	782	650	131	17
MAINE	288	269	19	6
MARYLAND	739	707	32	4
MASSACHUSETTS	756	742	14	2
MICHIGAN	1829	1521	308	17
MINNESOTA	1055	873	182	17
MISSISSIPPI	450	377	73	16
MISSOURI	856	734	122	14
MONTANA	153	128	25	17
NEBRASKA	248	204	43	17
NEVADA	242	221	20	8
NEW HAMPSHIRE	237	221	16	7
NEW JERSEY	1118	1097	21	2
NEW MEXICO	203	164	40	19
NEW YORK	2050	1920	129	6
NORTH CAROLINA	1187	1023	164	14
NORTH DAKOTA	128	105	24	18
OHIO	1542	1298	244	16
OKLAHOMA	486	411	76	16
OREGON	589	483	107	18
PENNSYLVANIA	1496	1368	128	9
RHODE ISLAND	111	109	2	2
SOUTH CAROLINA	641	549	91	14
SOUTH DAKOTA	124	103	21	17
TENNESSEE	793	682	111	14
TEXAS	3378	2978	400	12
UTAH	350	296	54	15
VERMONT	113	101	12	11
VIRGINIA	839	780	58	7
WASHINGTON	869	708	161	19
WEST VIRGINIA	249	212	37	15
WISCONSIN	934	807	128	14
WYOMING	104	86	18	17

Table 2.2.-33. MSAT Emissions (Tons) from Uncontrolled PFCs.

Pollutant	1999	2007	2010	2015	2020	2030
2,2,4-Trimethylpentane	5023	4899	4405	4682	5020	5719
Benzene	2229	2254	2118	2262	2423	2757
Ethylbenzene	2132	2080	1870	1987	2131	2428
n-Hexane	5570	5432	4884	5191	5566	6341
MTBE	7646	7458	6705	7126	7641	8705
Naphthalene	127	124	112	119	127	145
Toluene	10,731	10,467	9,410	10,002	10,724	12,218
Xylenes	6,123	5,972	5,369	5,707	6,119	6,971

Table 2.2.-34. Reduction in Benzene PFC Emissions (Tons) with Proposed Fuel Control (No Control on PFC Emissions).

Year	Reference Case	Control Case	Reduction
1999	2229	N. A.	N.A.
2015	2262	1359	903
2020	2423	1456	967
2030	2757	1657	1100

Table 2.2.-35. Reduction in Benzene PFC Emissions (Tons) with Proposed Fuel Control in 2030 by State (No Control on PFC Emissions).

State	Reference Case Tons	Control Case Tons	Reduction	% Change
AK	42	8	34	81
AL	65	15	50	77
AR	47	9	38	80
AZ	45	15	29	65
CA	92	92	0	1
CO	83	24	59	71
CT	11	8	3	27
DC	1	0	0	31
DE	3	2	1	24
FL	224	74	150	67
GA	84	27	57	67
HI	8	2	6	75
IA	42	12	30	72
ID	28	9	19	68
IL	98	37	61	62
IN	68	22	45	67
KS	46	14	33	70
KY	50	13	36	73
LA	68	14	54	80
MA	18	13	5	26
MD	20	15	5	23
ME	5	4	2	31
MI	219	48	171	78
MN	67	20	47	70
MO	80	24	56	70
MS	35	8	27	77
MT	18	5	13	73
NC	115	30	86	74
ND	10	3	7	72
NE	23	8	15	66
NH	12	3	9	74
NJ	26	19	7	26
NM	31	9	22	72
NV	13	5	8	61
NY	47	36	11	23
OH	167	46	121	73
OK	51	11	40	78
OR	92	25	66	72
PA	45	34	11	25

State	Reference Case Tons	Control Case Tons	Reduction	% Change
RI	2	2	0	15
SC	49	14	35	71
SD	9	3	6	70
UT	34	11	23	68
VA	30	22	7	25
VT	3	2	1	25
WA	135	40	95	70
WI	78	21	57	73
WV	33	7	26	79
WY	10	3	7	71

Table 2.2.-36. Emissions of Mobile Source Air Toxics from Gasoline Distribution in tons (2030 assumed to be same as 2020).

Pollutant	1999	2007	2010	2015	2020
2,2,4-trimethylpentane	5,473	5,646	5,825	5,981	6,174
Benzene	5,502	5,695	5,863	5,999	6,207
Ethyl Benzene	1,444	1,547	1,622	1,710	1,824
n-Hexane	10,700	10,925	11,174	11,309	11,607
MTBE	16,934	17,346	17,879	18,113	18,543
Naphthalene	427	446	460	471	489
Toluene	10,693	11,121	11,473	11,771	12,219
Xylenes	6,452	6,859	7,137	7,449	7,871

Table 2.2.-37. Nationwide Impact of the Proposed Controls on Emissions of Benzene from Gasoline Distribution in 2015 and 2020.

	2015 Reference Case	2015 Control Case	2015 Reduction	2020 Reference Case	2020 Control Case	2020 Reduction
Tons of Benzene	5,999	4,054	1,945	6,207	4,210	1,997

Table 2.2.-38. Reduction in Gasoline Distribution Emissions of Benzene (Tons) with Proposed Fuel Benzene Control by State, 2020.

State	Reference Case	Control Case	Reduction	% Change
ALABAMA	89	51	39	43
ALASKA	9	5	3	40
ARIZONA	81	48	32	40
ARKANSAS	42	24	18	43
CALIFORNIA	246	242	4	2
COLORADO	66	42	24	37
CONNECTICUT	48	44	4	8
DELAWARE	8	8	1	8
DISTRICT OF COLUMBIA	9	8	1	8
FLORIDA	236	143	94	40
GEORGIA	107	65	42	40
HAWAII	8	5	3	40
IDAHO	56	35	20	37
ILLINOIS	241	172	69	29
INDIANA	97	56	41	42
IOWA	94	51	43	46
KANSAS	158	86	73	46
KENTUCKY	119	70	49	41
LOUISIANA	284	162	123	43
MAINE	55	42	13	24
MARYLAND	71	60	10	15
MASSACHUSETTS	67	61	6	8
MICHIGAN	208	112	96	46
MINNESOTA	127	68	58	46
MISSISSIPPI	105	60	45	43
MISSOURI	66	42	24	36
MONTANA	30	19	11	37
NEBRASKA	26	14	12	46
NEVADA	18	11	7	40
NEW HAMPSHIRE	10	8	2	17
NEW JERSEY	78	72	7	8
NEW MEXICO	77	44	33	43
NEW YORK	819	707	112	14
NORTH CAROLINA	99	60	39	40
NORTH DAKOTA	23	12	11	46
OHIO	208	112	96	46
OKLAHOMA	151	82	70	46
OREGON	137	82	55	40
PENNSYLVANIA	194	124	70	36
RHODE ISLAND	12	11	1	8
SOUTH CAROLINA	50	30	20	40
SOUTH DAKOTA	15	8	7	46
TENNESSEE	119	64	55	46
TEXAS	935	666	269	29
UTAH	63	40	23	37
VERMONT	4	2	1	40
VIRGINIA	111	80	32	28
WASHINGTON	79	47	32	40
WEST VIRGINIA	151	91	60	40
WISCONSIN	67	42	24	37
WYOMING	31	20	11	37

2.2.2.2.2 Cold Temperature VOC Emission Control

Reductions in MSATs are proportional to reduced NMHC start emissions from vehicles subject to this rule. The magnitude of the reductions in these vehicles on a given gasoline is based entirely on the number and duration of events between engine off and engine on (vehicle soak) and the ambient conditions during them. The emissions reduced are those created in the engine start following the vehicle soak. These parameters are currently modeled by vehicle class and vehicle age in MOBILE6.2.[57, 58, 59, 60] MOBILE6.2 also provides the necessary information to adjust MSAT emission factors to account for geographic and seasonal effects on in-use fuels.

When all the affected vehicle classes meet the new emission standard we expect a 60% reduction of benzene and 1,3 butadiene from gasoline-fueled highway vehicles with GVWR ≤ 6000 lbs and 30% from gasoline fueled highway vehicles with GVWR > 6000 lbs. Effects on the trends in the inventories for the affected MSATs are shown in Table 2.2.-39 through Table 2.2.-44.

Table 2.2.-40. Reference Case, Light Duty Gasoline Vehicles and Trucks, 1999 MSAT Inventory.

Pollutant	Emissions in Tons
1,3-Butadiene	20,868
2,2,4-Trimethylpentane	170,366
Acetaldehyde	21,035
Acrolein	2,234
Benzene	171,154
Ethyl Benzene	67,091
Formaldehyde	54,104
n-Hexane	55,360
MTBE	51,457
Styrene	13,070
Toluene	453,141
Xylenes	255,940
Total MSATS	1,341,572

Table 2.2.-41. Reference and Vehicle Control Case, Light-Duty Gasoline Vehicles and Trucks, 2010 MSAT Inventories.

Pollutant	Reference Case Tons in Calendar Year 2010	Vehicle Control Case Tons in Calendar Year 2010	Reduction in Tons	Percent Reduction
1,3-Butadiene	10,091	9,347	744	7
2,2,4-Trimethylpentane	96,626	90,312	6,314	7
Acetaldehyde	12,218	11,215	1003	8
Acrolein	1,191	1,104	87	7
Benzene	104,779	96,980	7,799	7
Ethyl Benzene	38,003	35,567	2,436	6
Formaldehyde	25,180	23,110	2,070	8
n-Hexane	34,639	33,415	1,223	4
MTBE	26,271	25,931	340	1
Styrene	7,096	6,533	563	8
Toluene	253,844	236,623	17,221	7
Xylenes	143,177	133,474	9,703	7
Total MSATs	756,352	706,745	49,607	7

Table 2.2.-42. Reference and Vehicle Control Case, Light-Duty Vehicles, 2015 MSAT Inventories.

Pollutant	Reference Case Tons in Calendar Year 2015	Vehicle Control Case Tons in Calendar Year 2015	Reduction in Tons	Percent Reduction
1,3-Butadiene	9,585	7,964	1,621	17
2,2,4-Trimethylpentane	90.361	76,521	13,840	15
Acetaldehyde	11,901	9,695	2,206	19
Acrolein	1,140	948	192	17
Benzene	101,355	84,496	16,859	17
Ethyl Benzene	35,418	30,079	5,339	15
Formaldehyde	24,201	19,753	4,448	18
n-Hexane	29,589	26,911	2,679	9
MTBE	20,319	19,594	725	4
Styrene	6,901	5667	1234	18
Toluene	239,097	201,351	37,746	16
Xylenes	134,834	113,568	21,266	16
Total MSATs	707,877	599,492	108,385	15

Table 2.2.-43. Reference and Vehicle Control Case, Light-Duty Vehicles, 2020 MSAT Inventories.

Pollutant	Reference Case Tons in Calendar Year 2020	Vehicle Control Case Tons in Calendar Year 2020	Reduction in Tons	Percent Reduction
1,3-Butadiene	10,189	7,470	2,719	27
2,2,4-Trimethylpentane	92,586	69,374	23,212	25
Acetaldehyde	12,703	9,006	3,697	29
Acrolein	1,204	882	322	27
Benzene	106,071	77,966	28,105	27
Ethyl Benzene	36,175	27,213	8,962	25
Formaldehyde	25,661	18,323	7,338	29
n-Hexane	27,287	22,801	4,486	16
MTBE	16,056	14,909	1,147	7
Styrene	7,364	5,292	2,072	28
Toluene	246,984	183,618	63,366	26
Xylenes	139,250	103,549	35,701	26
Total MSATs	724,840	543,332	181,508	25

Table 2.2.-44. Reference and Vehicle Control Case, Light-Duty Vehicles, 2030 MSAT Inventories.

Pollutant	Reference Case Tons in Calendar Year 2030	Vehicle Control Case Tons in Calendar Year 2030	Reduction in Tons	Percent Reduction
1,3-Butadiene	12,067	7,379	4,688	39
2,2,4-Trimethylpentane	107,911	68,389	39,522	37
Acetaldehyde	15,165	8,938	6,227	41
Acrolein	1,422	875	547	39
Benzene	124,898	77,208	47,690	38
Ethyl Benzene	42,092	26,807	15,285	36
Formaldehyde	30,486	18,218	12,268	40
n-Hexane	29,958	22,322	7,636	25
MTBE	15,670	13,793	1,877	12
Styrene	8,760	5,228	3,532	40
Toluene	289,066	180,996	108,070	37
Xylenes	162,961	102,072	60,889	37
Total MSATs	844,366	535,479	308,887	37

State level reductions in calendar year 2030 benzene inventories are reported in Table 2.2.-45. Reductions are higher in States with cold winter temperatures, such as Alaska, where the reduction is 50%, and lowest in States with no winter or mild winters, such as Hawaii and Florida, where reductions are 4% and 14%, respectively.

Table 2.2.-45. 2030 Light-Duty Gasoline Vehicle Benzene Reference and Vehicle Control Cases by State.

State	2030 Reference Case Benzene Tons in Calendar 2030	2030 Control Case Benzene Tons in Calendar 2030	Reduction in Tons	Percent Reduction
Alabama	2128	1495	633	30%
Alaska	1260	639	620	49%
Arizona	1886	1241	646	34%
Arkansas	1252	854	398	32%
California	8984	5436	3548	39%
Colorado	2817	1645	1172	42%
Connecticut	1010	535	475	47%
DC	120	69	51	42%
Delaware	275	155	120	44%
Florida	4081	3512	569	14%
Georgia	4117	2807	1309	32%
Hawaii	188	181	7	4%
Idaho	1208	707	501	41%
Illinois	4674	2652	2022	43%
Indiana	3837	2315	1522	40%
Iowa	1682	1000	682	41%
Kansas	1809	1110	698	39%
Kentucky	2315	1409	907	39%
Louisiana	1509	1124	385	26%
Maine	754	413	340	45%
Maryland	1829	1041	788	43%
Massachusetts	1838	975	863	47%
Michigan	6885	4043	2842	41%
Minnesota	4086	2277	1809	44%
Mississippi	980	674	307	31%
Missouri	3385	2083	1302	38%
Montana	1047	586	461	44%
Nebraska	1180	702	479	41%
Nevada	1053	664	390	37%
New Hampshire	788	454	334	42%
New Jersey	2030	1118	912	45%
New Mexico	1363	926	437	32%
New York	6520	3721	2799	43%
North Carolina	3660	2393	1268	35%
North Dakota	650	359	291	45%
Ohio	5177	3029	2148	41%
Oklahoma	1906	1295	611	32%
Oregon	3131	1864	1268	40%
Pennsylvania	4947	2852	2095	42%
Rhode Island	267	143	124	46%

State	2030 Reference Case Benzene Tons in Calendar 2030	2030 Control Case Benzene Tons in Calendar 2030	Reduction in Tons	Percent Reductions
South Carolina	1999	1328	671	34%
South Dakota	612	348	263	43%
Tennessee	2843	1807	1036	36%
Texas	6373	4918	1455	23%
Utah	1442	822	621	43%
Vermont	536	305	231	43%
Virginia	3021	1863	1158	38%
Washington	4383	2431	1952	45%
West Virginia	784	454	330	42%
Wisconsin	3612	2056	1556	43%
Wyoming	663	379	285	43%
2030 Benzene Totals	**124898**	**77208**	**47670**	**38%**

2.2.2.2.3 Portable Fuel Container Control

The effect of PFC control on nationwide MSAT emissions are reported in Tables 2.2.-46 through 2.2.-49. Table 2.2.-50 reports reductions in benzene with PFC control by State in 2030. Similar patterns are expected for other MSATs, although State level inventories were not developed.

Table 2.2.-46. Estimated Reductions in MSAT Emissions from PFC Control, 2010.

Pollutant	Reference Case	Control Case	Reduction in Tons	Percent Reduction
Benzene	2118	1885	233	11
Naphthalene	112	100	11	10
Ethyl Benzene	1870	1680	190	10
Toluene	9410	8454	956	10
n-Hexane	4884	4388	496	10
2,2,4-Trimethylpentane	4405	3957	448	10
Xylenes	5369	4824	546	10
MTBE	6705	6024	681	10
Total	**34873**	**31312**	**3561**	**10**

Table 2.2.-47. Estimated Reductions in MSAT Emissions from PFC Control, 2015.

Pollutant	Reference Case	Control Case	Reduction in Tons	Percent Reduction
Benzene	2262	794	1468	65
Naphthalene	119	47	72	61
Ethyl Benzene	1987	779	1208	61
Toluene	10002	3922	6080	61
n-Hexane	5191	2035	3155	61
2,2,4-Trimethylpentane	4682	1836	2846	61
Xylenes	5707	2238	3469	61
MTBE	7126	2794	4332	61
Total	**37075**	**14445**	**22630**	**61**

Table 2.2.-48. Estimated Reductions in MSAT Emissions from PFC Control, 2020.

Pollutant	Reference Case	Control Case	Reduction in Tons	Percent Reduction
Benzene	2423	856	1567	65
Naphthalene	127	50	77	61
Ethyl Benzene	2131	841	1290	61
Toluene	10724	4234	6490	61
n-Hexane	5566	2197	3368	61
2,2,4-Trimethylpentane	5020	1982	3038	61
Xylenes	6119	2416	3703	61
MTBE	7641	3017	4624	61
Total	**39752**	**15594**	**24157**	**61**

Table 2.2.-49. Estimated Reductions in MSAT Emissions from PFC Control, 2030.

Pollutant	Reference Case	Control Case	Reduction in Tons	Percent Reduction
Benzene	2757	985	1772	64
Naphthalene	145	58	87	60
Ethyl Benzene	2428	968	1460	60
Toluene	12218	4872	7346	60
n-Hexane	6341	2528	3812	60
2,2,4-Trimethylpentane	5719	2280	3438	60
Xylenes	6971	2780	4191	60
MTBE	8705	3471	5234	60
Total	**45283**	**17942**	**27341**	**60**

Table 2.2.-50. Reductions in Benzene Emissions (Tons) with PFC Control by State, 2030.

State	Reference Case	Control Case	Reduction	% Change
ALABAMA	65	39	26	40
ALASKA	42	25	17	40
ARIZONA	45	27	18	40
ARKANSAS	47	27	20	43
CALIFORNIA	92	55	37	40
COLORADO	83	52	31	37
CONNECTICUT	11	10	1	9
DELAWARE	3	3	0	0
DISTRICT OF COLUMBIA	1	1	0	0
FLORIDA	224	134	90	40
GEORGIA	84	50	34	40
HAWAII	8	8	0	0
IDAHO	28	18	10	36
ILLINOIS	98	64	34	35
INDIANA	67	37	30	45
IOWA	42	23	19	45
KANSAS	46	25	21	46
KENTUCKY	50	29	21	42
LOUISIANA	68	39	29	43
MAINE	5	4	1	20
MARYLAND	20	16	4	20
MASSACHUSETTS	18	20	-2	-11
MICHIGAN	219	118	101	46
MINNESOTA	67	36	31	46
MISSISSIPPI	35	20	15	43
MISSOURI	80	46	34	43
MONTANA	18	11	7	39
NEBRASKA	23	13	10	43
NEVADA	13	10	3	23
NEW HAMPSHIRE	12	9	3	25
NEW JERSEY	26	24	2	8
NEW MEXICO	31	18	13	42
NEW YORK	47	32	15	32
NORTH CAROLINA	115	69	46	40
NORTH DAKOTA	10	6	4	40
OHIO	167	90	77	46
OKLAHOMA	51	28	23	45
OREGON	92	55	37	40
PENNSYLVANIA	45	29	16	36
RHODE ISLAND	2	2	0	0
SOUTH CAROLINA	49	29	20	41
SOUTH DAKOTA	9	5	4	44
TENNESSEE	69	42	27	39
TEXAS	104	65	39	38
UTAH	34	21	13	38
VERMONT	3	2	1	33
VIRGINIA	30	21	9	30
WASHINGTON	135	81	54	40
WEST VIRGINIA	33	20	13	39
WISCONSIN	78	46	32	41
WYOMING	10	7	3	30

2.2.2.2.4 Cumulative Reductions of Proposed Controls

Air toxic emissions from light-duty vehicles depend on both fuel benzene content and vehicle hydrocarbon emission controls. Similarly, the air toxic emissions from gas cans depend on both fuel benzene content and the gas can emission controls. Tables 2.2.-51 and 2.2.-52 summarize the expected reductions in benzene and MSAT emissions, respectively, from the combined effects of our proposed vehicle, fuel, and gas can controls.

Table 2.2.-53 summarizes the cumulative benzene emission reductions from these controls on highway gasoline vehicles, nonroad gasoline vehicles, gas cans, and gasoline distribution at the State level in 2030.

Table 2.2.-54 presents the impact of proposed controls on total benzene emissions from mobile sources and portable fuel containers, and the impacts on total benzene emissions from all sources. Table 2.2.-55 presents the cumulative impact of proposed controls on total emissions of mobile source air toxics from mobile source and portable fuel containers, as well as the impact on total emissions of mobile source air toxics from both mobile and stationary sources. As discussed previously, the fuel benzene control reduces stationary source emissions of benzene associated with gasoline distribution.

Table 2.2-51. Estimated Reductions in Benzene Emissions from All Proposed Control Measures by Sector, 2015 to 2030.

Benzene	1999	2015			2020			2030		
		Without Rule (tons)	With Rule (tons)	Reductions (tons)	Without Rule (tons)	With Rule (tons)	Reductions (tons)	Without Rule (tons)	With Rule (tons)	Reductions (tons)
Gasoline On-road Mobile Sources	178,465	103,798	77,155	26,643	108,256	71,326	36,930	127,058	70,682	56,376
Gasoline Nonroad Mobile Sources	58,710	37,747	33,247	4,500	36,440	32,018	4,422	39,162	34,400	4,762
Gas Cans	2,229	2,262	492	1,770	2,423	531	1,892	2,757	610	2,147
Gasoline Distribution	5,502	5,999	4,054	1,945	6,207	4,210	1,997	6,207	4,210	1,997
Total	244,905	149,806	114,948	34,858	153,326	108,085	45,241	175,184	109,902	65,282

Table 2.2.-52. Estimated Reductions in MSAT Emissions from All Proposed Control Measures by Sector, 2015 to 2030.

MSAT	1999	2015			2020			2030		
		Without Rule (tons)	With Rule (tons)	Reductions (tons)	Without Rule (tons)	With Rule (tons)	Reductions (tons)	Without Rule (tons)	With Rule (tons)	Reductions (tons)
Gasoline On-road Mobile Sources	1,415,502	731,283	613,227	118,056	745,769	555,541	190,228	865,767	548,298	317,469
Gasoline Nonroad Mobile Sources	673,922	432,953	428,506	4,447	390,468	386,095	4,373	405,119	400,408	4,711
Gas Cans	39,581	37,076	14,143	22,933	39,751	15,268	24,483	45,284	17,567	27,717
Gasoline Distribution	50,625	62,804	60,859	1,945	64,933	62,936	1,997	64,933	62,936	1,997
Total	2,179,630	1,264,116	1,116,735	147,381	1,240,921	1,019,840	221,081	1,381,103	1,029,209	351,894

Table 2.2.-53. Cumulative Benzene Emission Reductions From All Proposed Controls at the State level in 2030.

	Gasoline Highway Vehicles		Nonroad Gasoline Engines		Gas Cans		Gasoline Distribution		Total	
	Tons Reduced	%	Tons Reduced	%	Tons Reduced	%	Tons Reduced	%	Tons Reduced	%
ALABAMA	801	37	102	14	56	86	39	43	998	34
ALASKA	821	65	51	32	37	89	3	40	912	64
ARIZONA	756	39	70	11	35	79	32	40	893	34
ARKANSAS	500	39	68	15	42	89	18	43	628	36
CALIFORNIA	3979	44	314	10	37	40	4	2	4334	35
COLORADO	1402	39	85	15	68	81	24	37	1579	37
CONNECTICUT	482	47	8	2	4	33	4	8	498	35
DELAWARE	122	44	3	2	1	30	1	8	127	30
DISTRICT OF COLUMBIA	51	42	0	2	0	37	1	8	52	43
FLORIDA	989	23	424	14	180	80	94	40	1687	21
GEORGIA	1599	38	148	13	68	80	42	40	1857	34
HAWAII	8	4	1	1	6	75	3	40	18	6
IDAHO	614	50	49	18	23	80	20	37	706	47
ILLINOIS	2261	48	104	8	74	75	69	29	2508	40
INDIANA	1826	47	110	14	55	82	41	42	2032	43
IOWA	829	49	77	17	36	85	43	46	985	45
KANSAS	881	48	66	18	39	84	73	46	1059	47
KENTUCKY	1081	46	73	14	42	85	49	41	1245	42
LOUISIANA	527	34	131	17	60	88	123	43	841	33
MAINE	359	47	19	6	3	51	13	24	394	36
MARYLAND	820	44	32	4	7	37	10	15	869	32
MASSACHUSETTS	877	47	14	2	6	31	6	8	903	35
MICHIGAN	3428	49	308	17	193	88	96	46	4025	43
MINNESOTA	2187	53	182	17	56	84	58	46	2483	47
MISSISSIPPI	388	39	73	16	30	87	45	43	536	36

	Gasoline Highway Vehicles		Nonroad Gasoline Engines		Gas Cans		Gasoline Distribution		Total	
	Tons Reduced	%	Tons Reduced	%	Tons Reduced	%	Tons Reduced	%	Tons Reduced	%
MISSOURI	1582	46	122	14	66	83	24	36	1794	41
MONTANA	549	52	25	17	15	83	11	37	600	50
NEBRASKA	587	49	43	17	97	84	12	46	739	50
NEVADA	428	39	20	8	9	85	7	40	464	34
NEW HAMPSHIRE	350	44	16	7	10	80	2	17	378	37
NEW JERSEY	928	45	21	2	8	32	7	8	964	31
NEW MEXICO	605	43	40	19	26	84	33	43	704	43
NEW YORK	3018	46	129	6	22	47	112	14	3281	36
NORTH CAROLINA	1536	41	164	14	97	84	39	40	1836	36
NORTH DAKOTA	350	53	24	18	9	85	11	46	394	49
OHIO	2567	49	244	16	142	85	96	46	3049	43
OKLAHOMA	763	39	76	16	45	88	70	46	954	38
OREGON	1587	50	107	18	77	83	55	40	1826	47
PENNSYLVANIA	2302	46	128	9	24	52	70	36	2524	39
RHODE ISLAND	126	46	2	2	1	22	1	8	130	35
SOUTH CAROLINA	812	40	91	14	40	83	20	40	963	36
SOUTH DAKOTA	314	51	21	17	7	84	7	46	349	47
TENNESSEE	1233	43	111	14	59	85	55	46	1458	39
TEXAS	1963	30	400	12	55	53	269	29	2687	25
UTAH	741	50	54	15	27	80	23	37	845	45
VERMONT	286	47	12	11	1	55	1	40	300	42
VIRGINIA	1271	42	58	7	14	47	32	28	1375	35
WASHINGTON	2386	54	161	19	111	82	32	40	2690	50
WEST VIRGINIA	386	49	37	15	29	88	60	40	512	47
WISCONSIN	1802	49	128	14	66	85	24	37	2020	44
WYOMING	344	51	18	17	9	82	11	37	382	49

Table 2.2.-54. Impact of proposed controls on total benzene emissions from mobile sources, and the impacts on total benzene emissions from all sources.

	Mobile Source and PFC Tons Reduced	Mobile Source and PFC Tons	% of Mobile Source and PFC Tons Reduced	Total Tons Reduced	Total Mobile and Stationary Tons	% of Mobile and Stationary Tons Reduced
2015						
Fuel Benzene Control	16687	149602	11	18632	269787	7
Vehicle Control	16858	149602	11	16858	269787	6
Fuel, Vehicle and PFC Control	32912	149602	22	34857	269787	13
2020						
Fuel Benzene Control	16790	152618	11	18787	276295	7
Vehicle Control	28104	152618	18	28104	276295	10
Fuel, Vehicle and PFC Control	43245	152618	28	45242	276295	16
2030						
Fuel Benzene Control	20997	174753	12	20997	298430	7
Vehicle Control	47688	174753	27	47688	298430	16
Fuel, Vehicle and PFC Control	65281	174753	37	65281	298430	22

Table 2.2.-55. Cumulative impact of proposed controls on total emissions of mobile source air toxics from mobile source and portable fuel containers, as well as the impact on total emissions of mobile source air toxics from both mobile and stationary sources.

	Mobile Source and PFC Tons Reduced	Mobile Source and PFC Tons	% of Mobile and PFC Tons Reduced	Total Tons Reduced	Total Mobile and Stationary Tons	% of Mobile and Stationary Tons Reduced
2015	145436	1260205	12	147381	4164490	4
2020	240032	1229591	20	242029	4362301	6
2030	373658	1369867	27	375655	4502577	8

2.3 Potential Implications of New Emissions Data for Inventories

2.3.1 Newer Technology Light Duty Vehicles

MOBILE6.2 explicitly estimates emissions for the following air toxic compounds: benzene, 1,3-butadiene, formaldehyde, acetaldehyde, MTBE, and acrolein.[61, 62] MOBILE6.2 estimates air toxics emission factors by multiplying an air toxic to VOC (volatile organic compound) ratio by MOBILE6.2 VOC. For light-duty gasoline vehicles and trucks, the product for exhaust emissions is then multiplied by an off-cycle adjustment factor, which accounts for the difference in toxic fractions between Federal Test Procedure (FTP) and Unified Cycle (UC) operation.

Toxic to VOC ratios vary by technology group, vehicle type, whether a vehicle is a normal or high emitter (same definition as MOBILE6.2), and fuel characteristics. Evaporative toxic/VOC ratios do not vary among gasoline vehicle classes. Since toxic emission rates are a product of toxic/VOC emission ratios and VOC emission rates, anything that reduces VOC will also result in toxic emission reductions. Toxic/VOC ratios for individual technology group/vehicle type/emitter class combinations are determined using a series of algorithms which calculate the ratios based on fuel parameter inputs. These algorithms were derived from tests on 1990 model year technology vehicles and form the basis of the Complex Model for Reformulated Gasoline. MOBILE6.2 assumes that the same ratios are applicable to all post-1990 technology vehicles, including advanced technology low emission vehicles (LEVs) meeting Tier 2 standards.[63]

Eastern Research Group, under contract to EPA, recently compared exhaust emissions data from newer technology vehicles to see if the toxic to VOC fractions estimated from these data were statistically different from ratios predicted by MOBILE6.2. To make these comparisons, we used data collected by EPA Office of Research and Development/National Exposure Research Laboratory on 23 1998-2003 vehicles, the California Air Resources Board (46 vehicles) and Southwest Research Institute (3 vehicles). The contractor report and the data used are available in the docket for this rule.[64] The data from EPA's Office of Research and Development have been published.[65]

The conclusions from t-test comparisons were as follows:

1) When the off-cycle adjustment for benzene is factored out of the model results, MOBILE6.2 predicts statistically higher toxic fractions than one gets from the California Air Resources Board and Southwest Research Institute data, although for the large California dataset, the difference is only 10%. The fractions from the EPA Office of Research and Development data are higher than predicted by MOBILE6.2, but the difference is not statistically significant.

2) MOBILE6.2 is over-predicting toxic fractions for 1,3-butadiene.

3) The available data do not support a conclusion that MOBILE6.2 underestimates or overestimates fractions for MTBE, formaldehyde, acetaldehyde or acrolein.

There is a significant amount of scatter in the available test data, which makes it difficult to draw strong conclusions from the statistical comparisons. Also data are very limited for high emitters and off-cycle operation, which make a large contribution to total emissions. Nonetheless, at this point it appears that MOBILE6.2 toxic to VOC fractions for benzene, MTBE, formaldehyde, acetaldehyde, and acrolein are reasonably accurate for newer technology vehicles, but that fractions used for 1,3-butadiene are overestimating emissions for this pollutant.

The recent Energy Policy Act passed by Congress requires EPA to develop a new fuel effects model that reflects a 2007 fleet. The collection of a large amount of data and substantial analytical work is needed to meet this requirement, and to update the algorithms used in the current Complex Model and MOBILE6.2. Initial work is underway in a collaborative test program between EPA and members of the Alliance of Automobile Manufacturers to examine emissions of both regulated pollutants and air toxics from Tier 2 compliant vehicles. The current program focuses on changes in fuel sulfur, vapor pressure, and benzene levels, and will provide data for the air toxics rulemaking process as well as inform the design of a more comprehensive program covering a wider range of fuel properties and vehicle certification levels.

2.3.2 Heavy-Duty Vehicles (CRC E-55/E-59)

The primary objective of the E-55/59 research program was to quantify gaseous and PM emissions from primarily in-use heavy-duty diesel trucks in California's South Coast Air Basin, in support of emissions inventory development.[66] A second program objective was to quantify the influence of tampering and mal-maintenance on emissions from these vehicles. The program was conducted in four Phases (denoted as 1, 1.5, 2 and 3). The Phase 1 test fleet consisted of 25 heavy heavy-duty diesel trucks (HHDDT), selected to match a distribution of model years (MY) and to reflect engines in common use in California. In Phase 1.5 an additional twelve HHDDT were studied, with a thirteenth truck tested at idle alone. The Phase 2 test fleet consisted of ten HHDDT and nine medium heavy-duty trucks (MHDT), which included seven diesel-fueled medium heavy-duty trucks (MHDDT) and two gasoline-fueled medium heavy-duty trucks (MHDGT). Phase 3 gathered data from nine HHDDT, eight MHDDT, and two MHDGT. The Phase 2 and 3 data added post-2002 MY HHDDT (at 2.5 g/bhp-hr NO_x standard) to the program.

Sampling for chemical speciation was performed on thirteen HHDDT in Phase 1 and on five HHDDT and one MHDDT in Phase 2. However, only three of the thirteen Phase 1 trucks had their exhaust samples analyzed for air toxic emissions, and the remaining samples were being archived. Toxics species were measured from five HHDDT and one MHDDT (medium HDDTs) in the Phase 2 test fleet. PM data were acquired in Phases 1.5, 2 and 3. Exhaust data were acquired for methane and VOC. Semi-volatile organic compounds and PM soluble fractions were captured and analyzed,

along with carbonyls and nitrosamines. Ions and elemental/organic carbon (EC/OC) split were determined from quartz filters. The ion and metal analyses varied widely between trucks.

These data will be incorporated into EPA's MSAT inventories, and will help address limitations discussed in Sections 2.1.4 and 2.2.1.1.5.

2.3.3 Small Spark Ignition Engines

The National Mobile Inventory Model (NMIM) calculates air toxic emissions for small Spark Ignition (SI) engines by multiplying compound-specific fractions with volatile organic carbon (VOC) or particulate matter (PM) emission outputs from EPA's NONROAD model. These fractions were used in the 1999 National Air Toxics Assessment (NATA). These data were all obtained from a small number of uncontrolled engines.[67,68,69,70,71] In fiscal year 2004 EPA tested a mixture of in-use and new pre-control and Phase 1 small hand held SI trimmers, chain saws and a leaf blower[72]. In the same time period EPA performed engine tests on Phase I residential four-stroke lawn mowers. The emission data from both programs may impact future versions of NMIM and the inventories it calculates.

EPA tested four pre-control, nine Phase 1, two California-certified, and eight Phase 2 handheld engines. Five of the Phase 2 engines were new. All tests were fueled by either of two summer grades of gasoline. One was a gasoline ethanol blend meant to represent a reformulated gasoline and the other a conventional gasoline. All but one of the engines were two-cycle designs. However, the four-cycle engine was designed to operate on a typical two-cycle fuel lubricating oil mixture. All the test engines require that lubricating oil be mixed and consumed with the fuel. The program therefore used two different types of lubricating oil, one a mineral-based product and the other a "low smoke" synthetic. Both oils were commercially available. The testing was done over the Composite Two Mode (C2M) duty cycle. Table 2.3.-1 compares the emission factors used in NONROAD and the fractions used in NMIM with those based on the testing.

NONROAD and NMIM have not been adjusted to use the new data, but some increase in projected benzene inventories is likely once this occurs. In all but one engine and fuel combination the benzene/VOC fraction is greater than that currently used in NMIM. It is significant that two-cycle engines have a large proportion of their fuel being emitted in an unburned state. A reduction in fuel benzene content will have a significant effect on benzene emissions from them.

The other MSAT fractions are found in Table 2.3.-2. Some of the measured values are more consistent with NMIM values, but some are not (e.g., xylenes).

The second EPA test program involved six new Phase 2 four cycle lawn mower engines. These data are unpublished. The engines were tested after 20 hours of operation. The testing was done using the certification test procedure on certification gasoline. Formaldehyde and acetaldehyde were the only MSATs measured in the test program. A comparison of NMIM fractions and measured fractions are in Table 2.3.-.3.

The measured values are similar to the values used in NMIM. Incorporation of the new test data would not result in a dramatic change in inventories from these engines and use types.

Table 2.3.-1. Comparison between NONROAD Outputs and NMIM MSAT Fractions and Averaged Test Data for PM, VOC and Benzene from EPA Testing of 18 Handheld SI Engines Aggregated by Use, Engine Class, Emission Standard (Phase), Catalyst, and Engine Cycle

Type	Class	Condition	Phase	Catalyst Equipped	Engine Cycle	NONROAD PM10 EF (g/bhp)	Average Tested PM2.5 (g/bhp)	NONROAD HC EF (g/bhp)	Average Tested THC (g/bhp)	NMIM Benzene Fraction	Average Tested Benzene Fraction
BLOWER	V	New	2	YES	2	7.70	0.028	40.15	24.842	0.024	0.038
CHAIN SAW	IV	New	2	YES	2	7.70	0.228	26.87	30.254	0.080	0.022
CHAIN SAW	IV	Used	0	NO	2	9.24	3.072	313.20	185.976	0.080	0.016
CHAIN SAW	IV	Used	1	NO	2	9.93	2.051	231.84	110.567	0.080	0.014
CHAIN SAW	IV	Used	2	NO	2	9.93	1.483	42.66	98.066	0.080	0.014
CHAIN SAW	V	Used	1	NO	2	9.75	1.330	152.00	80.026	0.080	0.016
STRING TRIMMER	III	Used	0	NO	2	9.24	4.915	313.20	265.205	0.011	0.019
STRING TRIMMER	III	Used	1	NO	2	9.55	7.519	272.79	243.167	0.011	0.013
STRING TRIMMER	IV	New	2	YES	2	7.70	0.641	26.87	31.581	0.011	0.028
STRING TRIMMER	IV	New	2	NO	4	0.06	0.231	25.83	12.791	0.011	N.A.
STRING TRIMMER	IV	Used	0	NO	2	9.24	3.093	313.20	221.354	0.011	0.015
STRING TRIMMER	IV	Used	1	NO	2	9.93	3.856	231.84	154.140	0.011	0.017

Table 2.3.-2. NMIM MSAT Fractions versus Fractions from EPA Testing of 18 Handheld SI Engines

			Formaldehyde		Acetaldehyde		Acrolein		Propionaldehyde		Toluene		2,2,4-Trimethypentane		Xylene	
Type	Standard	Fuel	NMIM	Tested	NMIM	Tested	NMIM	Tested	NMIM	Tested	NMIM	Tested	NMIM	Tested	NMIM	Tested
BLOWER	Ph2	CG									0.0978	0.0979	0.0372	0.0122	0.1075	0.0224
SAW		CG	0.0068	0.0050	0.0013	0.0011	0.0004	0.0003	0.0001	0.0002	0.0598	0.0998	0.0372	0.0490	0.0931	0.0166
SAW	Ph1	CG	0.0068	0.0042	0.0013	0.0009	0.0004	0.0003	0.0003	0.0002	0.0598	0.1064	0.0372	0.0487	0.0931	0.0151
SAW	Ph1	RFG	0.0068	0.0053	0.0013	0.0046	0.0004	0.0004	0.0004	0.0002	0.0598	0.1105	0.0372	0.0280	0.0931	0.0231
SAW	Ph2	CG	0.0068	0.0052	0.0013	0.0011	0.0004	0.0004	0.0004	0.0002	0.0598	0.1065	0.0372	0.0409	0.0931	0.0177
SAW	Ph2	RFG	0.0068	0.0056	0.0013	0.0055	0.0004	0.0004	0.0004	0.0002	0.0598	0.0955	0.0372	0.0252	0.0931	0.0228
TRIMMER		CG	0.0029	0.0072	0.0006	0.0016	0.0003	0.0006	0.0004	0.0002	0.0978	0.1049	0.0372	0.0437	0.1075	0.0174
TRIMMER		RFG	0.0029	0.0077	0.0006	0.0066	0.0003	0.0006	0.0004	0.0002	0.0890	0.0891	0.0372	0.0242	0.0978	0.0232
TRIMMER	Ph1	CG									0.0978	0.1093	0.0372	0.0432	0.1075	0.0204
TRIMMER	Ph1	CG	0.0029	0.0039	0.0006	0.0009	0.0003	0.0003	0.0003	0.0002	0.0978	0.1000	0.0372	0.0497	0.1075	0.0163
TRIMMER	Ph1	RFG									0.0890	0.1096	0.0372	0.0249	0.0978	0.0299
TRIMMER	Ph1	RFG	0.0029	0.0045	0.0006	0.0046	0.0003	0.0003	0.0004	0.0002	0.0890	0.0906	0.0372	0.0279	0.0978	0.0238
TRIMMER	Ph2	CG	0.0029	0.0050	0.0006	0.0010	0.0003	0.0003	0.0006	0.0002	0.0978	0.1303	0.0372	0.0559	0.1075	0.0205
TRIMMER	Ph2	RFG	0.0029	0.0080	0.0006	0.0073	0.0003	0.0005	0.0009	0.0002	0.0890	0.1014	0.0372	0.0326	0.0978	0.0235

Table 2.3.-3. Comparison of NMIM Acetaldehyde and Formaldehyde to VOC fractions with Measured Fractions from OTAQ Test Program

MSAT	NMIM Fraction	Average Measured Fraction
Acetaldehyde	0.00440	0.00396
Formaldehyde	0.01256	0.01541

2.3.4 Nonroad CI engines

The Agency conducted three separate emission test programs measuring exhaust emissions from fifteen nonroad diesel engines and in-use pieces of nonroad diesel equipment[73,74,75]. The engines tested derived from construction, utility and agricultural equipment applications for the most part and ranged from seven horsepower (hp) up through 850 hp (425 hp, as tested). The test fuels used varied by sulfur concentration from nonroad-grade diesel fuels at 2500 and 3300 ppm sulfur to a nominal "D-2" diesel at 350 ppm sulfur and, lastly, to an ultra-low sulfur diesel, measured at less than 10 ppm sulfur. Test engines were run over both steady-state and transient duty cycles. Several of the transient cycles were application-specific, having been based on rubber-tire loader or excavator operations, for example. Criteria pollutants in the exhaust emissions were quantified for each test engine as well as sulfate, ammonia, N_2O and a range of C_1 - C_{12} compounds (aldehydes, ketones, alcohols, etc.). Emissions of several additional air toxic compounds were identified in two of the three programs. These emission species included benzene, toluene, ethylbenzene, xylenes, polyaromatic hydrocarbons (PAH), nitrated-PAHs and several metals. Emission results were summarized in both grams/hour and grams/brake-horsepower/hour.

With the emission data, EPA will address differences between Tier 1 and

unregulated NR diesel emissions, the impact of diesel fuel sulfur level on engine emissions, whether any adjustments to default modeling TAFs (transient adjustment factors) used in the NONROAD emissions model are warranted by the new data, and the necessity of creating category- and power-specific TAFs for NONROAD. The data will also be used to update NMIM inventories for toxic air compounds.

2.4 Description of Current Mobile Source Emissions Control Programs that Reduce MSATs

As described above, existing mobile source control programs will reduce MSAT emissions (not including diesel PM) by 60% between 1999 and 2020. Diesel PM from mobile sources will be reduced by 70% between 1999 and 2020. The mobile source programs include controls on fuels, highway vehicles, and nonroad equipment. These programs are also reducing hydrocarbons and PM more generally, as well as oxides of nitrogen. The sections immediately below provide general descriptions of these programs, as well as voluntary programs to reduce mobile source emissions, such as the National Clean Diesel Campaign and Best Workplaces for Commuters.

2.4.1 Fuels Programs

Several federal fuel programs reduce MSAT emissions. Some of these programs directly control air toxics, such as the reformulated gasoline (RFG) program's benzene content limit and required reduction in total toxics emissions, and the anti-backsliding requirements of the anti-dumping and current MSAT programs, which require that gasoline cannot get dirtier with respect to toxics emissions. Others, such as the gasoline sulfur program, control toxics indirectly by reducing hydrocarbon and related toxics emissions.

2.4.1.1 RFG

The RFG program contains two direct toxics control requirements. The first is a fuel benzene standard, requiring RFG to average no greater than 0.95 volume percent benzene annually (on a refinery or importer basis). The RFG benzene requirement includes a per-gallon cap on fuel benzene level of 1.3 volume percent. In 1990, when the Clean Air Act was amended to require reformulated gasoline, fuel benzene averaged 1.60 volume percent. For a variety of reasons, including other regulations, chemical product prices and refining efficiencies, most refiners and importers have achieved significantly greater reductions in benzene than required by the program. In 2003, RFG benzene content averaged 0.62 percent. The RFG benzene requirement includes a per-gallon cap on fuel benzene level of 1.3 volume percent.

The second RFG toxics control requires that RFG achieve a specific level of toxics emissions reduction. The requirement has increased in stringency since the RFG program began in 1995, when the requirement was that RFG annually achieve a 16.5% reduction in total (exhaust plus evaporative) air toxics emissions. Currently, a 21.5% reduction is required. These reductions are determined using the Complex Model. As

mentioned above, for a variety of reasons most regulated parties have overcomplied with the required toxics emissions reductions. During the 1998-2000 timeframe, RFG achieved, on average, a 27.5% reduction in toxics emissions.

2.4.1.2 Anti-dumping

The anti-dumping regulations were intended to prevent the dumping of "dirty" gasoline components, which were removed to produce RFG, into conventional gasoline (CG). Since the dumping of "dirty" gasoline components, for example, benzene or benzene-containing blending streams, would show up as increases in toxics emissions, the anti-dumping regulations require that a refiner's or importer's CG be no more polluting with respect to toxics emissions than the refiner's or importer's 1990 gasoline. The anti-dumping program considers only exhaust toxics emissions and does not include evaporative emissions.[B] Refiners and importers have either a unique individual anti-dumping baseline or they have the statutory anti-dumping baseline if they did not fulfill the minimum requirements for developing a unique individual baseline. In 1990, average exhaust toxics emissions (as estimated by the Complex Model) were 104.5 mg/mile[C]; in 2004, CG exhaust toxics emissions averaged 90.7 mg/mile. Although CG has no benzene limit, benzene levels have declined significantly from the 1990 level of 1.6 volume percent to 1.1 volume percent for CG in 2004.

2.4.1.3 2001 Mobile Source Air Toxics Rule (MSAT1)

As discussed above, both RFG and CG have, on average, exceeded their respective toxics control requirements. In 2001, EPA issued a mobile source air toxics rule (MSAT1, for the purposes of this second proposal), as discussed in section I.D. The intent of MSAT1 is to prevent refiners and importers from backsliding from the toxics performance that was being achieved by RFG and CG. In order to lock in superior levels of control, the rule requires that the annual average toxics performance of gasoline must be at least as clean as the average performance of the gasoline produced or imported during the three-year period 1998-2000. The period 1998-2000 is called the baseline period. Toxics performance is determined separately for RFG and CG, in the same manner as the toxics determinations required by the RFG[76] and anti-dumping rules.

Like the anti-dumping provisions, MSAT1 utilizes an individual baseline against which compliance is determined. The average 1998-2000 toxics performance level, or baseline, is determined separately for each refinery and importer.[D] To establish a unique individual MSAT1 baseline, EPA requires each refiner and importer to submit documentation supporting the determination of the baseline. Most refiners and many importers in business during the baseline period had sufficient data to establish an

[B]See RFG rule for why evaporative emissions are not included in the anti-dumping toxics determination.

[C]Phase II

[D]Except for those who comply with the anti-dumping requirements for conventional gasoline on an aggregate basis, in which case the MSAT1 requirements for conventional gasoline must be met on the same aggregate basis (40 CFR Part 80, Subpart E).

individual baseline. An MSAT1 baseline volume is associated with each unique individual baseline value. The MSAT1 baseline volume reflects the average annual volume of such gasoline produced or imported during the baseline period. Refiners and importers who did not have sufficient refinery production or imports during 1998-2000 to establish a unique individual MSAT1 baseline must use the default baseline provided in the rule.

The MSAT1 program began with the annual averaging period beginning January 1, 2002. Since then, the toxics performance for RFG has improved from a baseline period average of 27.5% reduction to 29.5% reduction in 2003. Likewise, CG toxics emissions have decreased from an average of 95 mg/mile during 1998-2000 to 90.7 mg/mile in 2003.

2.4.1.4 Gasoline Sulfur

EPA's gasoline sulfur program[77] requires, beginning in 2006, that sulfur levels in gasoline can be no higher in any one batch than 80 ppm, and must average 30 ppm annually. When fully effective, gasoline will have 90 percent less sulfur than before the program. Reduced sulfur levels are necessary to ensure that vehicle emission control systems are not impaired. These systems effectively reduce non-methane organic gas (NMOG) emissions, of which some are air toxics. With lower sulfur levels, emission control technologies can work longer and more efficiently. Both new and older vehicles benefit from reduced gasoline sulfur levels.

2.4.1.5 Gasoline Volatility

A fuel's volatility defines its evaporation characteristics. A gasoline's volatility is commonly referred to as its Reid vapor pressure, or RVP. Gasoline summertime RVP ranges from about 6-9 psi, and wintertime RVP ranges from about 9-14 psi, when additional vapor is required for starting in cold temperatures. Gasoline vapors contain a subset of the liquid gasoline components, and thus can contain toxics compounds such as benzene. EPA has controlled summertime gasoline RVP since 1989 primarily as a VOC and ozone precursor control, which also results in some toxics pollutant reductions.

2.4.1.6 Diesel Fuel

In early 2001, EPA issued rules requiring that diesel fuel for use in highway vehicles contain no more than 15 ppm sulfur beginning June 1, 2006. [78] This program contains averaging, banking and trading provisions, as well as other compliance flexibilities. In June 2004, EPA issued rules governing the sulfur content of diesel fuel used in nonroad diesel engines.[79] In the nonroad rule, sulfur levels are limited to a maximum of 500 ppm sulfur beginning in 2007 (current levels are approximately 3000 ppm). In 2010, nonroad diesel sulfur levels must not exceed 15 ppm.

EPA's diesel fuel requirements are part of a comprehensive program to combine engine and fuel controls to achieve the greatest emission reductions. The diesel fuel

provisions enable the use of advanced emission-control technologies on diesel vehicles and engines. The diesel fuel requirements will also provide immediate public health benefits by reducing PM emissions from current diesel vehicles and engines.

2.4.1.7 Phase-Out of Lead in Gasoline

One of the first programs to control toxic emissions from motor vehicles was the removal of lead from gasoline. Beginning in the mid-1970s, unleaded gasoline was phased in to replace leaded gasoline. The phase-out of leaded gasoline was completed January 1, 1996, when lead was banned from motor vehicle gasoline. The removal of lead from gasoline has essentially eliminated on-highway mobile source emissions of this highly toxic substance.

2.4.2 Highway Vehicle and Engine Programs

The 1990 Clean Air Act Amendments set specific emission standards for hydrocarbons and for PM. Air toxics are present in both of these pollutant categories. As vehicle manufacturers develop technologies to comply with the hydrocarbon (HC) and particulate standards (e.g., more efficient catalytic converters), air toxics are reduced as well. Since 1990, we have developed a number of programs to address exhaust and evaporative hydrocarbon emissions and PM emissions. Table 2.4-1 shows current mobile source programs for highway vehicles.

Two of our recent initiatives to control emissions from motor vehicles and their fuels are the Tier 2 control program for light-duty vehicles and the 2007 heavy-duty engine rule. Together these two initiatives define a set of comprehensive standards for light-duty and heavy-duty motor vehicles and their fuels. In both of these initiatives, we treat vehicles and fuels as a system. The Tier 2 control program establishes stringent tailpipe and evaporative emission standards for light-duty vehicles and a reduction in sulfur levels in gasoline fuel beginning in 2004.[80] The 2007 heavy-duty engine rule establishes stringent exhaust emission standards for new heavy-duty engines and vehicles for the 2007 model year as well as reductions in diesel fuel sulfur levels starting in 2006.[81] Both of these programs will provide substantial emissions reductions through the application of advanced technologies. We expect 90% reductions in PM from new diesel engines compared to engines under current standards.

Some of the key earlier programs controlling highway vehicle and engine emissions are the Tier 1 and NLEV standards for light-duty vehicles and trucks; enhanced evaporative emissions standards; the supplemental federal test procedures (SFTP); urban bus standards; and heavy-duty diesel and gasoline standards for the 2004/2005 time frame.

Table 2.4-1. Current On-Highway Engine and Vehicle Programs Providing Significant Additional MSAT Reductions.

Category	Rule & FRM Date	Implementation Schedule	VOC Standards*	PM Standards
Light-duty cars and trucks	Tier 2 (including low sulfur fuel), February 10, 2000	2004 - 2009	x	x
	NLEV (National Low-Emitting Vehicle)	1999 - 2003	x	x
	Enhanced Evaporative Emissions		x	
	SFTP (Supplemental FTP) Procedures	2001 (start)	x	
Heavy-duty trucks	2004 Heavy-duty Rule October 6, 2000	2004 - 2007	x	x
	2007 Heavy-duty Rule (including low sulfur fuel), January 18, 2001	2007 - 2010		
Urban Buses	HD Diesel Retrofit	1994 - 1998		x
Highway motorcycles	December 2003	2006 - 2010	x	

* Standards in various forms including HC, NMHC, NMOG, and NOx+NMHC

Table 2.4-2 Current Nonroad Engine/Vehicle Programs.

Category	Rule & FRM Date	Implementation Schedule	VOC Standards*	PM Standards
Land-based diesel	Tier 2, October 23, 1998	2001-2006	x	x
	Tier 3, October 23, 1998	2006-2008	x	x
	Tier 4 (w/ low sulfur fuel) June 29, 2004	2008-2014	x	x
Locomotives	Tier 0, Tier 1, Tier 2 April 16, 1998	2002 – 2005	x	x
Marine	Spark-ignition Gasoline Engine Standards, October 4, 1996	1998 - 2006	x	
	Diesel Engines, less than 50hp	1999 - 2005		x
	Recreational Diesel, November 8, 2002	Starting 2006/2009	x	x
	Commercial Diesel, February 28, 2003	Starting 2004/2007	x	x
Large spark-ignition engines	Tier 1 Standards Tier 2 Standards November 8, 2002	2004 - 2007 2007 - 20XX	x	
Small spark-ignition engines	Phase 1 Standards,	1997 - 2007	x	
	Handheld Phase 2 Standards, April 25, 2000	2002 - 2007	x	
	Non-handheld Phase 2 Standards, March 30, 1999	2001 - 2007		
Aircraft (NOx Std in 2005; Smoke Std in 1982)		No current/recent standards for VOC or PM		
Recreational vehicles	November 8, 2002	2006 - 2012	x	

* Standards in various forms including HC, NMHC, NMOG, and NOx+NMHC

2.4.3 Nonroad Engine Programs

There are various categories of nonroad engines, including land-based diesel engines (e.g., farm and construction equipment), small land-based spark-ignition (SI) engines (e.g., lawn and garden equipment, string trimmers), large land-based SI engines (e.g., forklifts, airport ground service equipment), marine engines (including diesel and SI, propulsion and auxiliary, commercial and recreational), locomotives, aircraft, and recreational vehicles (off-road motorcycles, “all terrain” vehicles and snowmobiles).

Table 2.4-2 shows current mobile source programs for nonroad engines. Brief summaries of our current and anticipated programs for these nonroad categories follow. As with highway vehicles, the VOC standards we have established for nonroad engines will also significantly reduce VOC-based toxics from nonroad engines. In addition, the standards for diesel engines (in combination with the stringent sulfur controls on nonroad diesel fuel) will significantly reduce diesel PM and exhaust organic gases, which are mobile source air toxics.

In addition to the engine-based emission control programs described below, fuel controls will also reduce emissions of air toxics from nonroad engines. For example, restrictions on gasoline formulation (the removal of lead, limits on gasoline volatility and RFG) are projected to reduce nonroad MSAT emissions because most gasoline-fueled nonroad vehicles are fueled with the same gasoline used in on-highway vehicles. An exception to this is lead in aviation gasoline. Aviation gasoline, used in general (as opposed to commercial) aviation, is a high octane fuel used in a relatively small number of aircraft (those with piston engines). Such aircraft are generally used for personal transportation, sightseeing, crop dusting, and similar activities.

2.4.3.1 Land-based Diesel Engines

We recently finalized stringent new emissions standards for land-based nonroad diesel engines, used in agricultural and construction equipment as well as many other applications (although the standards do not apply to locomotive, mining equipment and marine engines).[82] These standards are similar in stringency to the 2007 highway diesel engine standards, and are likewise enabled by stringent controls on sulfur levels is diesel fuel, as explained earlier in section 2.4.1.6. The new engine standards, starting in 2008, will reduce PM from new 2008 nonroad diesel engines by about 95 percent compared to engines under today's standards. The fuels controls are scheduled to begin in mid-2007.

2.4.3.2 Small Land-Based SI Engines

Small land-based spark-ignition (Small SI) engines at or below 25 hp are used primarily in lawn and garden equipment such as lawn mowers, string trimmers, chain saws, lawn and garden tractors, and other similar equipment. Our Phase 1 emission controls for this category of engines took effect beginning in 1997 and are projected to result in a roughly 32 percent reduction in VOC emissions for new engines, on average, versus pre-controlled engines.[83] We also have Phase 2 regulations for these engines which, when fully phased-in, are projected to result in additional combined HC and NOx reductions beyond the Phase 1 levels of 60 percent for new non-handheld engines and of 70 percent for new handheld engines.[84] We are currently developing a proposal for Phase 3 standards that would further reduce HC emissions from Small SI engines.

2.4.3.3 Large Land-Based SI engines

Since the MSAT1 rule was published, we have also finalized emissions standards for SI engines above 25 hp used in commercial applications.[85] Such engines are used in a

variety of industrial equipment such as forklifts, airport ground service equipment, generators and compressors. The Tier 1 standards went into effect in 2004 and the Tier 2 standards will start in 2007, providing additional emissions reductions. These standards will provide about a 90 percent reduction in HC emissions on average for new engines versus Tier 1 controlled engines.

2.4.3.4 Recreational Vehicles

Standards for recreational vehicles, including snowmobiles, off-road motorcycles and "all terrain" vehicles, will begin in 2006. These standards will require significant reductions in HC emissions from new engines, ranging from 50 to 86 percent compared to pre-controlled engines.[86]

2.4.3.5 Marine engines

Marine engines cover a very wide range of products, from 10-horsepower outboard engines to 100,000-horsepower engines on oceangoing vessels. We have active emission-control programs to address the need for emission controls for every kind of marine engine. For gasoline-fueled engines, we adopted an initial tier of standards with a phase-in schedule that is complete in the 2006 model year. These standards, which apply to outboard and personal-watercraft engines, have led to a major shift to four-stroke engines and advanced-technology two-stroke engines for an estimated 75 percent reduction in hydrocarbon emissions from uncontrolled levels.[87] We are developing a proposal to adopt new, more stringent standards for these engines that would reduce emissions from these engines by an additional 60 percent or more from the previous tier.

Another kind of gasoline-fueled marine engine, referred to as stern drive and inboard engines, uses an automotive-type engine. These engines have uncontrolled emission rates that are well below the current standards that apply to outboard and personal-watercraft engines. These engines are not currently subject to emission standards, but we intend to include new emission standards for these engines in an upcoming gasoline marine engine proposal.[88] These new standards would likely be based on the application of catalyst technology to substantially reduce hydrocarbon and NOx emissions.

We have adopted emission standards for marine diesel engines in four separate rulemakings. All of these standards are based on in-engine controls and do not require aftertreatment. First, we adopted two tiers of standards for marine engines below 50 horsepower that apply equally to land-based and marine engines. These standards were phased in from 1999 to 2005. Second, we adopted emission standards for commercial marine diesel engines with per-cylinder engine displacement up to 30 liters. These standards are comparable to the standards for land-based nonroad diesel engines that apply in the same time frame, with several adjustments to test procedures and compliance provisions appropriate for marine engines.[89] The emission standards generally apply in 2007 for locomotive-size engines and in 2004 for smaller engines. Third, the emission standards adopted for recreational marine diesel engines are very similar to the

comparable commercial engines, with implementation scheduled two years after the commercial standards take effect. All the emission standards in these three rulemakings targeted reductions in NOx and PM emissions. Finally, we adopted standards to control NOx emissions at levels consistent with the requirements from the International Maritime Organization (IMO), but we adopted these as EPA standards under the Clean Air Act to make them mandatory for all engines with per-cylinder displacement above 2.5 liters installed on U.S.-flag vessels starting in the 2004 model year. We are in the process of reviewing the emission standards for all sizes of marine diesel engines and expect to propose new requirements in the near future.

EPA is also investigating the possibility of designating U.S. coastal areas as SOx Emission Control Areas (SECAs) under the IMO. Such a designation would trigger a requirement for any vessel entering such an area to use reduced-sulfur fuel or operate exhaust scrubbers to prevent SOx emissions.

2.4.3.6 Locomotives

Our regulations for locomotive engines consist of three tiers of standards, applicable depending on the date a locomotive or a particular engine was originally manufactured.[90] The first set of standards (Tier 0) applies to locomotives and their locomotive engines originally manufactured from 1973 through 2001, starting from the time the engine was manufactured or later at "remanufacture."[E] The second set of standards (Tier 1) applies to locomotives and their engines manufactured from 2002 through 2004 and again at engine manufacture or rebuild. The third set of standards (Tier 2) applies to locomotive engines manufactured in 2005 and later. The Tier 0 and Tier 1 regulations were primarily intended to reduce NOx emissions. The Tier 2 regulations are projected to result in 50 percent reductions in VOC and diesel PM as compared to unregulated engine emission levels, as well as additional NOx reductions beyond the Tier 0 and Tier 1 regulations. We are currently developing a new tier of more stringent emissions standards for locomotive engines.

2.4.3.7 Aircraft

A variety of emission regulations have been applied to commercial gas turbine aircraft engines, beginning with limits on smoke and fuel venting in 1974. In 1984, limits were placed on the amount of unburned HC that gas turbine engines can emit per landing and takeoff cycle. In 1997, we adopted standards that were equivalent to the existing International Civil Aviation Organization (ICAO) NOx and CO emission standards for gas turbine engines. In 2005, we tightened the NOx emission standards to levels that are equivalent to the ICAO standards that became effective in 2004. These actions have resulted in minimal emissions reductions, and have largely served to prevent increases in aircraft emissions. We continue to explore ways to reduce emissions from aircraft throughout the nation.

[E] "Remanufacture" is an engine rebuild "to new" during four-to-eight year long maintenance cycles.

2.4.4 Voluntary Programs

In addition to the fuel and engine control programs described above, we are actively promoting several voluntary programs to reduce emissions from mobile sources, such as the National Clean Diesel Campaign, anti-idling measures, and Best Workplaces for Commuters. While the stringent emissions standards described above apply to new highway and nonroad diesel engines, it is also important to reduce emissions from the existing fleet of about 11 million diesel engines. EPA has launched a comprehensive initiative called the National Clean Diesel Campaign, one component of which is to promote the reduction of emissions in the existing fleet of engines through a variety of cost-effective and innovative strategies. The goal of the Campaign is to reduce emissions from the 11 million existing engines by 2014. Emission reduction strategies include switching to cleaner fuels, retrofitting engines through the addition of emission control devices, and engine replacement. For example, installing a diesel particulate filter achieves diesel particulate matter reductions of approximately 90 percent (when combined with the use of ultra low sulfur diesel fuel). The Energy Policy Act of 2005 includes grant authorizations and other incentives to help facilitate voluntary clean diesel actions nationwide.

The National Clean Diesel Campaign is focused on leveraging local, state, and federal resources to retrofit or replace diesel engines, adopt best practices, and track and report results. The Campaign targets five key sectors: school buses, ports, construction, freight, and agriculture.

Reducing vehicle idling provides important environmental benefits. As a part of their daily routine, truck drivers often keep their vehicles at idle during stops to provide power, heat and air conditioning. EPA's SmartWay Transport Partnership is helping the freight industry to adopt innovative idle reduction technologies and take advantage of proven systems that provide drivers with basic necessities without using the engine. To date, there are 50 stationary anti-idling projects, and mobile technology has been installed on nearly 20,000 trucks. The SmartWay Transport Partnership also works with the freight industry to reduce fuel use (with a concomitant reduction in emissions) by promoting a wide range of new technologies such as advanced aerodynamics, single-wide tires, weight reduction speed control and intermodal shipping.

Daily commuting represents another significant source of emissions from motor vehicles. EPA's Best Workplaces for Commuters[SM] program is working with employers across the country to reverse the trend of longer, single-occupancy vehicle commuting. OTAQ has created a national list of the Best Workplaces for Commuters to formally recognize employers that offer superior commuter benefits such as free transit passes, subsidized vanpools/carpools, and flexi-place, or work-from-home, programs. More than 1,300 employers representing 2.8 million U.S. workers have been designated Best Workplaces for Commuters.

Much of the growth in the Best Workplaces for Commuters program has been through metro area-wide campaigns. Since 2002, EPA has worked with coalitions in 14

major metropolitan areas to increase the penetration of commuter benefits in the marketplace and the visibility of the companies that have received the BWC designation. Another significant path by which the program has grown is through Commuter Districts including corporate and industrial business parks, shopping malls, business improvement districts and downtown commercial areas. To date EPA has granted the Best Workplaces for Commuters "District" designation to twenty locations across the country including downtown Denver, Houston, Minneapolis and Tampa.

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