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Analysis of the Impacts of Control Programs on Motor Vehicle Toxics Emissions and Exposure in Urban Areas and Nationwide: Volume I

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Assessment and Modeling Division
Office of Mobile Sources
U.S. Environmental Protection Agency

Report No. SR99-11-02

Analysis of the Impacts of Control Programs on Motor Vehicle Toxics Emissions and Exposure in Urban Areas and Nationwide

Volume I

prepared for:

U.S. Environmental Protection Agency

November 30, 1999

prepared by:

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Analysis of the Impact of Control Programs on Motor Vehicle Toxics Emissions and Exposure in Urban Areas and Nationwide

Volume I

prepared for:

U.S. Environmental Protection Agency
under Contract No. 68-C7-0051
Work Assignment 1-06

November 30, 1999

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Analysis of the Impact of Control Programs on Motor Vehicle Toxics Emissions and Exposure in Urban Areas and Nationwide

Volume I

Table of Contents

page

Table of Contents, continued

List of Appendices

1. SUMMARY

Under Work Assignment 1-06 of U.S. Environmental Protection Agency (EPA) contract #68-C7-0051, Sierra Research, Inc. (Sierra), in conjunction with subcontractor Radian International Corporation/Eastern Research Group (Radian/ERG), has performed a number of tasks related to the evaluation of motor vehicle air toxics emissions, exposure, and risk assessment. This study expanded upon a previous analysis of motor vehicle air toxics performed by Sierra, Radian, and Energy and Environmental Analysis (EEA) in 1998[1*] to include additional control scenarios and modeled areas.

As described below, emissions and exposure estimates were prepared for the following air toxics: benzene, acetaldehyde, formaldehyde, 1,3-butadiene, MTBE, and Diesel particulate. The analysis was performed for ten selected urban areas in the U.S. under a variety of control scenarios. An additional 16 regional areas were evaluated in order to provide a broad range of fuel parameters, temperature regimes, and I/M programs that were needed for national estimates of toxics emissions and exposure. Estimates were prepared for calendar years 1990, 1996, 2007, and 2020. Although risk estimates were not prepared as part of this study, the modeling framework to perform those calculations, with the unit risk factor for each toxic as a variable input, was developed.

Modeled Areas and Control Scenarios

Under this work assignment, on-road motor vehicle air toxics emissions, exposure, and cancer risk were estimated for ten urban areas consisting of Atlanta, Chicago, Denver, Houston, Minneapolis, New York City, Philadelphia, Phoenix, Spokane, and St. Louis. Emissions modeling was also performed for an additional 16 geographic regions to reflect the range of potential fuels, temperatures, and I/M programs observed in the U.S. These estimates were used in conjunction with the urban area analyses to prepare national level emissions, exposure, and risk estimates Modeling was performed for 1990, 1996, 2007, and 2020. The forecast years included the following scenarios that were defined in consultation with EPA:

- *Scenario 0* -Baseline fuels and emission rates, assuming the implementation of a National Low-Emission Vehicle (NLEV) program.

- *Scenario 1* - Baseline emission factors with an assumed national gasoline regulation limiting sulfur levels to 30 ppm.

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[*] Superscripts denote references provided in Section 14.

- *Scenario 2* - Scenario 1 with more stringent tailpipe hydrocarbon emission standards for light-duty cars and trucks (i.e., reflecting Tier 2 emission standards).

- *Scenario 3* - Scenario 2 with an assumed increase in light-duty Diesel vehicle penetration beginning in model year 2004.

- *Scenario 4* - Tier 2 emission standards with a national gasoline regulation capping benzene content at 1% (modeled as 0.95% in-use).

- *Scenario 5* - Tier 2 emission standards with a national gasoline regulation requiring compliance with a 25% toxics reduction performance standard based on the Complex model.

- *Scenario 6* - More stringent light-duty vehicle emission standards equivalent to 0.055 g/mi non-methane hydrocarbon (NMHC) coupled with a national 30 ppm sulfur cap.

- *Scenario 7* - Scenario 2 with more stringent heavy-duty gasoline vehicle exhaust and evaporative emission standards proposed by EPA in October 1999.[2]

- *Scenario 8* - Scenario 2 with more stringent heavy-duty Diesel vehicle PM emission standards (equivalent to 0.01 g/bhp-hr).

- *Scenario 9* - Scenario 2 with more stringent heavy-duty Diesel vehicle PM emission standards (equivalent to 0.05 g/bhp-hr).

The above scenarios were evaluated to estimate potential impacts of control programs. These scenarios do not necessarily represent either planned or likely controls.

Methodology

Emissions Estimates - The methodology used to prepare the emission estimates for this study was similar to the approach used by EPA in its development of toxics emission rates for the 1993 Motor Vehicle Related Air Toxics Study (MVRATS). In that approach, the MOBILE model is used to generate total organic gas (TOG) emissions from on-road motor vehicles by vehicle class and model year. Toxics fractions, developed as a percentage of the toxic compound of interest contained in TOG emissions, are then applied to the MOBILE-based TOG gram per mile (g/mi) results to arrive at toxic emission rates in g/mi or milligrams per mile (mg/mi). The toxics fractions are developed as a function of vehicle type (e.g., light-duty versus heavy-duty), fuel type (gasoline versus Diesel), and technology type (e.g., non-catalyst versus catalyst).

Although there are similarities between the emissions methodology used in the 1993 MVRATS and the methodology used in this study, there are also a number of areas in which improvements were made. These are summarized below.

- The on-road motor vehicle TOG emission rates were based on more recent estimates that were developed by EPA to support the Tier 2 rulemaking. In addition to revised base emission rate equations, off-cycle emissions effects, revised fleet characteristics, and revised fuel effects were incorporated into the analysis. It should be noted that EPA provided the study team with the applicable inputs for each control scenario.

- The emissions response (both in terms of TOG and toxics) of newer technology vehicles to changes in fuel parameters was based on an evaluation performed with the Complex model for reformulated gasoline. This model was not available at the time the 1993 MVRATS was completed.

- Instead of applying a single toxics fraction to each technology or model year, the emissions impacts of particular fuel formulations on late-model vehicles were assessed separately for normal and high emitting vehicles. The approach used to implement this methodology relied on the development of "toxic-TOG curves" that plotted the target fuel toxic emission rate (in mg/mi) against the base fuel TOG emission rate (in g/mi). Different toxic-TOG curves were developed for each of the fuel formulations investigated in this study. The MOBILE model was then revised to apply the calculated TOG emission rate to the toxic-TOG curve to determine the corresponding toxic emission rate.

Because of the vast number of model runs required in this effort, the process was automated as much as possible. Software was developed to create area-specific input files and to process the model output into a format that could be easily used in the ensuing exposure calculations.

<u>Exposure Estimates</u> - Once the toxics emission rates were developed, toxics exposure was estimated according to the following formula:

$$TOX_{Exposure(\mu g/m3)} = [CO_{Exposure(\mu g/m3)}/CO_{EF(g/mi)}]_{1990} \times TOX_{EF(g/mi)}$$

where TOX reflects one of the six toxic pollutants considered in this study. Because some of the toxic pollutants evaluated in this study (e.g., 1,3-butadiene) have a different photochemical reactivity than CO, the exposure concentrations were adjusted to account for atmospheric transformation. In addition, because the CO ratios are based on the 1990 calendar year, an adjustment was made to account for the increase in VMT relative to 1990. These adjustments were developed in consultation with EPA.

The 1990 CO exposure estimates above were based on modeling performed under contract to EPA with the Hazardous Air Pollutant Exposure Model (HAPEM). These estimates were provided to the study team for each of the modeled urban areas and represent only that portion of CO exposure attributable to on-road motor vehicles. Separate exposure estimates were provided by quarter and for three different demographic groups: (1) total population, (2) outdoor workers, and (3) children 0 to 17 years of age. Outdoor workers were selected because they represent the highest exposed demographic group, while children are generally considered a very sensitive demographic group.

Similar to the toxics emissions estimates, the 1990 CO emission factors were based on a modified version of MOBILE5b that incorporated many revisions expected to be implemented with MOBILE6. This included revised base emission rates, incorporation of off-cycle effects, and revised oxygenated fuel effects.

The 1990 CO emission factors, toxics emission factors (all calendar years and scenarios), and 1990 CO exposure estimates were compiled in a FORTRAN routine to generate exposure estimates according to the formula above. Estimates are prepared according to urban area, calendar year, season, control scenario, vehicle class, demographic group, and toxic compound.

Risk Assessment - Although the original work plan drafted for this study included the analysis of cancer risk, EPA requested that cancer risk estimates not be prepared at this time because work is still underway to develop appropriate unit risk factors to assign to each toxic. Instead, Sierra was instructed to develop a modeling methodology that would allow EPA to input appropriate unit risk factors at a later date. This was accomplished within the FORTRAN routines developed to calculate exposure.

Within the exposure model, estimates of individual cancer risk are calculated with the following formula:

$$CAN_{Ind} = TOX_{Exposure\text{-}Adj\ (\mu g/m3)} \times (UR / YPL)$$

where $TOX_{Exposure\text{-}Adj\ (\mu g/m3)}$ is the toxic exposure estimate adjusted for VMT growth and atmospheric transformation; UR is the unit risk in cancer cases or deaths per person exposed in a lifetime to 1 $\mu g/m^3$ of the toxic compound of interest; and YPL is years per lifetime (typically assumed to be 70 years).

To calculate the total cancer cases for the population, the individual cancer risk defined above was simply multiplied by the population subject to the toxic compound exposure, i.e.,

$$CAN_{Pop} = CAN_{Ind} \times \text{Population}$$

Nationwide Inventory Estimates - As part of this work assignment, toxics emissions inventories (in tons per year) were prepared for each county in the U.S. for all scenarios and calendar years.* To determine the toxics emission rates applicable to individual counties, each county was "mapped" to one of the 26 modeled areas on the basis of similarities in fuels, temperatures, and I/M programs. Once that mapping was completed, it was a simple matter to combine the emission rates with county-level VMT estimates. In addition to the county-level inventories, total emissions were summed for each state and for the U.S. as a whole. For the nationwide estimates, results were prepared for all 50 states and for the 50 states excluding Alaska, California, and Hawaii at the direction of EPA.

Nationwide Exposure and Risk Estimates - In addition to national inventory estimates, a methodology was developed in which national-level exposure and risk estimates were prepared. This included separate estimates for urban areas, rural areas, and the entire United States.

Emissions Results

Gasoline Sulfur and Light-Duty Vehicle Controls - Figures 1-1 and 1-2 show benzene emission rate estimates for Atlanta and Chicago, respectively, for the following control scenarios:

- Scenario 0 (baseline NLEV),
- Scenario 1 (30 ppm national sulfur cap),
- Scenario 2 (Tier 2 emission standards), and
- Scenario 6 (0.055 g/mi NMHC standards for light-duty vehicles).

Because of the voluminous nature of the estimates prepared for this study, results are presented in Figures 1-1 and 1-2 only for Atlanta (a non-RFG area) and Chicago (an RFG area); more detailed results (i.e., other pollutants and areas) can be found in Section 7 and in Volume II of this report. However, the results shown in Figures 1-1 and 1-2 are generally reflective of the trends observed for these control scenarios.

Reviewing the fleet-average toxics emission factors in Figures 1-1 and 1-2, the following observations can be made:

- Significant reductions in fleet-average toxics emissions are observed between 1990 and 2020 with no further vehicle or fuel controls. This is a result of fleet-turnover resulting in full implementation of the federal emission control regulations currently on the books.

- Implementation of Scenario 1, a 30 ppm national gasoline sulfur cap, resulted in a net decrease in benzene for both areas. Atlanta experienced a larger

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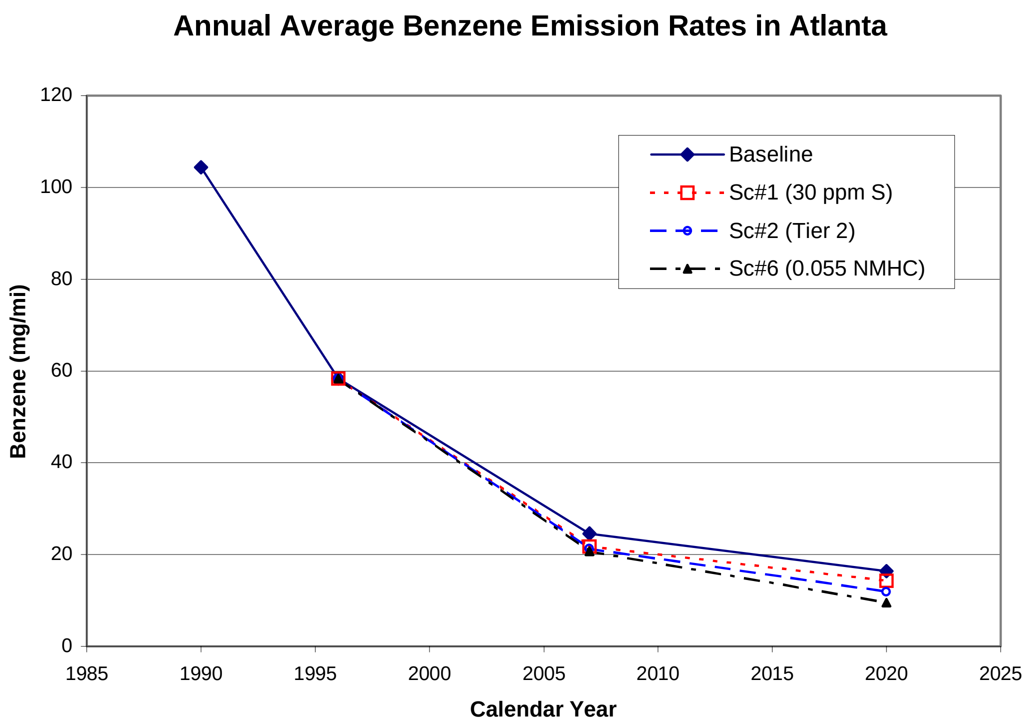
* As explained later in the report, it was not possible to prepare national inventories for Scenarios 4 and 5. Instead, emissions estimates and inventories were generated for seven specific urban areas to give a range of potential emissions impacts.

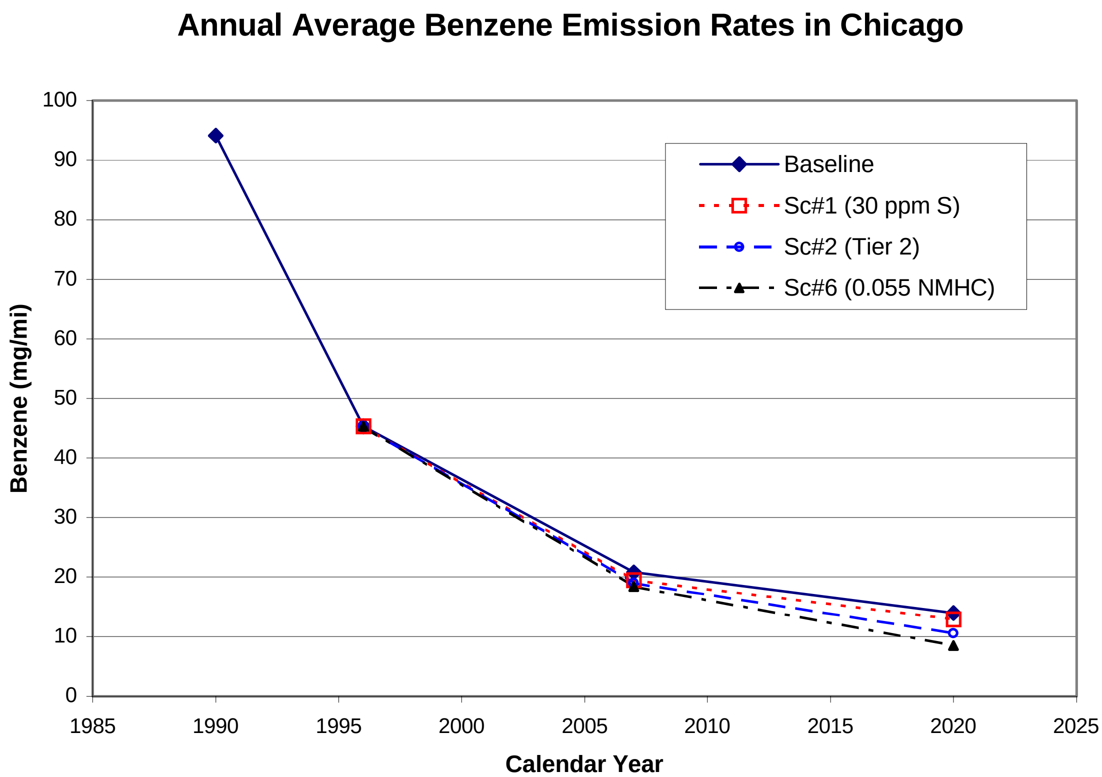
decrease because Chicago was assumed to use RFG in the baseline scenario. This measure resulted in a decrease of all toxic emissions except Diesel PM.

Figure 1-1



Annual Average Benzene Emission Rates in Atlanta
Benzene (mg/mi)
120
100
80
60
40
20
0
1985
1990
1995
2000
2005
2010
2015
2020
2025
Calendar Year
Baseline
Sc#1 (30 ppm S)
Sc#2 (Tier 2)
Sc#6 (0.055 NMHC)

Figure 1-2



Annual Average Benzene Emission Rates in Chicago
Benzene (mg/mi)
100
90
80
70
60
50
40
30
20
10
0
1985
1990
1995
2000
2005
2010
2015
2020
2025
Calendar Year
Baseline
Sc#1 (30 ppm S)
Sc#2 (Tier 2)
Sc#6 (0.055 NMHC)

- Implementation of Scenario 6, more stringent light-duty vehicle emission standards (0.055 g/mi NMHC), results in reductions beyond those achieved by the Tier 2 standards.

The Tier 2 emission standards reflected in Scenario 2 result in reductions in all pollutants. The benefits of Scenario 2 are greater for the 2020 runs because of the fleet turnover that occurs between 2007 and 2020. The Tier 2 standards also include reductions in light-duty Diesel particulate emissions, but the reductions in fleet-average Diesel PM are very moderate under Scenario 2 because of the small contribution of light-duty Diesel cars and trucks to overall fleet VMT. Although not shown in Figures 1-1 and 1-2, the increased light-duty Diesel penetration scenario (Scenario 3) generally reduced benzene emissions and increased formaldehyde emissions. Fleet-average Diesel PM emissions also increased under that case.

<u>Fuel Controls</u> - In addition to the 30 ppm sulfur cap, two other fuel scenarios were evaluated in this study:

- Scenario 4 - a national gasoline regulation capping benzene content at 1% (modeled as 0.95% in-use); and

- Scenario 5 - a national regulation requiring compliance with a 25% toxics reduction performance standard using the Complex model.

Both of these scenarios were modeled assuming that Tier 2 emission standards were in place, and estimates were prepared for 2007 and 2020. Because of the difficulty in predicting fuel specifications for these scenarios, and because some areas would be relatively unaffected by these rules (e.g., areas that already had benzene levels below 0.95% would see no impact from Scenario 4), these scenarios were modeled only for the following areas: Atlanta, Cleveland, Eau Claire, Kansas City, Minneapolis, Pittsburgh, and Seattle. A summary of the fleet-average results for benzene for selected areas is given in Table 1-1. The results for the remaining pollutants can be found in Volume II of this report.

Several items are worth noting with respect to the results presented in Table 1-1. First, the benzene cap scenario does not impact all areas equally because the baseline fuels (i.e., the 30 ppm sulfur case) in each area has a different benzene level. In areas such as Seattle, which has a relatively high baseline benzene level (1.8% to 2.2%, depending on season), substantial reductions in benzene emission rates are observed for Scenario 4. However, scenario 4 resulted in a slight increase in benzene in Atlanta because the 30 ppm S fuel in those areas had annual average benzene levels that were below the 0.95% level, and the fuel parameters provided by EPA for modeling the impacts of the benzene cap was set at 0.95% for all areas. Under the 25% toxics reduction performance standard scenario, all areas were predicted to have reductions in benzene levels. Again, however, the extent of that reduction was dependent upon the specifications of the baseline fuel.

Table 1-1 **Fleet-Average Benzene Emission Rates for Fuel Control Scenarios**			
		Benzene (mg/mi)	
Area	Scenario	2007	2020
Atlanta	Sc#2 (30 ppm S) Sc#4 (Bnz Cap) Sc#5 (25% Red.)	21.3 22.2 19.1	11.9 12.4 10.7
Cleveland	Sc#2 (30 ppm S) Sc#4 (Bnz Cap) Sc#5 (25% Red.)	24.4 23.3 21.0	13.4 12.8 11.6
Kansas City	Sc#2 (30 ppm S) Sc#4 (Bnz Cap) Sc#5 (25% Red.)	34.0 31.7 30.4	22.5 20.8 20.0
Seattle	Sc#2 (30 ppm S) Sc#4 (Bnz Cap) Sc#5 (25% Red.)	32.4 24.8 20.8	17.8 13.7 11.6

Heavy-Duty Vehicle Controls - A final set of emissions estimates that was prepared for this study involved changes to heavy-duty vehicles. Three separate scenarios were modeled in this case:

- Scenario 7 - more stringent heavy-duty gasoline vehicle emission standards proposed by EPA in October 1999;
- Scenario 8 - more stringent heavy-duty Diesel vehicle PM emission standards (equivalent to 0.01 g/bhp-hr); and
- Scenario 9 - more stringent heavy-duty Diesel vehicle PM emission standards (equivalent to 0.05 g/bhp-hr).

The above scenarios were run for all urban areas (and geographic areas) modeled in this study for the 2007 and 2020 calendar years. It was assumed that the Scenario 2 assumptions applied to light-duty vehicles for the analysis of Scenarios 7 to 9.

The results for Scenario 7 are summarized in Table 1-2, which shows class-specific emission rates in Atlanta and Chicago for benzene, acetaldehyde, formaldehyde, and 1,3-butadiene. Because HDGVs make up such a small fraction of the total VMT, the impact of this control measure on fleet-average emissions is very slight (about 0.8% in Atlanta in 2020). For the HDGV class, this control measure achieves a 13% to 15% reduction in benzene emissions in 2020. Similar reductions are observed for the other toxics as well. It is interesting to note that a significant reduction in HDGV emissions is observed between 2007 and 2020 without further controls. This is a result of the fact that compliance with the 2.5 g/bhp-hr HC + NOx standard beginning in 2004 is assumed to be in the baseline emission estimates.

Table 1-2
<u>Class-Specific</u> Emission Rates for More Stringent Emission Standards for Heavy-Duty Gasoline Vehicles (Scenario 7)

Area	Year	Scenario	Emission Rate (mg/mi)			
			Bnz	Acet	Form	1,3-But
Atlanta	2007	Sc#2	59.0	7.4	30.0	5.7
		Sc#7	56.6	7.2	29.3	5.6
	2020	Sc#2	28.2	2.7	9.3	1.6
		Sc#7	24.5	2.5	8.6	1.5
Chicago	2007	Sc#2	40.1	15.6	28.2	4.9
		Sc#7	38.3	15.2	27.5	4.8
	2020	Sc#2	18.3	5.6	7.9	1.1
		Sc#7	15.5	5.2	7.3	1.0

A summary of the Diesel PM emissions estimates for Scenarios 8 and 9 is contained in Table 1-3. Based on the simple assumptions that were used in this analysis (e.g., no deterioration in PM emissions, even though trap technology would likely be required to meet these emission levels), significant emission reductions are achieved in the 2020 runs for both the 0.01 g/bhp-hr case and the 0.05 g/bhp-hr case. However, this represents a best-case scenario, and is not necessarily reflective of what would occur in customer service. Note that these results are not presented by area. That is because the PART5 model does not account for regional differences in Diesel fuel or temperature in its estimates.

Table 1-3
Fleet-Average Diesel PM Emission Rates for More Stringent Heavy-Duty Diesel PM Emission Standards (Scenarios 8 and 9)

Scenario	2007 (mg/mi)	2020 (mg/mi)
Sc#2 (Baseline)	19.0	15.5
Sc#8 (0.01 g/bhp-hr)	17.8	3.0
Sc#9 (0.05 g/bhp-hr)	18.2	8.7

Exposure Results

Exposure Estimates–Gasoline Sulfur and Light-Duty Vehicle Controls - Annual average benzene and Diesel PM exposure results for the fleet (i.e., all vehicle classes combined) are given in Tables 1-4 and 1-5, respectively, for Atlanta and Chicago for the following control scenarios:

- Scenario 0 (baseline NLEV),
- Scenario 1 (30 ppm national sulfur cap),
- Scenario 2 (Tier 2 emission standards),
- Scenario 3 (increased light-duty Diesel penetration), and
- Scenario 6 (0.055 g/mi NMHC standards for light-duty vehicles).

Insert Table 1-4

It is interesting to note that the motor vehicle air toxics exposures are estimated to decrease substantially between 1990 and 2020, even without additional controls on vehicles and fuels. This is a result of fleet-turnover and the full implementation of federal regulations that are currently in place. However, for some pollutants for which heavy-duty Diesel vehicles are a large contributor (i.e., formaldehyde and Diesel PM), exposure increases between 2007 and 2020. This is a result of fleet VMT growing at a faster rate than the reduction in fleet emissions between 2007 and 2020.

Table 1-4
Annual Average Exposure Results for Benzene
Total Population -- All On-Road Vehicles
(Units: ug/m3)

Area	Scenario	1990 CO Ratio	Calendar Year 1990	1996	2007	2020
Atlanta	Base	8.80	0.930	0.836	0.480	0.428
	Sc#1	8.80	---	---	0.424	0.374
	Sc#2	8.80	---	---	0.413	0.309
	Sc#3	8.80	---	---	0.406	0.272
	Sc#6	8.80	---	---	0.401	0.247
Chicago	Base	8.36	0.784	0.482	0.264	0.220
	Sc#1	8.36	---	---	0.248	0.204
	Sc#2	8.36	---	---	0.241	0.167
	Sc#3	8.36	---	---	0.237	0.147
	Sc#6	8.36	---	---	0.233	0.133

As one might expect, the benefits of Scenario 1, a national gasoline rule limiting sulfur to 30 ppm, are greatest in areas that do not have a pre-existing reformulated gasoline program such as Atlanta. Areas with an RFG program (e.g., Chicago) show more

Insert Table 1-5

moderate decreases in motor vehicle toxics exposure, depending on pollutant, as a result of a national gasoline sulfur limit. The more stringent light-duty vehicle exhaust emission standards included in Scenario 2 (Tier 2 standards) and Scenario 6 (0.055 g/mi NMHC standards) in general show greater decreases in toxics exposure than the other light-duty vehicle control scenarios modeled in this effort, particularly for the 2020 calendar year run. Finally, the increased light-duty Diesel penetration scenario modeled in Scenario 3 results in increased Diesel particulate exposure levels, although benzene exposure is decreased.

Exposure Estimates–Fuel Controls - As noted above, two other fuel scenarios were evaluated in this study in addition to the national 30 ppm sulfur cap:

- Scenario 4 - a national gasoline regulation capping benzene content at 1%, and
- Scenario 5 - a national regulation requiring compliance with a 25% toxics reduction performance standard.

Both of these scenarios were modeled assuming that Tier 2 emission standards were in place, and estimates were prepared for 2007 and 2020. A summary of results is given in Table 1-6. Because area-specific CO exposure estimates were not available for Cleveland, Eau Claire, Kansas City, Pittsburgh, and Seattle, the results in Table 1-6 are

Table 1-5
Annual Average Exposure Results for Diesel PM
Total Population -- All On-Road Vehicles
(Units: ug/m3)

Area	Scenario	1990 CO Ratio	Calendar Year 1990	1996	2007	2020
Atlanta	Base	8.80	0.775	0.582	0.365	0.411
	Sc#1	8.80	---	---	0.365	0.411
	Sc#2	8.80	---	---	0.363	0.399
	Sc#3	8.80	---	---	0.397	0.445
	Sc#6	8.80	---	---	0.363	0.399
Chicago	Base	8.36	0.761	0.387	0.240	0.250
	Sc#1	8.36	---	---	0.240	0.250
	Sc#2	8.36	---	---	0.239	0.243
	Sc#3	8.36	---	---	0.261	0.271
	Sc#6	8.36	---	---	0.239	0.243

subject to some uncertainty. This should be kept in mind when evaluating the results of the exposure modeling.

Table 1-6
Annual Average Benzene Exposure for Fuel Control Scenarios
All On-Road Vehicles – Total Population

Area	Scenario	Benzene Exposure (μg/m^3)	
		2007	2020
Atlanta	Sc#2 (30 ppm S)	0.413	0.309
	Sc#4 (Bnz Cap)	0.432	0.323
	Sc#5 (25% Red.)	0.369	0.279
Cleveland	Sc#2 (30 ppm S)	0.324	0.209
	Sc#4 (Bnz Cap)	0.310	0.200
	Sc#5 (25% Red.)	0.278	0.181
Eau Claire	Sc#2 (30 ppm S)	0.831	0.684
	Sc#4 (Bnz Cap)	0.743	0.610
	Sc#5 (25% Red.)	0.702	0.578
Kansas City	Sc#2 (30 ppm S)	0.286	0.238
	Sc#4 (Bnz Cap)	0.268	0.222
	Sc#5 (25% Red.)	0.257	0.213
Minneapolis	Sc#2 (30 ppm S)	0.736	0.620
	Sc#4 (Bnz Cap)	0.591	0.493
	Sc#5 (25% Red.)	0.586	0.488
Pittsburgh	Sc#2 (30 ppm S)	0.268	0.184
	Sc#4 (Bnz Cap)	0.275	0.188
	Sc#5 (25% Red.)	0.245	0.169
Seattle	Sc#2 (30 ppm S)	0.733	0.540
	Sc#4 (Bnz Cap)	0.562	0.415
	Sc#5 (25% Red.)	0.471	0.352

Reviewing the results in Table 1-6 one finds that benzene exposure is generally estimated to be the highest in Eau Claire and Minneapolis. That is because 1990 CO exposure was relatively high in Minneapolis (which was also used for Eau Claire), these areas are predicted not to have I/M programs in the future, and both areas have relatively high aromatics content in their gasoline (which is a large contributor to exhaust benzene emissions). On the other hand, Pittsburgh and Cleveland were predicted to have the lowest benzene exposure for the fuel control scenarios because both areas were assumed to have an I/M program in place in the future and the 1990 CO exposure assumed for these areas was relatively low compared to Minneapolis and Eau Claire.

Exposure Estimates–Heavy-Duty Vehicle Controls - A final set of exposure estimates that was prepared for this study involved changes to heavy-duty vehicles. Three separate scenarios were modeled in this case:

- Scenario 7 - more stringent heavy-duty gasoline vehicle emission standards;
- Scenario 8 - more stringent heavy-duty Diesel vehicle PM emission standards (equivalent to 0.01 g/bhp-hr); and
- Scenario 9 - more stringent heavy-duty Diesel vehicle PM emission standards (equivalent to 0.05 g/bhp-hr).

The above scenarios were run for all urban areas (and geographic areas) modeled in this study for the 2007 and 2020 calendar years.

The exposure results for Scenario 7 are summarized in Table 1-7, which shows results for Atlanta and Chicago for benzene, acetaldehyde, formaldehyde, and 1,3-butadiene. As seen in the table, Scenario 7 has a very small impact on exposure from motor vehicles. That is because HDGVs make up a small portion of the overall fleet VMT.

Table 1-7
Annual Average Exposure Results for More Stringent Emission Standards for Heavy-Duty Gasoline Vehicles (Scenario 7)
All On-Road Vehicles – Total Population

Area	Year	Scenario	Emission Rate (μg/m^3)			
			Bnz	Acet	Form	1,3-But
Atlanta	2007	Sc#2	0.413	0.064	0.175	0.042
		Sc#7	0.412	0.064	0.175	0.042
	2020	Sc#2	0.309	0.063	0.170	0.038
		Sc#7	0.307	0.063	0.169	0.038
Chicago	2007	Sc#2	0.241	0.079	0.129	0.023
		Sc#7	0.240	0.079	0.129	0.023
	2020	Sc#2	0.167	0.061	0.113	0.019
		Sc#7	0.166	0.061	0.112	0.019

A summary of the Diesel PM exposure estimates for Scenarios 8 and 9 is contained in Table 1-8 for Atlanta and Chicago, along with estimates from Scenario 2. Based on the simple assumptions that were used in this analysis (e.g., no deterioration in PM emissions, even though trap technology would likely be required to meet these emission levels), significant reductions in exposure are achieved in the 2020 runs for both the 0.01 g/bhp-hr case and the 0.05 g/bhp-hr case. Under the baseline case assumed in Table 8-14 (i.e., Scenario 2), Diesel PM exposure is estimated to increase between 2007 and 2020. This is a result of VMT growth exceeding reductions in fleet-average emissions and is more pronounced in Atlanta than in Chicago.

Table 1-8
Annual Average Diesel PM Exposure Results for More Stringent Heavy-Duty Diesel PM Emission Standards (Scenarios 8 and 9)
All On-Road Vehicles – Total Population

Area	Scenario	2007 (μg/m^3)	2020 (μg/m^3)
Atlanta	Sc#2 (Baseline) Sc#8 (0.01 g/bhp-hr) Sc#9 (0.05 g/bhp-hr)	0.363 0.340 0.349	0.399 0.077 0.224
Chicago	Sc#2 (Baseline) Sc#8 (0.01 g/bhp-hr) Sc#9 (0.05 g/bhp-hr)	0.239 0.224 0.230	0.243 0.047 0.136

Nationwide Inventory Estimates

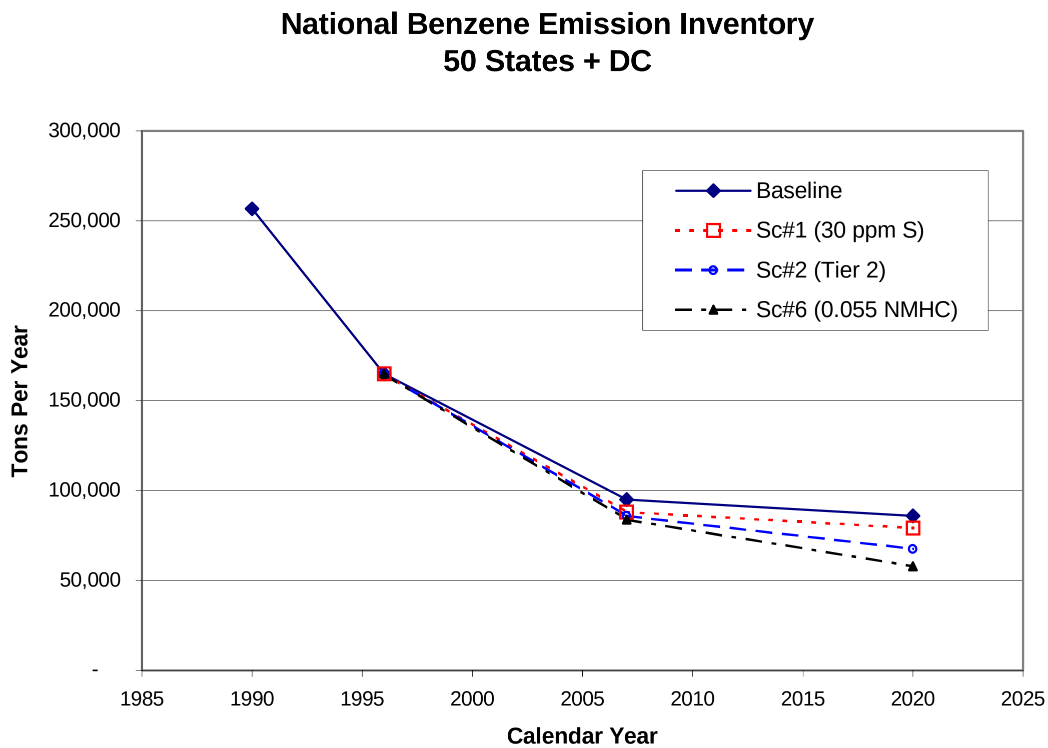
Annual average emissions inventories were also prepared for each county in the U.S. for the calendar years and scenarios described above. (As noted previously, inventories were not prepared for Scenarios 4 and 5). The results of that analysis are summarized in Table 1-9. It is also useful to view these results in terms of trend lines, which is given in Figure 1-3 for benzene emissions evaluated for Scenarios 0 (baseline), 1, 2, and 6. As observed in that figure, substantial decreases in emissions occur between 1990 and 2007. Between 2007 and 2020, more moderate decreases are observed as VMT growth starts to overtake the fleet-average emission reductions achieved through fleet-turnover.

Table 1-9

Table 1-9
Annual Toxics Emissions Summary for the Total U.S.

Calendar Year	Scenario	Annual Emissions (tons per year)					
		Benzene	Acet.	Form.	Butadiene	MTBE	Diesel PM
1990	Base	256,761	40,912	138,607	36,396	54,584	202,265
1996	Base	165,023	27,411	80,262	22,206	64,611	111,530
2007	Base	95,101	15,366	37,455	12,762	23,506	65,462
	Sc#1 (30 ppm S)	88,158	14,887	36,461	11,471	25,408	65,462
	Sc#2 (Tier 2)	86,058	14,634	35,881	11,291	25,280	65,180
	Sc#3 (Inc. Diesel)	84,332	14,758	36,507	11,276	24,639	71,165
	Sc#6 (0.055 NMHC)	83,973	14,415	35,377	10,998	25,105	65,180
	Sc#7 (HDGV Stds)	85,850	14,612	35,815	11,282	25,064	65,180
	Sc#8 (0.01 HDDV PM)	86,058	14,634	35,881	11,291	25,280	61,047
	Sc#9 (0.05 HDDV PM)	86,058	14,634	35,881	11,291	25,280	62,660
2020	Base	85,930	15,182	37,181	12,718	18,032	69,693
	Sc#1 (30 ppm S)	79,160	14,701	36,139	11,406	19,611	69,693
	Sc#2 (Tier 2)	67,503	13,281	33,074	10,169	18,684	67,641
	Sc#3 (Inc. Diesel)	58,750	13,258	33,977	9,467	16,050	75,510
	Sc#6 (0.055 NMHC)	58,020	12,325	31,164	8,459	17,624	67,641
	Sc#7 (HDGV Stds)	67,017	13,250	32,978	10,156	17,872	67,641
	Sc#8 (0.01 HDDV PM)	67,503	13,281	33,074	10,169	18,684	12,983
	Sc#9 (0.05 HDDV PM)	67,503	13,281	33,074	10,169	18,684	37,945

Figure 1-3


National Benzene Emission Inventory
50 States + DC
Tons Per Year
300,000
250,000
200,000
150,000
100,000
50,000
-
1985
1990
1995
2000
2005
2010
2015
2020
2025
Calendar Year
Baseline
Sc#1 (30 ppm S)
Sc#2 (Tier 2)
Sc#6 (0.055 NMHC)

2. INTRODUCTION

Background

The 1990 Amendments to the Clean Air Act added requirements for hazardous air pollutants (HAPs), or air toxics. For the most part, those requirements are spelled out in Section 112, which focuses on stationary and area sources. In addition, other sections of the Act include provisions for air toxics. In particular, Section 202(l) contains two requirements specific to motor vehicles:

- By May 15, 1992, EPA was to complete a study of the need for, and feasibility of, controlling emissions of toxic air pollutants associated with motor vehicles and motor vehicle fuels. That study was to focus on the categories of emissions that pose the greatest risk to human health (or about which significant uncertainties remain), including benzene, formaldehyde, and 1,3-butadiene.

- By May 15, 1995, EPA was to promulgate regulations containing reasonable requirements to control HAPs from motor vehicles and motor vehicle fuels. At a minimum, those regulations were to apply to benzene and formaldehyde.

The result of the first directive was the "Motor Vehicle-Related Air Toxics Study," (MVRATS) finalized by EPA in April 1993.[3] Although emission standards specific to air toxics were included in the reformulated gasoline rulemaking promulgated in December 1993,[4] EPA has yet to adopt HAP emissions regulations for motor vehicles, as required under the second directive above.

Last year, Sierra and its subcontractors carried out a work assignment (Work Assignment 0-07 of Contract No. 68-C7-0051) to support possible regulatory action required by Section 202(l) and to estimate cancer risk in the regulatory impact analysis for the proposed Tier 2 tailpipe emission standards. Since the completion of Work Assignment 0-07 (WA#0-07), EPA has revised a number of assumptions related to modeling emissions as part of the Tier 2 rulemaking effort. Because of that, there is a need to update the toxics emissions and exposure estimates previously prepared under WA#0-07.

In addition to updating the previous toxics emissions and exposure estimates, this work assignment (WA#1-06) involved the preparation of toxics emissions estimates for additional areas, additional vehicle control scenarios (including heavy-duty vehicles), additional fuel scenarios, and additional light-duty Diesel vehicle penetration scenarios.

Revised exposure estimates were prepared on a nationwide basis and for 10 urban areas (i.e., the nine areas previously analyzed and Atlanta). As in the previous work assignment, the toxic compounds addressed in WA#1-06 included benzene, 1,3-butadiene, formaldehyde, acetaldehyde, MTBE, and Diesel particulate matter (PM).

Project Scope

Under this work assignment, on-road motor vehicle air toxics emissions, exposure, and cancer risk were estimated for ten urban areas consisting of Atlanta, Chicago, Denver, Houston, Minneapolis, New York City, Philadelphia, Phoenix, Spokane, and St. Louis. Emissions modeling was also performed for an additional 16 geographic regions to reflect the range of potential fuels, temperatures, and I/M programs observed in the U.S. These estimates were used in conjunction with the urban area analyses to prepare national level emissions, exposure, and risk estimates Modeling was performed for 1990, 1996, 2007, and 2020. The forecast years included the following scenarios that were defined in consultation with EPA:

- *Scenario 0* - Baseline fuels and emission rates, assuming the implementation of a National Low-Emission Vehicle (NLEV) program.

- *Scenario 1* - Baseline emission factors with an assumed national gasoline regulation limiting sulfur levels to 30 ppm.

- *Scenario 2* - Scenario 1 with more stringent tailpipe hydrocarbon emission standards for light-duty cars and trucks (i.e., reflecting Tier 2 emission standards).

- *Scenario 3* - Scenario 2 with an assumed increase in light-duty Diesel vehicle penetration beginning in model year 2004.

- *Scenario 4* - Tier 2 emission standards with a national gasoline regulation capping benzene content at 1% (modeled as 0.95% in-use).

- *Scenario 5* - Tier 2 emission standards with a national gasoline regulation requiring compliance with a 25% toxics reduction performance standard.

- *Scenario 6* - More stringent light-duty vehicle emission standards equivalent to 0.055 g/mi non-methane hydrocarbon (NMHC) coupled with a national 30 ppm sulfur cap.

- *Scenario 7* - Scenario 2 with more stringent heavy-duty gasoline vehicle emission standards proposed by EPA in October 1999.

- *Scenario 8* - Scenario 2 with more stringent heavy-duty Diesel vehicle PM emission standards (equivalent to 0.01 g/bhp-hr).

- *Scenario 9* - Scenario 2 with more stringent heavy-duty Diesel vehicle PM emission standards (equivalent to 0.05 g/bhp-hr).

The methodology used to determine motor vehicle toxics emission rates, exposure, and cancer risk consisted of the following steps:

1. On-road motor vehicle toxic pollutant emission factors (in mg/mi) were generated using a modified version of the MOBILE5b emission factors model. That model, known as MOBTOX5b, has been revised to allow the user more flexibility to model the impacts of off-cycle operation and fuel sulfur effects. In addition, that model allows the user to input toxics fractions (by model year and technology) that are applied to total organic gas (TOG) emission rates calculated by the model. This step involved the development of TOG base emission rate equations (BERs) as well as toxics fractions.[*] The toxic pollutants evaluated in this study included benzene; formaldehyde; acetaldehyde; 1,3-butadiene; MTBE; and Diesel particulate (which was estimated with the PART5 model). Toxic pollutant emission rates were calculated for each of the urban areas and geographic regions, calendar years (separate estimates for quarters 1 to 4), and control scenarios included in this study.

2. On-road motor vehicle carbon monoxide (CO) g/mi emission factors were developed for each of the urban areas and geographic regions included in the study using a modified version of the Tier 2 Analysis Tool (T2AT). These calculations were performed for calendar year 1990 to be consistent with the CO exposure estimates described in Step 3 below.

3. CO exposure estimates (in $\mu g/m^3$) were calculated previously for the ten urban areas included in this study for calendar year 1990. Using the CO emission factors developed in Step 2 above, ratios of CO exposure (adjusted to reflect only the on-road motor vehicle contribution to the inventory in each urban area) to the CO emission factor for 1990 were developed. These ratios were prepared for the entire population, children under 18 years of age, and outdoor workers (the highest exposed demographic group) for quarters 1 to 4.

4. Using the toxic pollutant emission rates and the CO ratios described above, estimates of toxic exposure were developed for each urban area, calendar year (by quarter), and control scenario investigated in this study. These estimates were calculated according to the following formula:

$$TOX_{Exposure(\mu g/m3)} = [CO_{Exposure(\mu g/m3)}/CO_{EF(g/mi)}]_{1990} \times TOX_{EF(g/mi)}$$

[*] As described in Section 4 of this report, the final methodology developed for this project uses a slightly different approach for estimating exhaust toxics emission rates. (See the discussion of toxic-TOG curves in the text.)

where TOX reflects one of the six toxic pollutants considered in this study. Because some of the toxic pollutants evaluated in this study (e.g., 1,3-butadiene) have a different photochemical reactivity than CO, the exposure concentrations were adjusted to account for atmospheric transformation. In addition, because the CO ratios are based on the 1990 calendar year, an adjustment was made to account for the increase in VMT relative to 1990. These adjustments were developed in consultation with EPA.

5. Using the toxic pollutant exposure concentrations generated in Step 4, a methodology to estimate cancer risk was developed that applies cancer potency estimates (i.e., unit risk factors) for each toxic to the exposure estimates. Because cancer potency estimates were not finalized for inclusion in this work assignment, the model developed to compile the emissions and exposure data was structured to allow the user to input alternative potency estimates. Based on these inputs, the model calculates cancer risk for the entire population, the highest exposed demographic group (i.e., outdoor workers), and children 0–17 years of age. Total cancer cases for the entire population of each modeled urban area can be estimated.

6. The toxic emission rates prepared for each urban area and geographic region were coupled with VMT estimates for each county in the U.S. to generate national-level annual average emission inventories for each analysis year and control scenario described above.* This analysis was performed by "mapping" each county in the U.S. to one of the 26 different modeled areas (10 urban areas and 16 geographic regions) analyzed in this study on the basis of similarities in fuels, temperatures, and control programs (i.e., I/M).

7. Using national average estimates of toxics emissions, CO emissions, and CO exposure, a model was developed to estimate exposure and risk on a nationwide basis. At the direction of EPA, results are presented for all 50 states (+ D.C.) and for the 50 states (+ D.C.) excluding Alaska, California, and Hawaii.

In addition to the calculation of toxics emissions, exposure, and risk, two other tasks were performed in this study. First, the modeled exposure results for 1996 were compared to available monitoring data for a number of different urban areas. Second, a sensitivity analysis was performed in which a number of inputs to the emissions modeling protocol were modified to investigate the impact that those modifications had on the model output.

This project was conducted by Sierra Research and Radian International/Eastern Research Group (Radian/ERG). Sierra served in an oversight capacity and had primary responsibility for generating toxics fractions, TOG base emission rate equations, and the CO emissions estimates. In addition, Sierra was responsible for generating exposure estimates and developing the model to estimate cancer risk. Radian/ERG was responsible

* As explained later in the text, national level estimates for Scenarios 4 and 5 were not generated.

for constructing MOBTOX5b and PART5 input files, modifying the model to incorporate the methodologies developed during the course of this project, and performing the model runs. Radian/ERG also had lead responsibility for the comparison of modeled exposure estimates to ambient concentrations, while Sierra had primary responsibility for defining the sensitivity cases and providing modified input to Radian/ERG for the resulting model runs.

Organization of the Report

This report is bound as two separate volumes. This volume (Volume I) contains a description of the study, the methodologies used to generate toxic emission rate and exposure estimates, and a summary of the results. Volume II contains detailed toxic emission rate and exposure estimates calculated for each of the study areas, years, control scenarios, seasons, and demographic groups evaluated in this effort.

Immediately following this introduction, Volume I continues with Section 3, which describes the modifications to the MOBILE5b modeling methodology for calculating TOG and CO emissions to account for a number of planned revisions for MOBILE6. This includes revised base emission rate equations, inclusion of off-cycle emissions impacts, revised fuel sulfur and oxygenate effects, and revised fleet characteristics. Section 4 presents the modeling methodology used to estimate motor vehicle air toxics emission rates. Section 5 presents a detailed description of the control scenarios modeled in this study. Section 6 details the specific MOBILE inputs used for the emissions modeling, while Section 7 summarizes the results of the toxics emissions modeling for the 10 urban areas evaluated in this effort. Section 8 explains how the emissions data were combined with 1990 CO exposure data to generate toxics exposure estimates for the 10 urban areas assessed in this study. The results of that modeling are also briefly discussed in that section. A description of how the national level emission rates and inventories were developed is contained in Section 9, while Section 10 provides details of the national-level exposure estimates. Section 11 presents a summary of risk assessment and describes how the exposure model developed for this study was structured to allow the user to input alternative unit risk factors to calculate individual cancer risk and estimated cancer cases. Finally, the comparison of modeled exposure results to monitoring data is presented in Section 12, and Section 13 contains the results of the sensitivity analysis. A listing of the references cited in this report is contained in Section 14.

Volume II of this study consists only of tables that summarize the results of the evaluation, presented in four primary sections:

- Modeled Urban Area Toxics Emission Estimates;
- Modeled Urban Area Toxics Exposure Estimates;
- National Level Toxics Inventory Estimates; and

- National Level Toxics Exposure Estimates.

###

3. TOG AND CO MODELING METHODOLOGY

As outlined in the previous section of this report, estimates of total organic gas (TOG) and carbon monoxide (CO) emission rates are needed for this study. As such, EPA's MOBILE model served as the basis of those estimates. The latest "official" version of EPA's on-road motor vehicle emission factors model is MOBILE5b, which was based on the MOBILE5a model. Although MOBILE5b was released in October 1996, the changes made to the model were minimal relative to MOBILE5a, consisting primarily of (1) revisions to account for the effect of regulations that had been finalized after the release of MOBILE5a, and (2) revisions to inspection and maintenance (I/M) program inputs to reflect program designs being pursued by states that were not included in the MOBILE5a model. The most substantive change to CO modeling between MOBILE5a and MOBILE5b was a result of including the impacts of the gasoline detergent additive regulation in the MOBILE5b model.

Most of the algorithms included in MOBILE5b are based on data and analyses performed seven years ago. (MOBILE5 was released in December 1992. That model was updated and released as MOBILE5a in March 1993 to correct errors found in the original release of the model.) Since that time, a significant amount of data has been collected on in-use emissions performance, vehicle operational characteristics, and the impact of fuel parameters on emissions. Over the past two to three years, EPA has been in the process of updating MOBILE5b to reflect the latest knowledge on vehicle emissions. In fact, a modified version of the model was developed to estimate the emissions impacts of possible Tier 2 controls at the time the original Tier 2 Study was released in the spring of 1998. As discussed in the documentation prepared for that model,[5] which was termed the Tier 2 Analysis Tool (T2AT), the modified MOBILE5b model was developed as a "surrogate for MOBILE6," addressing four primary areas of development: (1) basic emission rates, (2) off-cycle effects, (3) fuel effects (primarily sulfur), and (4) fleet characteristics.[*]

Many of the model inputs used in the April 1998 Tier 2 analysis were incorporated into the analysis of air toxics performed last year under WA#0-07. Since that time, EPA has continued to refine its estimates of base emission rates, off-cycle effects, and sulfur

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[*] EPA has also developed a toxics version of T2AT, termed T2ATTOX. The T2ATTOX model was the starting point for the model developed for this study. However, significant modifications were made to that model to incorporate the algorithms developed in this study. The resulting model will be called MOBTOX5b throughout this report to distinguish it from those developed by EPA.

impacts. The input parameters used in the current study (WA#1-06) incorporate available elements used to model VOC emissions in the Tier 2 final rule.
To summarize, the following elements were incorporated into the toxics modeling performed for this effort:

- Base Emission Rates - The base emission rates (BERs) used in this study were updated by EPA based on more recent test data. The revised BERs reflect much lower deterioration rates than the current factors in MOBILE5b. This shift was directed at early-1980 model year vehicles and later. Thus, the net impact of this change is to lower fleet average in-use emission rates for future calendar years (i.e., the impact of fleet turnover is greater than that predicted by MOBILE5b).

- Off-Cycle Effects - Concern about inconsistencies between ambient measurements and inventory estimates led to a closer evaluation of the basis of emission factor estimates in the late 1980s. As a result, the 1990 Clean Air Act Amendments directed EPA to assess the magnitude of “off-cycle” emissions and to develop regulations for their control. During the early 1990s, a significant effort to better define in-use vehicle operation was undertaken by EPA and CARB. The result of that effort was the development of driving cycles more representative of true vehicle operation (i.e., higher speed and acceleration). In addition, Supplemental Federal Test Procedure (SFTP) regulations were adopted that will control off-cycle emissions starting with the 2000 model year (2001 for NLEVs). The net result of adding off-cycle emissions impacts is to increase emissions for pre-SFTP vehicles, which are then decreased in future years as SFTP controls are implemented and the fleet turns over.

- Revised Fuel Effects - The impact of both gasoline sulfur and oxygen levels will be revised in MOBILE6. The impact of gasoline sulfur levels was accounted for in the modeling performed for the Tier 2 rulemaking and has also been included in the toxics estimates prepared for this study. For oxygenated fuels, draft correction factors have been proposed by EPA that indicate the oxygenated fuel CO benefits for late-model vehicles are much lower than those predicted by MOBILE5b. These revised factors were incorporated into the CO estimates prepared for this study.

- Revised Fleet Characteristics - Because of the high sales fraction of light-duty trucks relative to passenger cars in the last several years, estimates of the car versus truck VMT split are being revised for MOBILE6. Current indications are that there will be a large shift to light trucks with MOBILE6, with the trend continuing beyond 2010. Because of the higher per-mile emission rates of light trucks relative to passenger cars, this shift will result in an increase in fleet-average emissions in the future. In addition to the car/truck VMT fractions, vehicle age distributions are being revised for MOBILE6 that will likely result in an older vehicle fleet than currently predicted by MOBILE5b. However, in the short-term, continued use of local data is preferable. These modifications were also incorporated into the emissions estimates prepared for this study.

Described below are the specific changes made to the MOBILE inputs to incorporate the revisions outlined above. Note that the starting point for the modeling conducted in this analysis was a toxics version of T2AT developed by EPA called T2ATTOX. That model was provided to us by EPA and contained modifications to allow the estimation of motor vehicle air toxics emission rates. That model was ultimately revised by the study team to streamline calculations and modify several specific aspects of the methodology, and the resulting model is called MOBTOX5b to distinguish it from the models developed by EPA.

TOG Emissions

The first step in estimating toxic emission rates from on-road motor vehicles was to make revisions to the MOBILE5b TOG inputs and calculation methodology to better reflect the anticipated structure of MOBILE6. Properly characterizing TOG emissions is important because both exhaust and evaporative TOG emission rates serve as the basis of the toxics emissions estimates, i.e., toxic emissions are generally estimated by assuming a certain fraction of TOG consists of the compound of interest. For example, benzene typically comprises 3% to 4% of light-duty gasoline vehicle exhaust TOG emissions. Thus, a vehicle with a TOG emission rate of 1.0 gram per mile (g/mi) would be expected to emit between 0.03 and 0.04 g/mi benzene.[*]

As outlined above, EPA is currently in the process of revising the MOBILE model to better reflect current knowledge and data on in-use emissions. Although none of the revisions planned for MOBILE6 have been finalized, it is possible to make educated assumptions regarding the nature of those revisions. This was done during the development of the emissions estimates prepared for the Tier 2 rulemaking, and EPA continues to refine its estimates of in-use emissions. For this study, EPA provided inputs or revisions to the following model parameters related to TOG emissions estimates:

- Base emission rate equations;
- Off-cycle corrections;
- Fuel sulfur impacts; and
- Fleet characteristics (e.g., registration distributions).

[*] This value could actually be more or less, depending on the benzene and aromatic content of the gasoline.

A review of these parameters and the approach used to incorporate them into the model is discussed below.

Base Emission Rate Equations - EPA provided the base emission rates to be used in this study in terms of non-methane hydrocarbons (NMHC), which were subsequently converted to a TOG basis for input to the MOBILE model. Because toxics emissions were estimated out to 2020 in this effort, future-year emission rates were an important element of the analysis. For this evaluation, it was assumed that a national low-emission vehicle (NLEV) program would be implemented beginning in model year 1999 for areas in the Ozone Transport Region (OTR) and in model year 2001 for non-OTR regions. Four sets of baseline BERs were provided by EPA, representing various levels of control:

- Non-I/M, Non-OTR NLEV implementation schedule;
- I/M, Non-OTR NLEV implementation schedule;
- Non-I/M, OTR NLEV implementation schedule; and
- I/M, OTR NLEV implementation schedule.

In addition to the above, a separate set of BERs was provided to reflect Tier 2 emission standards as well as a number of other control scenarios that are defined later in this report.

A summary of the revised NMHC BERs for light-duty gasoline vehicles (LDGVs), light-duty gasoline trucks under 6,000 lbs. gross vehicle weight rating (LDGT1s), and light-duty gasoline trucks over 6,000 lbs. gross vehicle weight rating (LDGT2s) is contained in Table 3-1. The BERs in that table reflect the I/M, Non-OTR emission rates. In addition, these BERs reflect vehicles certified to the proposed Tier 2 standards.

Several items are worth noting with respect to the revised BERs contained in Table 3-1. First, only 1981 and later BERs are included. That is because the earlier model year BERs did not change relative to MOBILE5b. Second, significant reductions in the base emission rate equations are observed in 2001 for the LDGV and LDGT1 categories as a result of the NLEV program, and then again in 2004 (for the LDGT1 and LDGT2 categories) as a result of potential Tier 2 controls. Also of note is that although the LDGT2 category is not part of the NLEV program, it is subject to the proposed Tier 2 regulations. This becomes important in the future as more trucks are certified in the heavier weight classes. Finally, the NMHC emission rate for LDGVs under the proposed Tier 2 regulations is unchanged from the NLEV case. Consistent with the approach that EPA will use in MOBILE6, the BERs have two deterioration rates (DR1 and DR2) for some model years. The use of a second deterioration rate depends on the data and assumptions that were used to develop the model year specific emission rates.

To put the revised BERs in perspective, the LDGV emission rates have been plotted against the MOBILE5b base emission rates in Figure 3-1. The two top lines in that figure represent non-I/M hydrocarbon emissions for Tier 0 and Tier 1 vehicles modeled by MOBILE5b. The three bottom lines in the figure reflect the revised BERs used in this analysis.* As seen in the figure, the revised BERs are significantly lower than the MOBILE5b estimates, even for vehicle certified to the same emission standards.

* Note that the MOBILE5b rates are reported in terms of total HC (which included methane), while the revised rates are in terms of NMHC. Correcting the MOBILE5b results to an NMHC basis would lower those rates, but only slightly.

Table 3-1
Revised FTP-Based NMHC BERs Used in Emissions Analysis
I/M, Non-OTR NLEV Implementation -- Tier 2 Beginning in MY2004

Vehicle Class	Model Year	ZM (g/mi)	DR1 (g/mi/10K)	DR2 (g/mi/10K)	Flex Point (10,000 mi)	Comments
LDGV	1981	0.360	0.093	0.004	14.632	
	1982	0.356	0.092	0.005	14.632	
	1983	0.256	0.049			
	1984	0.265	0.047			
	1985	0.274	0.044			
	1986	0.283	0.037			
	1987	0.289	0.036			
	1988	0.189	0.030			
	1989	0.193	0.031			
	1990	0.190	0.030			
	1991	0.189	0.030			
	1992	0.192	0.030			
	1993	0.191	0.030			
	1994	0.168	0.027			
	1995	0.145	0.024			
	1996-2000	0.133	0.022	0.021	9.052	Tier 2=NLEV
	2001+	0.055	0.012	0.013	14.636	for 2004+ MY
LDGT1	1981-82	1.198	0.073			
	1983	1.196	0.073			
	1984	0.406	0.050			
	1985	0.399	0.050			
	1986	0.381	0.052			
	1987	0.365	0.054			
	1988	0.273	0.040			
	1989	0.269	0.038			
	1990	0.263	0.037			
	1991	0.255	0.039			
	1992-93	0.262	0.035			
	1994	0.221	0.031			
	1995	0.181	0.028			
	1996-2000	0.161	0.026	0.023	11.839	NLEV Stds
	2001-2003	0.062	0.013	0.015	17.195	in 2001
	2004+	0.055	0.012	0.014	16.611	Tier 2 Stds
LDGT2	1981-82	1.198	0.073			
	1982	1.198	0.073			
	1984	0.406	0.050			
	1985	0.399	0.050			
	1986	0.381	0.052			
	1987	0.365	0.054			
	1988	0.273	0.040			
	1989	0.269	0.038			
	1990	0.263	0.037			
	1991	0.255	0.039			
	1992	0.262	0.035			
	1993-95	0.262	0.035			
	1996	0.221	0.032			No NLEV for
	1997-2003	0.181	0.029	0.024	13.926	LDGT2
	2004	0.085	0.016	0.017	13.046	
	2005	0.089	0.017	0.017	12.593	Tier 2 Stds
	2006	0.083	0.016	0.017	13.593	Phased-in
	2007	0.077	0.015	0.016	14.450	Beginning with
	2008	0.066	0.014	0.015	16.333	2004 MY
	2009+	0.055	0.012	0.014	17.989	

Figure 3-1

In addition to making revisions to the light-duty vehicle NMHC emission rates, BERs for heavy-duty gasoline vehicles (HDGVs) and heavy-duty Diesel vehicles (HDDVs) were also revised. Again, the modified rates were provided by EPA, and the baseline BERs are summarized in Table 3-2. (See Section 6 for a discussion of the HDGV control case.)

A final adjustment that was made to the BER equations before formatting them for use in the MOBTOX5b model was to adjust the NMHC values to a TOG basis. (For the calculation of air toxics, the MOBTOX5b model requires alternative BERs to be input in terms of TOG.) These adjustments were provided by EPA and are a function of vehicle class and technology. For example, the following TOG/NMHC correction factors were used for light-duty gasoline cars and trucks:

- Non-catalyst - 1.0988
- Oxidation catalyst - 1.1725
- Three-way catalyst - 1.1687
- Three-way + oxidation catalyst - 1.3829

Figure 3-1

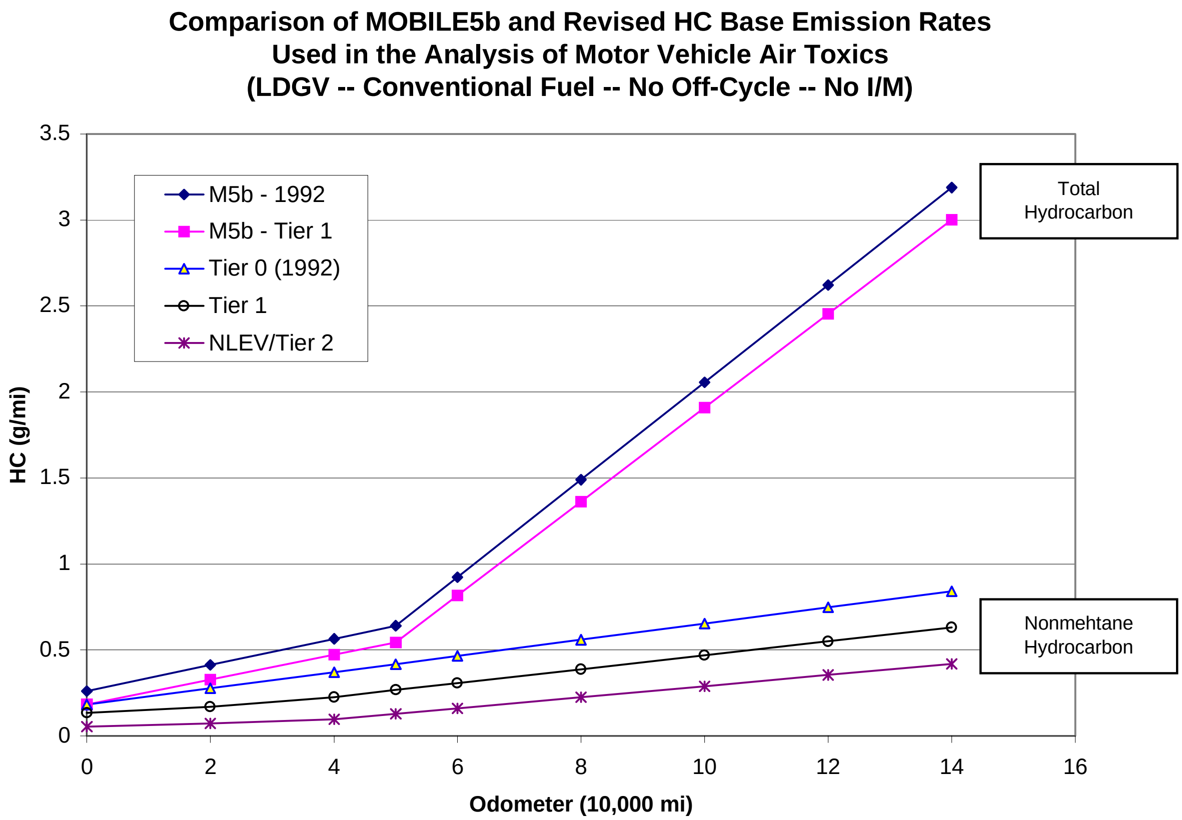
Comparison of MOBILE5b and Revised HC Base Emission Rates
Used in the Analysis of Motor Vehicle Air Toxics
(LDGV -- Conventional Fuel -- No Off-Cycle -- No I/M)
M5b - 1992
M5b - Tier 1
Tier 0 (1992)
Tier 1
NLEV/Tier 2
Total Hydrocarbon
Nonmehtane Hydrocarbon
HC (g/mi)
Odometer (10,000 mi)
0
0.5
1
1.5
2
2.5
3
3.5
0
2
4
6
8
10
12
14
16

Table 3-2
Revised Baseline NMHC BERs for HDGV and HDDV Vehicle Classes

Vehicle Class	Model Year	ZM (g/bhp-hr)	DR (g/bhp-hr/10,000 mi)
HDGV (2004+ MY Include I/M Effects)	1981-1983	3.427	0.161
	1984	3.436	0.161
	1985	2.477	0.051
	1986	2.196	0.051
	1987	0.985	0.092
	1988-1989	0.849	0.026
	1990	0.546	0.026
	1991-1997	0.528	0.024
	1998-2003	0.533	0.024
	2004-2006	0.156	0.010
	2007+	0.117	0.007
HDDV	1988	0.778	0.0
	1989	0.784	0.0
	1990	0.661	0.0
	1991	0.577	0.0
	1992	0.578	0.0
	1993	0.559	0.0
	1994	0.321	0.0
	1995	0.318	0.0
	1996+	0.316	0.0

These factors were used to generate model-year-specific TOG/NMHC ratios by weighting each model year by the fraction of each technology in the fleet. Those calculations were performed by EPA and the results were submitted to Sierra in spreadsheet form. A summary of the TOG/NMHC ratios used in this study, by model year and vehicle class, is contained in Appendix A. In addition, the resulting BERs, in the format used by the MOBTOX5b model, are also summarized in Appendix A.

Note that the emission factors provided by EPA were based on low-altitude regions. Because Denver was one of the urban areas modeled in this study, an adjustment for high-altitude operation had to be made. This was accomplished by determining the ratio of $(BER_{High\text{-}Alt}/BER_{Low\text{-}Alt})_{MOBILE5b}$ and applying that ratio to the revised low-altitude base emission rates. Note that this adjustment was applied only to the zero-mile level, since the low-altitude and high-altitude deterioration rates in MOBILE5b are the same. The same correction was applied to other high-altitude areas as well.

Although there were no California cities included in the urban areas selected for evaluation, Northern California and Southern California were areas evaluated for the regional analysis that fed into the national toxics emissions and exposure estimates. Thus, California-specific emission factors had to be developed for this effort. This was accomplished by simply applying a ratio of emission standards (i.e., CA Stds/U.S. Stds) to the zero-mile component of the applicable base emission rate equations. The resulting BER files used in the MOBTOX5b model are also contained in Appendix A.

Off-Cycle Effects - In the analysis prepared by EPA for the Tier 2 rulemaking, off-cycle effects were incorporated into the base emission rate equations within a spreadsheet model developed for that evaluation.* Because thousands of model runs were required for the toxics analyses performed in this study, it was not practical to use a spreadsheet model. In addition, because the toxics fractions developed in this effort (as described in the next section of this report) are based on FTP emission rates (i.e., without off-cycle effects included), it was necessary to estimate off-cycle impacts separately from the FTP-based emission rates. The approach used to perform this analysis is described below.

Using the spreadsheet model developed for the Tier 2 rulemaking, EPA extracted base emission rate equations that included off-cycle effects and base emission rate equations that did not include off-cycle effects. These results, which were reported by model year, were provided to the study team. Based on these equations, it was possible to generate an off-cycle offset for each model year that was a function of vehicle mileage. (Recall that the base emission rate equations are a function of mileage; see Table 3-1.) For example, Figure 3-2 illustrates the off-cycle offset for LDGVs as a function of vehicle mileage for a number of model years. These estimates were then fit with a second-order polynomial function for use in the MOBTOX5b model.

Several points can be made with respect to the off-cycle impacts shown in Figure 3-2:

- The off-cycle impact is very small for 2004 and later model year vehicles. That is the result of full implementation of the SFTP regulations.

- The off-cycle impact for the 1986 model year decreases with vehicle mileage. That is because there are more high-emitters in the fleet at higher mileage, and EPA has assumed that high-emitters have less of an off-cycle impact for this model year group. In fact, for some non-I/M cases (which have a larger fraction of high-emitters at high mileage), the off-cycle offset is negative at high mileage.

- Similar off-cycle impacts are observed for 1992 (Tier 0) and 1996 (Tier 1) models.

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* Note that EPA's most recent analysis of off-cycle impacts indicates that air conditioning has a negligible effect on HC emissions. Thus, the off-cycle effects modeled in the Tier 2 study included only an aggressive driving component for exhaust HC.

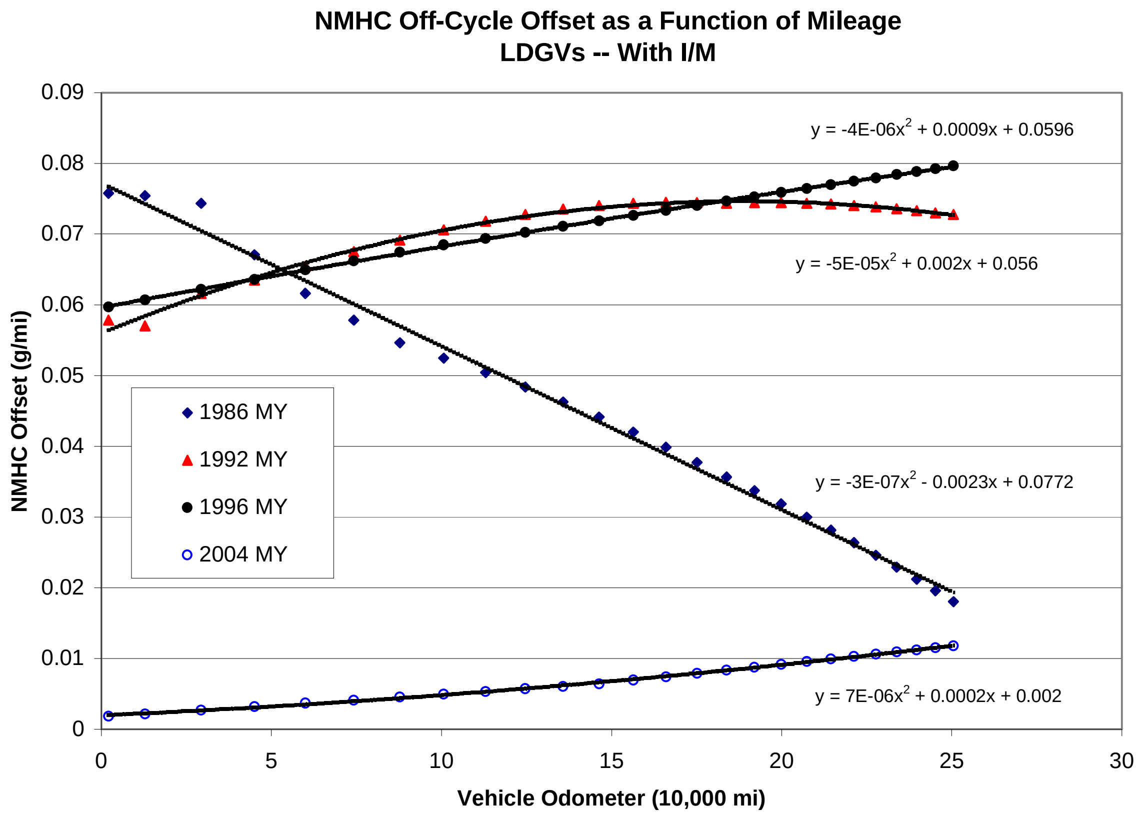
Figure 3-2

The above methodology was used to generate off-cycle inputs for 1981 and newer model year LDGVs, LDGT1s, and LDGT2s. For pre-1981 model year vehicles, EPA provided a constant offset that was used in this work. That offset amounted to 0.045 g/mi NMHC for LDGVs and 0.146 g/mi NMHC for the LDGT1 and LDGT2 classes.

The results of the above analysis (i.e., the coefficients from the polynomial equation) were converted to a TOG basis and formatted into a series of input files that were ultimately read by the MOBTOX5b model. Separate files were prepared for I/M versus non-I/M areas and for OTR vs non-OTR areas. The files prepared for this analysis are contained in Appendix A.

<u>Fuel Sulfur Impacts</u> - As part of the analysis of emissions impacts prepared to support the Tier 2 NPRM, EPA developed revised estimates of the impacts of gasoline sulfur levels on exhaust emission rates. These estimates were provided to the study team for use in the evaluation of motor vehicle air toxics. The equations relating sulfur level to emissions impacts were developed by EPA such that a correction factor is calculated for a given baseline fuel sulfur level (generally assumed to be 330 ppm) and a target fuel sulfur level. Two forms of equations were developed by EPA, depending on vehicle class and standard stringency: log-log and log-linear. The equations used for this analysis are summarized in Table 3-3, and examples of how each form of the equation is used are given below.

Figure 3-2


NMHC Off-Cycle Offset as a Function of Mileage
LDGVs -- With I/M
NMHC Offset (g/mi)
Vehicle Odometer (10,000 mi)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
5
10
15
20
25
30
1986 MY
1992 MY
1996 MY
2004 MY
y = -4E-06x2 + 0.0009x + 0.0596
y = -5E-05x2 + 0.002x + 0.056
y = -3E-07x2 - 0.0023x + 0.0772
y = 7E-06x2 + 0.0002x + 0.002

Insert Table 3-3

Log-Log - Consider the equation developed for normal-emitting vehicles certified to Tier 2 emission standards. As noted in Table 3-3, the equational form is log-log and the coefficient is 0.13992. To generate the sulfur correction factor in going from a 330 ppm S baseline fuel to a 30 ppm S target fuel, the following calculation is performed:

$$S_{cor} = \exp(0.13992*\ln(30))/\exp(0.13992*\ln(330)) = 0.715$$

where ln represents the natural logarithm of the argument. Thus, a 28.5% reduction in exhaust HC emissions is predicted for normal-emitting Tier 2 vehicles when sulfur level is reduced from 330 ppm to 30 ppm.

Log-Linear - The other form of the sulfur equations developed by EPA is termed log-linear. Taking Tier 1 light-duty vehicles as an example, the coefficient reported by EPA is 0.0007223, and the correction factor in going from 330 ppm S to 30 ppm S is calculated as follows:

$$S_{cor} = \exp(0.0007223*30)/\exp(0.0007223*330) = 0.805$$

Thus, a 19.5% reduction in exhaust HC is predicted for normal-emitting Tier 1 vehicles when gasoline sulfur level is reduced from 330 ppm to 30 ppm.

Note that fuel sulfur has a smaller impact on less advanced technology and on higher emitting vehicles, and separate equations have been developed for normal emitters and high emitters. Note also that these corrections were not applied directly to the base emission rate equations in this study. Instead, the sulfur impact was included in the

Table 3-3
Sulfur Equations Provided by EPA

Vehicle Class	Emitter Category	Equation Form	Coeffients	Base Sulfur	Target Sulfur	Correction Factor
Tier 2	Normal	Log-Log	0.13992	330	30	0.715
LDV/T1 LEV	Normal	Log-Log	0.13992	330	30	0.715
LDT2 LEV	Normal	Log-Log	0.08956	330	30	0.807
LDT3 LEV	Normal	Log-Log	0.08956	330	30	0.807
LDT4 LEV	Normal	Log-Log	0.08956	330	30	0.807
LDV/T1 Tier 1	Normal	Log-Linear	0.0007223	330	30	0.805
LDT2 Tier 1	Normal	Log-Linear	0.0007223	330	30	0.805
LDT3 Tier 1	Normal	Log-Linear	0.0007223	330	30	0.805
LDT4 Tier 1	Normal	Log-Linear	0.0007223	330	30	0.805
Tier 0 -- All	Normal	Log-Log	0.05502	330	30	0.876
All Highs	High	Log-Linear	0.00003727	330	30	0.989

development of the "toxic-TOG" curves that are described in the next section of this report.

Fleet Characteristics - Two primary revisions to the modeling conducted in this study were made to account for more recent information on the fleet make-up. These included modifications to the registration distributions (i.e., the fraction of vehicles making up the fleet by vehicle age) and modifications to the VMT mix used to compile vehicle-class-specific emission rates into an overall fleet average. The registration distributions were modified to reflect the fact that vehicles are remaining in the fleet for a longer period of time. This effect was incorporated into the 2007 and 2020 model runs. (The locality-specific registration fractions were used in the 1990 and 1996 calendar year analyses.) The VMT mix was revised to account for the large increase in light-duty truck sales (e.g., minivans and sport-utility vehicles) over the last several years. Revised registration and VMT mix inputs were provided by EPA and are consistent with the values used in the Tier 2 analysis. (More detail on the specific values used in this study is given in a later section of the report.)

CO Emissions

As outlined above, the TOG emissions estimates formed the basis of the toxics emissions estimates prepared for this study. As such, TOG emissions were calculated for the four calendar years evaluated in this work (i.e., 1990, 1996, 2007, and 2020). On the other hand, the CO emissions estimates were needed only for the 1990 calendar year. That is because they were used only to calculate the $[CO_{Exposure(\mu g/m3)} / CO_{EF(g/mi)}]_{1990}$ ratios. Those ratios were then combined with the toxics estimates to generate toxic exposure estimates for each scenario.

As with the TOG emissions estimates, a number of changes related to CO were made to the MOBILE5b model to implement revisions planned for MOBILE6.[*] These include the following:

- Revised base emission rate equations;
- Application of off-cycle correction factors; and
- Revised oxygenated fuels effects.

A discussion of how these revisions were implemented for this study is included below.

Base Emission Rate Equations - The base emission rate equations supplied for this element of the study were also developed by EPA. Revised emission factors were provided for 1981 through 1990 model year LDGVs, and for 1984 through 1990 model year LDGT1s and LDGT2s. (Although the file containing the BERs included pre-1981 model year vehicles, those BERs are the same as the existing MOBILE5b factors.) A

[*] As described below, EPA's T2ATTOX model was used as the starting point for the CO modeling performed for this study because it has more flexibility than the MOBILE5b model.

review of the BERs indicates that the revised factors include lower deterioration rates than the baseline MOBILE5b factors, similar to the TOG factors. A summary of the revised BERs is provided in Table 3-4, and the BER inputs used in the modeling are contained in Appendix B.

Table 3-4
Revised FTP-Based CO BERs Used in Emissions Analysis

Vehicle Class	Model Year	ZM (g/mi)	DR1 (g/mi/10K)	DR2 (g/mi/10K)	Flex Point (10,000 mi)
LDGV	1981 - 82	4.301	2.441	3.037	1.50
	1983 - 85	2.813	0.191	1.650	2.16
	1986 - 89	2.795	0.696	na	na
	1990	2.188	0.076	0.556	1.85
LDGT1	1984 - 89	6.045	0.496	1.094	5.34
	1990	5.382	0.245	0.717	5.37
LDGT2	1984 - 89	6.045	0.496	1.094	5.34
	1990	5.382	0.245	0.717	5.37

Because revised factors were supplied only for low-altitude areas, a correction for high altitude was needed for the Denver runs. This was accomplished by determining the ratio of $(BER_{High\text{-}Alt}/BER_{Low\text{-}Alt})_{Mobile5b}$ and applying that ratio to the revised low-altitude base emission rates. Note that this adjustment was applied only to the zero-mile level, since the low-altitude and high-altitude deterioration rates in MOBILE5b are the same.

The BERs contained in Table 3-4 were used in conjunction with the T2ATTOX model to generate CO emissions estimates for this study. That model was used because it is capable of accepting more detailed sets of alternative BERs than the MOBILE5b model (e.g., variable flex points). Although T2AT could have been used for this purpose, the non-toxics portion of the T2ATTOX code is no different when that model is used to generate HC, CO, and NOx emissions estimates, and it was used in this case because the code was immediately available for the off-cycle and oxygenated fuels revisions described below.

Off-Cycle Corrections - CO off-cycle correction factors were also provided by EPA for use in this analysis. However, those corrections were provided in a different format than the TOG factors described above. Instead of being reported as an offset, the CO off-cycle corrections were provided as multiplicative adjustments. A summary of the CO off-cycle factors used in this analysis is contained in Table 3-5 for LDGVs, and the complete set of factors is contained in Appendix B.

Of note in Table 3-5 is that the off-cycle correction factors are much larger for CO than for TOG, and a correction for A/C is included as well as an aggressive driving correction.

When modeling the impacts of aggressive driving CO effects, there is concern that at low temperature (which causes greatly elevated CO emissions) a multiplicative adjustment may overstate the magnitude of the off-cycle increase. Thus, for this study, the aggressive driving element of off-cycle effects was incorporated by first determining a CO offset at 75°F, adjusting that estimate for fuels effects (i.e., in-use fuel and oxygenates), and then adding it to the temperature-corrected CO value estimated by the

Table 3-5
LDGV CO Off-Cycle Correction Factors

Model Year	Non-I/M Factors		I/M Factors	
	Agg Drv	A/C	Agg Drv	A/C
1965 - 66	1.328	1.217	1.328	1.217
1967	1.324	1.215	1.324	1.215
1968	1.370	1.237	1.370	1.237
1969	1.365	1.235	1.365	1.235
1970	1.375	1.240	1.375	1.240
1971	1.371	1.238	1.371	1.238
1972	1.432	1.265	1.432	1.265
1973	1.426	1.263	1.426	1.263
1974	1.419	1.260	1.419	1.260
1975	1.574	1.321	1.574	1.321
1976	1.568	1.319	1.568	1.319
1977	1.560	1.316	1.560	1.316
1978	1.552	1.313	1.552	1.313
1979	1.543	1.310	1.543	1.310
1980	1.861	1.407	1.861	1.407
1981 - 91	1.611	1.326	1.630	1.340

model. A similar approach was taken to incorporate the A/C effect, but this was only done when the ambient temperature was over 69°F as described below. These adjustments were performed within the "BEF" subroutine in T2ATTOX.

The aggressive driving component was calculated for all model runs, while the A/C adjustment was applied only during periods of higher temperature (i.e., above 69°F). Further, between 69° and 85°F, the A/C adjustment was interpolated between 1.0 and the factor shown in Table 3-5. The 85°F point was chosen because it represents the temperature corresponding to a 52% compressor-on fraction,[6] which was the basis of the estimates given in Table 3-5. The factors were linearly scaled between 85° and 108°F, with the upper end of that range representing a 100% compressor-on fraction. Finally, the model-year-specific factors given in that table were adjusted for the fraction of vehicles assumed to be equipped with functioning air conditioning systems. These estimates were based on data contained in EPA's draft air conditioning activity effects recommended for MOBILE6[4] and are summarized in Appendix B.

Oxygenated Fuels Effects - The impacts of oxygenated fuels on CO emissions modeled in this effort were based on estimates prepared by Sierra under contract to API.[7] Sierra worked closely with EPA staff during the development of those estimates, and, in fact, EPA has recommended that the results of that study be used in the MOBILE6 model[8] to estimate the emissions impacts of oxygenated fuels on pre-1994 model year vehicles. Because the current analysis is aimed at the 1990 calendar year, estimates for Tier 1 and more advanced technologies were not needed. In addition, because the analysis referenced above only considered 1981 and later model year vehicles, the CO oxygenated fuel effects were revised in this analysis only for 1981 to 1990 model year vehicles; existing MOBILE5 oxygenated fuels impacts were retained for pre-1981 model year vehicles as well as for heavy-duty gasoline vehicles.

The oxygenated fuels impacts used in this analysis are summarized in Table 3-6. As observed in that table, the fuel oxygen impact is a function of emitter category and technology, i.e., vehicles equipped with adaptive learning (ADL) computer logic are less sensitive to oxygen in the fuel than are older-technology vehicles. However, one shortcoming of this approach is that the fraction of the fleet equipped with ADL systems has not been estimated by model year. For this analysis, we needed only the fraction of vehicles equipped with ADL systems for 1986 and later model years (pre-1986 model year vehicles were analyzed separately, without regards to ADL capability).

Table 3-6
Recommended CO Effects From the Use of Oxygenated Fuels for Matched RVP Blends at 75°F

Emitter Category	Technology	CO Impact Per Wt% Oxygen	Typical MTBE Blend (2.7 wt% O)	Typical Ethanol Blend (3.5 wt% O)
Normal	1988+ TWC/ADL	-3.1% (n=133)[a]	-8.4%	-10.9%
	1986-87 TWC/ADL	-4.8% (n=104)	-13.0%	-16.8%
	1986+ TWC/No ADL	-5.7% (n=151)	-15.4%	-20.0%
	1981-85 TWC/CL	-4.0% (n=73)	-10.8%	-14.0%
	OX/OL[b]	-9.4%	-25.4%	-32.9%
	Non-Catalyst[b]	-6.6%	-17.8%	-23.1%
High	1981+ TWC/CL	-5.3% (n=134)[a]	-14.3%	-18.6%
	OX/OL[b]	-9.4%	-25.4%	-32.9%
	Non-Catalyst[b]	-6.6%	-17.8%	-23.1%

[a] Sample size shown in parentheses.

[b] Open-loop and non-catalyst factors are based on an EPA analysis used to support oxygenated fuel impacts in MOBILE4.1 and MOBILE5.[9]

Based roughly on the fraction of vehicles in the EPA emission factors database that were also included in the Complex model database (which, by design, had to be equipped with ADL), the following phase-in of ADL systems was assumed for this analysis:

- 1986 to 1987 - 50% equipped with ADL;
- 1988 to 1989 - 75% equipped with ADL; and
- 1990 to 1991 - 90% equipped with ADL.

Using the ADL technology weightings above (as well as the catalyst type technology weightings used elsewhere in this analysis), oxygenated fuel factors for normal and high emitting vehicles were generated for 1981 to 1991 model years, and the results are shown in Table 3-7 for LDGVs. Based on discussions with EPA, the light-duty truck categories were assumed to lag passenger cars in terms of ADL technology implementation by five years. Thus, the 1986+ TWC/No ADL factors from Table 3-6 were used to represent all 1986 to 1990 model year trucks. The final factors used in this analysis are summarized in Appendix B.

Table 3-7
Model-Year Specific CO Benefits from Oxygenated Fuel for LDGVs
(Reductions are in Terms of % per wt% Oxygen)

Model Year	Normals		Highs	
	% Reduction	g/mi	% Reduction	g/mi
1981	5.5	4.9	6.5	20.5
1982	5.8	4.9	6.6	20.5
1983	5.3	4.9	6.3	20.5
1984	4.3	4.9	5.5	20.5
1985	4.4	4.9	5.6	20.5
1986	5.4	3.2	5.4	20.5
1987	5.3	3.2	5.4	20.5
1988	3.8	3.0	5.3	20.5
1989	3.8	3.0	5.3	20.5
1990	3.4	2.8	5.3	20.5
1991	3.4	2.8	5.3	20.5

Because different oxygenated fuels impacts are applied to normal-emitting vehicles and to high-emitting vehicles, a method to estimate the fraction of normals and highs in the fleet (as a function of vehicle or mileage) was needed. This was accomplished by first determining the average CO emission level of the normal- and high-emitting vehicles used to generate the CO impacts listed in Table 3-6. These averages were used to compute the mean normal and high emission rate in the model-year-specific factors shown in Table 3-7.

From Table 3-7, the mean CO from a 1988 normal-emitting LDGV is 3.0 g/mi and the mean CO from a high-emitting vehicle is 20.5 g/mi. If the mean CO emission rate of a

1988 LDGV in calendar year 1990 is 7.0 g/mi, then the fraction of normal emitters in the fleet at that point (N) can be determined as follows:

$$7.0 \text{ g/mi} = 3.0*N + 20.5*(1-N)$$

Solving the above equation for N results in 77.1% of the fleet being normal emitters and 22.9% of the fleet being high emitters. The impact of oxygenated fuel (assuming 3.5% oxygen by weight) can then be estimated as follows (taking values from Table 3-7 for the 1988 model year):

$$\text{Non-oxygen CO} = 3.0*0.771 + 20.5*0.229 = 7.01 \text{ g/mi}$$

$$\text{Oxygen CO} = 3.0*0.771*(1-0.038*3.5) + 20.5*0.229*(1-0.053*3.5) = 5.83 \text{ g/mi}$$

Thus, an overall oxygenated fuel benefit of 16.8% (i.e., 1 - 5.83/7.01) is estimated for this case. This same general approach was used to determine the oxygenated fuel impacts for all 1981 and later model year cars and light trucks. This methodology was incorporated into the T2ATTOX model by making revisions to the “FUEL” subroutine.

###

4. TOXICS EMISSIONS MODELING METHODOLOGY

Once the revisions to the methodology and inputs needed to estimate TOG emissions were finalized, it was necessary to develop an approach to generate air toxics estimates. As described below, the approach utilized for exhaust emissions makes use of "toxic-TOG" curves in which the FTP-based g/mi TOG emission rates are used to extract the corresponding mg/mi toxic emission rates. In this way, the differences in toxics fractions between normal- and high-emitting vehicles were accounted for in the calculations. For evaporative emissions, a simpler method was used in which the mass fraction of each toxic (as a fraction of TOG emissions) was applied to the evaporative emissions estimates calculated by the standard MOBILE5b routine contained within the MOBTOX5b model. Finally, Diesel PM emissions were estimated directly from EPA's PART5 model, with changes where appropriate to account for revised emission rates. Each of these elements of the toxics modeling performed for this study is presented in this section of the report.

Exhaust Emissions

Previous EPA Estimates - During the development of the 1993 Motor Vehicle Related Air Toxics Study, EPA spent considerable effort developing estimates of on-road motor vehicle air toxics. At that time, the number of motor vehicle test programs that measured air toxics was limited, and because most of the available data were from low-mileage, well-maintained vehicles, EPA found it difficult to develop a direct gram per mile (or milligram per mile) toxic emission rate reflective of the in-use fleet. Instead, available emissions data were used to estimate air toxics emissions as a fraction of the total organic gases (TOG) emitted from the test vehicles. Those estimates were then applied to output from an emission factor model (MOBILE4.1 in the case of the EPA MVRATS) to estimate air toxics from the in-use fleet.

In developing emission estimates for motor vehicle air toxics, EPA found that the toxics fractions were a function of a vehicle's emission control system design and fuel type (i.e., gasoline versus Diesel). Thus, toxics fractions were developed separately for each of the following technologies:

- Three-way catalyst (TW CAT),
- Three-way plus oxidation catalyst (TW+OX CAT),
- Oxidation catalyst (OX CAT),
- No catalyst (NO CAT),
- Light-duty Diesel vehicle (LD Diesel), and

- Heavy-duty Diesel vehicle (HD Diesel).

A summary of the toxics fractions for benzene, 1,3-butadiene, formaldehyde, and acetaldehyde from the 1993 MVRATS is contained in Table 4-1. Several items are worth noting with respect to this table. First, although the benzene fractions are reported as single values, EPA developed equations for the gasoline technologies that estimated the benzene fraction as a function of fuel benzene content and fuel aromatic content (i.e., as fuel benzene and aromatic content go up, so does the benzene fraction in the exhaust).[*] The benzene fractions shown in Table 4-1 are based on the fuel parameters specified in the Clean Air Act for baseline gasoline (i.e., RF-A in the Auto/Oil Air Quality Improvement Research Program). Second, although the 1,3-butadiene, formaldehyde, and acetaldehyde fractions are shown as single values, EPA found those to vary as a function of whether the gasoline contained oxygenate. (The values in the table assume no oxygenate.) For example, a fuel containing MTBE would result in higher formaldehyde fractions than shown in Table 4-1.

Table 4-1
Exhaust Toxics Fractions as a % of TOG Emissions
Used by EPA in the 1993 Motor Vehicle Related Air Toxics Study

Technology	Benzene[a]	1,3-Butadiene	Formaldehyde	Acetaldehyde
TW CAT	5.27	0.57	0.87	0.47
TW+OX CAT	2.87	0.44	1.37	0.45
OX CAT	4.05	0.44	1.39	0.44
NO CAT	4.05	0.98	2.69	0.62
LD Diesel	2.29	1.03	3.91	1.25
HD Diesel	1.06	1.58	2.80	0.75

[a] The benzene fractions for gasoline-fueled vehicles are based on 1990 industry-average gasoline, which contained an average of 1.53 vol% benzene, 32 vol% aromatics, and no oxygenates.

Also of interest in Table 4-1 is the fact that benzene and 1,3-butadiene fractions are higher for more advanced emission control technology (i.e., the TW CAT technology). However, the lower overall TOG mass from those vehicles more than compensated for

[*] Note that oxygenate was determined <u>not</u> to have a significant direct impact on the percentage of benzene in exhaust, and it is not a parameter in the equations developed by EPA. However, to the extent that the addition of oxygenate reduces the concentration of benzene and aromatics through dilution effects, it impacts the percentage of benzene in exhaust hydrocarbons.

the increased toxics fractions, and a net reduction in toxics emissions resulted from newer technology vehicles in EPA's analysis.

Complex Model for Reformulated Gasoline - Following the release of the 1993 MVRATS, EPA finalized the reformulated gasoline (RFG) regulations. As part of those regulations, the Complex model[10] was developed that allows refiners to assess whether particular fuel formulations meet the RFG performance standards (i.e., percent reductions of VOC, NOx, and toxics). That model calculates the emissions impacts of alternative gasoline formulations relative to the baseline 1990 industry average fuel defined in the 1990 Clean Air Act Amendments. The fuel parameters included in the calculations are listed below.

- Oxygenate content (wt %) and type (i.e., MTBE, ethanol, ETBE, or TAME)
- Sulfur content (ppm)
- RVP (psi)
- E200 (%)
- E300 (%)
- Aromatics (vol %)
- Olefins (vol %)
- Benzene (vol %)

In addition to VOC and NOx, the Complex model estimates the impact of varying fuel formulation on benzene, acetaldehyde, formaldehyde, 1,3-butadiene, and polycyclic organic matter (POM) exhaust emissions. Because the Complex model was based on a much larger database than the toxic fractions used in the MVRATS, EPA has been criticized in the past for not using the Complex model results in that study. However, that criticism is not warranted, since the Complex model was not available at the time the emissions analysis was performed for the MVRATS. In addition, the Complex model has its own limitations. First, the database used to develop the Complex model included only 1986 to 1990 model year vehicles, so it cannot be used to predict toxic emission rates from older technology vehicles, and projecting results onto future technologies introduces uncertainty into the analysis. Second, only gasoline-fueled light-duty cars and trucks were included in the Complex model database, so it cannot be used to predict toxics emissions from Diesel vehicles, heavy-duty gasoline vehicles, or motorcycles.

The above limitations notwithstanding, the Complex model remains the most robust tool currently available with which to estimate toxics emissions from late-model vehicles, particularly when alternative fuel formulations are being investigated. For that reason, the Complex model was used in this study to generate toxics emissions estimates from light-duty vehicles equipped with three-way catalyst systems. For this analysis, EPA provided an "unconsolidated" version of the Complex model that generated separate emissions estimates as a function of technology, e.g., port fuel injection (PFI) was broken out separately from throttle body injection (TBI). In addition, results were reported separately for normal-emitting vehicles and for high-emitting vehicles. With this level of detail, it was possible to generate model-year-specific toxics fractions and emission rates by applying the appropriate technology sales mix to each model year and vehicle class. In addition, because the response to differing fuel formulations is often much different for high-emitting vehicles relative to normal-emitting vehicles, modeling those effects separately resulted in improved toxics emissions estimates.

A sample output from the unconsolidated Complex model is given in Figure 4-1. For that particular run, the fuel parameters for Chicago in the summer of 1990 were used. As outlined in the figure, the model first calculates a percentage change for exhaust VOC, exhaust benzene, acetaldehyde, formaldehyde, and 1,3-butadiene for each technology group (i.e., TG1, TG2, etc.) based on the difference in fuel parameters between the baseline gasoline (as defined in the Clean Air Act) and the target fuel. These percentage changes are then applied to baseline emission rates (in mg/mi) to arrive at the target fuel emission rate. For the winter runs, the baseline fuel specifications are slightly different. In addition, the winter runs held the RVP to 8.7 psi for both the baseline and target fuel because RVPs typical of wintertime fuels (e.g., on the order of 13.5 psi) are outside the range of the Complex model. Finally, because temperature corrections were applied within the modified MOBILE model developed for this study, the technology-group-specific baseline emission rates in the summer version of the Complex model were not modified to reflect winter temperatures.

As part of this study, MTBE emissions were also estimated. However, the standard version of the Complex model does not calculate MTBE emissions separately. Thus, EPA provided Sierra with an unpublished version of an MTBE model that is patterned after the Complex model.[11] It should be noted that the MTBE model contains a strong caveat that the regression analyses upon which the model was based have not been peer reviewed, and therefore the results are subject to some uncertainty.

Treatment of Normal and High Emitters ("Toxic-TOG Curves") - An issue that received considerable discussion at the beginning of this project was how to implement an approach that treated normal and high emitters separately. The issue here is that normal emitters and high emitters may have different characteristics in terms of their response to fuel parameters (and corresponding toxics fractions) and therefore need to be treated separately. This becomes difficult when different I/M scenarios are considered that impact the distribution of normals and highs in the fleet. A methodology to account for normal and high emitters within the MOBTOX5b code was suggested by EPA. A summary of this method is presented below, and the original write-up provided by EPA is included in Appendix C.

Although the approach suggested by EPA was presented in algebraic terms, it is useful to start with a simple example and work backward from there. Assume that the TOG emission rates, benzene emission rates, and benzene fractions for normal and high emitters corresponding to a baseline fuel and a target fuel are as listed in Table 4-2.

Using the values presented in Table 4-2, if MOBTOX5b calculated a fleet-average emission rate of 1.0 g/mi TOG for the baseline fuel, the fraction of normals and highs making up the 1.0 g/mi emission rate could be calculated as follows:

$$1.0 \text{ g/mi} = F_N * TOG_{N,\text{ Base Fuel}} + F_H * TOG_{H,\text{ Base Fuel}}$$

where F_N is the fraction of normals and F_H is the fraction of highs. The TOG emission rates for normals and highs on base fuel ($TOG_{N, Base Fuel}$ and $TOG_{H, Base Fuel}$) can be

Figure 4-1

Unconsolidated Complex Model Run Based on Chicago 1990 Summertime Fuel Parameters

Fuel Prameters

	CAA Base	Target Fuel
OXYGEN (wt%)	0	0
SULFUR (ppm)	339	512
RVP (psi)	8.7	8.67
E200 (%)	41	47.2
E300 (%)	83	78.6
AROMATICS (vol%)	32	28.8
OLEFINS (vol%)	9.2	8.6
BENZENE (vol%)	1.53	1.35

Percent Change

	Exh VOC	Exh ben	Ace	Form	But
TG 1	8.91	0.21	12.32	6.97	11.95
TG 2	6.63	-6.16	12.32	6.97	2.57
TG 3	10.85	4.90	12.32	6.97	7.61
TG 4	19.67	-6.16	11.63	6.97	-4.38
TG 5	18.25	-12.66	12.32	6.97	2.57
TG 6	5.37	-6.16	12.32	6.97	11.18
TG 7	11.10	-6.16	12.32	6.97	2.57
TG 8	---	---	---	---	---
TG 9	11.10	-36.76	12.32	6.97	2.57
High Emitters	-2.75	-6.62	12.32	8.86	-2.12

Baseline mg/mi

	Exh VOC	Exh ben	Ace	Form	But
TG 1	493	27.30	2.42	5.91	2.67
TG 2	404	22.39	1.99	4.85	2.19
TG 3	408	22.59	2.01	4.89	2.21
TG 4	771	42.72	3.79	9.25	4.18
TG 5	317	17.58	1.56	3.81	1.72
TG 6	354	19.64	1.74	4.25	1.92
TG 7	689	38.20	3.39	8.27	3.74
TG 8	---	---	---	---	---
TG 9	457	25.33	2.25	5.49	2.48
High Emitters	3075	190.65	15.01	29.58	43.97

Target Fuel mg/mi

	Exh VOC	Exh ben	Ace	Form	But
TG 1	537	27.35	2.72	6.33	2.99
TG 2	431	21.01	2.23	5.19	2.25
TG 3	452	23.69	2.25	5.23	2.38
TG 4	923	40.09	4.23	9.90	4.00
TG 5	375	15.35	1.75	4.07	1.76
TG 6	373	18.43	1.96	4.55	2.14
TG 7	765	35.85	3.81	8.85	3.83
TG 8	---	---	---	---	---
TG 9	508	16.02	2.53	5.87	2.54
High Emitters	2990	178.02	16.85	32.20	43.04

Table 4-2
Hypothetical TOG and Benzene Emissions

Fuel	TOG (g/mi)		Benzene Fraction		Benzene (g/mi)	
	Normal	High	Normal	High	Normal	High
Base	0.50	2.0	5%	8%	0.025	0.16
Target	0.40	1.9	4%	7%	0.016	0.133

obtained from Table 4-2, and the fraction of highs is just $(1-F_N)$. Substituting these into the equation above gives:

$$1.0 \text{ g/mi} = F_N*0.5 + (1-F_N)*2.0$$

Solving the above for F_N results in the fraction of normals being 0.667 and the fraction of highs being 0.333.

Using these fractions with the benzene emission rate for normals and highs, one can obtain the mean benzene emission rate for the target fuel presented in this example, i.e.,

$$BZ_{Flt,Target} = F_N*BZ_{N,Target} + F_H*BZ_{H,Target}$$

where $BZ_{Flt,Target}$ is the fleet-average benzene emission rate for the target fuel, $BZ_{N,Target}$ is the average benzene emissions from normal emitters operating on the target fuel, and $BZ_{H,Target}$ is the average benzene emissions from high emitters operating on the target fuel. Substituting the fraction of normals and highs calculated above and the benzene emission rates from Table 4-2, the following is obtained:

$$BZ_{Flt,Target} = 0.667*0.016 + 0.333*0.133 = 0.055 \text{ g/mi (or 55 mg/mi)}$$

Note that this approach used the benzene emission rate for the target fuel directly without first adjusting the base fuel TOG levels for the target fuel.

As outlined in Appendix C, the emissions data presented in Table 4-2 can also be thought of in graphical terms, as illustrated in Figure 4-2. Using this presentation, the target fuel benzene emission level (in g/mi or mg/mi) can be thought of as a linear function of the baseline fuel TOG emission rate. The baseline fuel normal emitter TOG emission rate defines the lower end of the curve, while the baseline fuel high emitter TOG emission rate defines the upper end of the curve. Thus, the points plotted in Figure 4-2 are simply the values outlined in Table 4-2.

Figure 4-2

Benzene-TOG curve

Based on the relationships presented in Appendix C, these "toxic-TOG curves" can be defined by an intercept (A) and a slope (B), according to the following:

$$A_{Target} = (TOG_{H,\ Base\ Fuel} * BZ_{N,\ Target} - TOG_{N,\ Base\ Fuel} * BZ_{H,\ Target}) / (TOG_{H,\ Base\ Fuel} - TOG_{N,\ Base\ Fuel})$$

$$B_{Target} = (BZ_{H,\ Target} - BZ_{N,\ Target}) / (TOG_{H,\ Base\ Fuel} - TOG_{N,\ Base\ Fuel})$$

where the TOG and BZ variables are those defined previously.

Using baseline fuel normal and high emitter TOG emission rates (in g/mi) and the target fuel normal and high emitter benzene emission rates (in mg/mi) defined in Table 4-2 as an example, the values of A and B are calculated as:

$$A_{Target} = (2.0*16 - 0.5*133)/(2.0 - 0.5) = -23.0$$

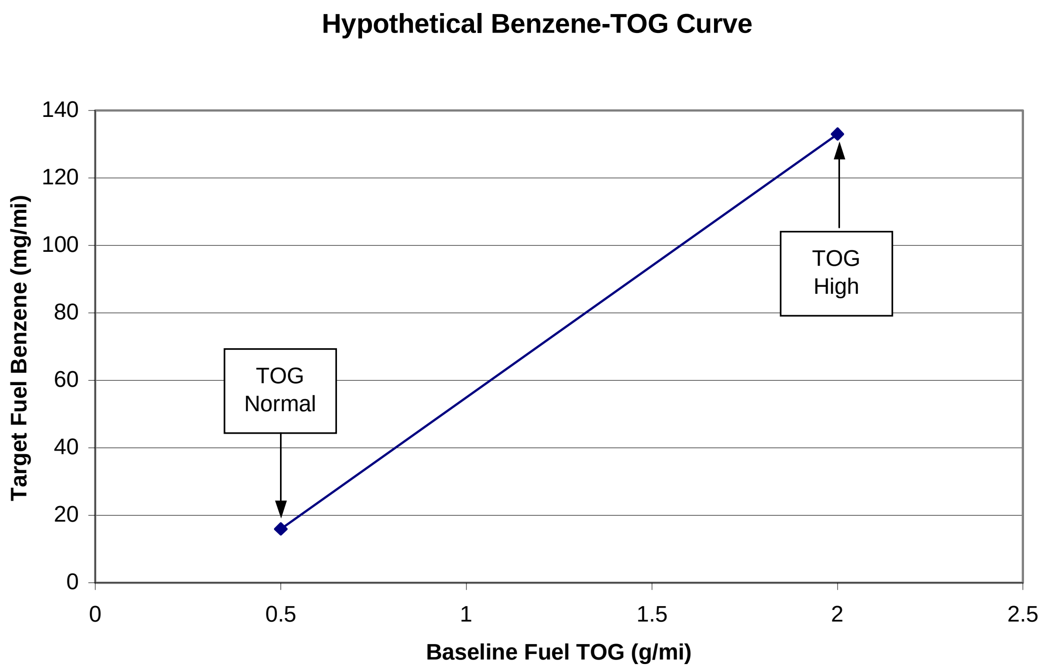
$$B_{Target} = (133 - 16)/(2.0 - 0.5) = 78.0$$

Using the above example of a fleet-average TOG emission rate of 1.0 g/mi on the base fuel, the fleet-average benzene emission rate (in mg/mi) is calculated as:

$$BZ_{Flt,\ Target} = A_{Target} + B_{Target} * TOG_{Flt,\ Base\ Fuel}$$

$$BZ_{Flt,\ Target} = -23.0 + 78.0*1 = 55.0 \text{ mg/mi}$$

Figure 4-2


Hypothetical Benzene-TOG Curve
Target Fuel Benzene (mg/mi)
140
120
100
80
60
40
20
0
TOG
Normal
TOG
High
0
0.5
1
1.5
2
2.5
Baseline Fuel TOG (g/mi)

which matches the calculation performed above.

An issue related to the above methodology is whether the linear assumption is valid for baseline TOG values above the high emitter point and below the normal emitter point. This is particularly relevant in cases where A and B values are determined from Tier 0 vehicles (e.g., the Complex model), but the results are applied to Tier 1 and LEV-category vehicles. For the simple example presented above, negative benzene emissions are estimated for the target fuel when the baseline fleet-average TOG emission rate falls below 0.295 g/mi. Thus, for fleet-average emission rates below (and above) the normal (and high) emitter values, a different methodology was needed. In those cases, it was assumed that the toxic emission rate was the same on a fractional basis. For the example above, the benzene emission rate for a baseline TOG value of 0.1 g/mi would be calculated as follows:

$$BZ_{(TOG=0.1\ g/mi)} = 0.1\ g/mi * (16\ mg/mi\ BZ / 0.5\ g/mi\ TOG) = 3.2\ mg/mi$$

This has the effect of forcing the toxic-TOG curve from the normal-emitter point back through the origin. The same approach is used in cases where the fleet-average baseline TOG emission rate is above the high emitter point.

The above approach was used to estimate toxic emissions as a function of baseline fuel TOG emission rates for all categories of vehicles. (For this analysis, industry-average fuel defined in the 1990 Clean Air Act Amendments was considered the baseline fuel.) Rather than generating the A and B terms outside of the model, an input file was created with the normal and high emitter TOG emission rates (in g/mi) and the corresponding normal and high toxic emission rates (in mg/mi). This approach made the QC process much easier and only required a few lines of code to implement.

<u>Toxic-TOG Curves: Pre-Complex Model Vehicles</u> - For pre-Complex model light-duty gasoline cars and trucks, heavy-duty gasoline vehicles, and Diesel vehicles, there are insufficient data with which to establish toxic emission rates as a function of normal and high emitters. As such, the toxic-TOG curves were generated by establishing the normal emitter point at the origin and the high emitter baseline TOG emission rate at 10 g/mi. The toxic emission rates corresponding to the 10 g/mi TOG value were then calculated from equations developed by EPA, many of which were updated from those developed for the 1993 MVRATS. A summary of these relationships is given in Appendix D.

As an example of the methodology used in this analysis, consider benzene emissions from a non-catalyst HDGV using a fuel with 1.2 vol% benzene and 31 vol% aromatics. The equation relating the fuel parameters to the benzene level (as a percentage of TOG emissions) for non-catalyst HDGVs (from Appendix D) is as follows:

$$BZ\ \%TOG = 0.8551 * vol\%\ BZ + 0.12198 * vol\%\ ARO - 1.1626$$

$$BZ\ \%TOG = 0.8551 * 1.2 + 0.12198 * 31 - 1.1626 = 3.64\%$$

Thus, if the high-emitter TOG emission rate is assumed to be 10 g/mi, the resulting benzene emission rate would be:

$$BZ_{High\ Emitter} = 10\ g/mi * 0.0364 = 0.364\ g/mi\ (or\ 364\ mg/mi)$$

For cases in which the target fuel contained an oxygenate or an RVP level below the baseline fuel assumption (i.e., 8.7 psi),* the TOG emission rate was decreased to account for that effect prior to generating the toxic pollutant emission point. The corrections used to model those impacts were provided by EPA and are summarized in Table 4-3.

Table 4-3
TOG Oxygenate and RVP Adjustments for Non-Complex Model Vehicles

Fuel Parameter	Non-Catalyst Vehicles	Oxidation Catalyst Vehicles
Oxygen, per 1 wt%	- 1.6%	- 4.46%
RVP, per 1 psi decrease	- 1.8%	- 1.7%

The methodology described above was applied to all technology groups and vehicle classes that were not evaluated with the Complex model. Open-loop three-way catalyst technologies, which are not evaluated by the Complex model, were treated as open-loop oxidation catalyst vehicles for this analysis. (Note that this technology was used only during the early 1980s, and it never accounted for more than 20% of the light-duty vehicle fleet in any model year.) Technology-specific toxic emission rates were developed based on a 10 g/mi TOG emission rate, and model-year-specific technology fractions (described later in this section of the report) were used to compile model-year-specific toxic-TOG curves.

<u>Toxic-TOG Curves: Tier 0 Vehicles</u> - The toxic-TOG curves developed for closed-loop Tier 0 vehicles made use of the unconsolidated Complex model provided to Sierra by EPA. (All open-loop technologies were analyzed as described above.) The Complex model provides emissions estimates for eight different technology groups plus high emitters. For this study, the Complex model technology groups were collapsed to be consistent with available data on the fleet make-up (based on MOBILE5a definitions). The mapping between the Complex model technology groups and the technology groups utilized in this analysis was suggested by EPA (see Appendix E) and is summarized in Table 4-4.

* Note that the RVP effect was applied only during the spring and summer evaluation periods. That is because the impact of RVP on exhaust emissions is generally thought to be a result of canister purge. Thus, under cold temperature conditions, this effect would be mitigated.

Table 4-4 MOBILE5a and Complex Model Technology Group Mappings	
MOBILE5a Tech Group	Complex Model Tech Groups
Carbureted (3W and 3W+OX)	9
3W PFI	Average of 1, 2, and 5
3W TBI	Average of 3 and 6
3W+OX PFI	4
3W+OX TBI	7
High Emitters (All Technologies)	High Emitter

The first step in this part of the analysis was to develop baseline fuel TOG emission rates for normal and high emitters in the Complex model. Because the Complex model exhaust hydrocarbon emissions estimates are based on volatile organic carbon (VOC) emissions (VOC = TOG - methane - ethane), a conversion to TOG was necessary. This was based on conversion factors provided by EPA, which recommended that toxic fractions based on VOC be scaled by a factor of 0.8079 for three-way catalyst vehicles and a factor of 0.7166 for three way + oxidation catalyst vehicles. Alternatively, dividing VOC emissions by these factors results in TOG emission estimates. Thus, after combining the technology groups as described in Table 4-4, the resulting VOC emission rates were converted to a TOG basis. These are shown in Table 4-5. Note that two estimates for TOG are given in Table 4-5: one based on 339 ppm S fuel (which is the sulfur level of the baseline fuel in the Complex model) and the other based on 330 ppm S fuel. Because the base emission rates provided by EPA were generated based on conventional fuel with a 330 ppm sulfur content, the base fuel TOG emission rates used in developing the toxic-TOG curves were estimated from the Complex model assuming a sulfur level of 330 ppm.

Table 4-5 Mean Complex Model Base Fuel VOC and TOG Emission Rates (g/mi) by Technology Group			
MOBILE5a Tech Group	Mean VOC (339 ppm S)	Mean TOG (339 ppm S)	Mean TOG (330 ppm S)
Carbureted (3W and 3W+OX)[a]	0.457	0.638	0.635
3W PFI	0.405	0.501	0.499
3W TBI	0.381	0.472	0.470
3W+OX PFI	0.771	1.076	1.068
3W+OX TBI	0.689	0.961	0.957
High Emitters (All Technologies)[b]	3.075	4.034	4.036

[a] The VOC-to-TOG correction was based on 3W+OX technology for this group.
[b] The VOC-to-TOG correction was based on an average of 3W and 3W+OX technology groups for high emitters.

From this point, it was a simple matter of running the Complex model for the fuel parameters being analyzed and compiling the resulting toxics emission rates for each technology group. However, this was a two-step process. First, the Complex model was run with the target fuel parameters (in the example below, 1990 summertime Chicago fuel specifications) <u>but sulfur was set at 330 ppm</u>. Because separate sulfur corrections were developed by EPA for the Tier 2 study, those were then applied to the toxics emissions results to obtain the toxics emission rates for the target fuel specifications.[*] For example, Table 4-6 shows the Complex model results for benzene to be 22.83 mg/mi for the 1990 Chicago fuel specifications, assuming a sulfur level of 330 ppm. This was then corrected to the actual sulfur level of 512 ppm using the equations contained in Table 3-3 for Tier 0 vehicles. For example, the correction for carbureted vehicles was:

$$BNZ_{512\ ppm\ S} = BNZ_{330\ ppm\ S} * \exp(0.05502*\ln(512))/\exp(0.05502*\ln(330))$$

$$BNZ_{512\ ppm\ S} = 22.83\ mg/mi * 1.024 = 23.38\ mg/mi$$

The model-year-specific emission rates for normal emitters were then developed by weighting the technology-specific Complex model results by the fraction of each technology in the fleet. A sample of this calculation is shown for TOG and benzene in Table 4-6 for 1988 model year LDGVs evaluated with 1990 Chicago summertime fuel parameters. Note that the four values in the lower right corner of the table shown in bold print would be used to establish the normal and high emitter points on the benzene-TOG curve for this model year and vehicle class. The same methodology was used for the remaining model years that had Tier 0 vehicles equipped with closed-loop technology.

Table 4-6
Sample Calculation Used to Develop the Toxic-TOG Curve for Benzene
1988 Model Year LDGV - 1990 Chicago Summertime Fuel

Tech Group	Fraction	TOG (g/mi) (330 ppm S)	BNZ (mg/mi) (330 ppm S)	BNZ (mg/mi) (512 ppm S)
Carbureted	0.101	0.635	22.83	23.38
3W PFI	0.444	0.499	18.93	19.39
3W TBI	0.327	0.470	18.21	18.66

[*] This has the effect of applying the same percentage impact to the benzene emission rate (and the other toxics) as that observed for TOG. Although it could be argued that there could be a differential impact on emissions, i.e., sulfur affecting the toxics rates more or less than TOG, this approach was selected because of concerns that the Complex model was less certain at the very low sulfur levels being investigated in this study.

Table 4-6 Sample Calculation Used to Develop the Toxic-TOG Curve for Benzene 1988 Model Year LDGV - 1990 Chicago Summertime Fuel				
3W+OX PFI	0.048	1.068	37.70	38.62
3W+OX TBI	0.080	0.957	33.72	34.54
Normal Emitters	--	**0.567**	**21.17**	**21.69**
High Emitters	--	**4.036**	**167.44**	**168.58**

Toxic-TOG Curves: Tier 1 Vehicles - For Tier 1 vehicles, the normal-emitter point developed according to the methodology described above for closed-loop Tier 0 vehicles was modified to reflect (1) the Tier 1 specific sulfur adjustments, and (2) the fact that Tier 1 vehicles are certified to more stringent hydrocarbon standards. Based on a review of information presented at the July 1992 MOBILE5a workshop, Tier 0 vehicles (which are certified to a 0.41 g/mi total hydrocarbon standard) have an effective NMHC standard of 0.377 g/mi. Tier 1 vehicles are certified to 0.25 g/mi NMHC. Thus, the lower point on the toxic-TOG curve developed from the Complex model was adjusted by the ratio 0.25/0.377. This correction was used for both cars and trucks, since the Complex model relationships were based on data from cars and trucks, and similar fractional NMHC reductions occur between Tier 1 and Tier 0 vehicles. Because there is no information to suggest that Tier 1 high emitters will be substantially different than Tier 0 high emitters (although there should be fewer of them), the high-emitter point on the toxic-TOG curve was left unchanged.

Toxic-TOG Curves: Tier 2 and LEV-Category Vehicles - As with Tier 1 and Tier 0 vehicles, the high-emitter point on the toxic-TOG curves remained the same for LEVs as that calculated for Tier 0 vehicles. (It is too early to determine if high-emitting LEVs will be significantly different than high-emitting Tier 0 vehicles.) In addition, the normal-emitter point on the toxic-TOG curve required an adjustment to account for the LEV-specific sulfur adjustments and the certification standards differences. The sulfur adjustments are outlined in Table 3-3, while the differences in the standards were accounted for by scaling the normal emitter point by 0.075/0.377 for Tier 2 vehicles and LDV/LDT1 LEVs and by 0.100/0.377 for the heavier light-duty truck classes (i.e., above 3,750 lbs. test weight).

Technology Fractions - Because toxics emissions and toxics fractions are a function of technology, the model-year-specific toxic-TOG curves developed for this study were generated by weighting technology-specific emissions by the estimated sales mix of each technology as a function of model year. For gasoline-fueled vehicles, the following technology types were considered:

- Open-loop, non-catalyst;
- Open-loop, catalyst;
- Closed-loop, carbureted;
- Closed-loop, three-way catalyst, PFI;
- Closed-loop, three-way + oxidation catalyst, PFI;

- Closed-loop, three-way catalyst, TBI; and
- Closed-loop, three-way + oxidation catalyst, TBI.

For pre-1991 model year light-duty cars and trucks and all heavy-duty gasoline vehicles, the technology fractions were based on those developed by EPA for MOBILE5a. Technology fractions for 1992 and later model year LDGV, LDGT1, and LDGT2 categories were derived from a recent report prepared in support of MOBILE6.[12] However, because that study did not report PFI and TBI technologies separately for 1996 and later model year LDGTs, Sierra had to make assumptions regarding the phase-out of TBI technology. In this analysis it was assumed that TBI technology on light-duty gasoline trucks would be phased-out under the NLEV program (i.e., by the 2001 model year for non-OTR states). The technology distribution for LDGTs for the 1996 to 2000 model years was estimated by interpolating between the 1995 and 2001 values. The final model-year-specific technology fractions used in this study are summarized in Appendix F.

<u>Off-Cycle (Aggressive Driving) Correction</u> - The vast majority of data and models related to motor vehicle air toxics is based on FTP testing. However, to be consistent with the approach taken in the modeling for the Tier 2 rule, EPA recommended that an adjustment for aggressive driving behavior be applied to the toxics estimates developed in this work assignment. This adjustment can be thought of as two discrete steps: (1) an adjustment (i.e., typically an increase) to the TOG mass to account for off-cycle operation, and (2) an adjustment (increase or decrease) to account for the difference in mass fraction of each toxic compound of interest between the FTP and the Unified Cycle (UC). The UC, or LA92, is used here because that cycle reflects a more accurate distribution of aggressive driving behavior than the LA4 cycle used in the FTP. In addition, the UC was used because toxics data were available for vehicles tested on both the LA4 and the UC.

The methodology used to apply an aggressive driving correction to the toxics estimates for this study is best illustrated with an example. Consider a case in which a 1990 model year LDGV has an FTP-based TOG emission rate of 0.6 g/mi and the benzene mass fraction is 5%. Assume that the benzene mass fraction on the Unified Cycle is 7%. Using the off-cycle factors developed by EPA for the Tier 2 analysis, the TOG emission rate, corrected for aggressive driving behavior, would be as follows:

$$TOG_{UC} = OCCF_{Agg} * TOG_{FTP}$$

$$TOG_{UC} = 1.14 * 0.6 \text{ g/mi} = 0.684 \text{ g/mi}$$

where 1.14 is the aggressive driving correction for a 1990 model year LDGV evaluated in 1990.*

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* Recall that the off-cycle correction is initially calculated as an offset in the MOBTOX5b model. However, to be consistent with the off-cycle methodology previously developed for WA#0-07, that offset (continued...)

In this example, the benzene emission rates over the two cycles would be:

$$BNZ_{FTP} = 0.6 \text{ g/mi} * 0.05 = 0.030 \text{ g/mi}$$

$$BNZ_{UC} = 0.684 \text{ g/mi} * 0.07 = 0.048 \text{ g/mi}$$

where BNZ_{UC} reflects the "in-use" benzene emission rate corrected for aggressive driving behavior.

Continuing with this example, an off-cycle toxics adjustment factor can be developed from the ratio of the benzene fraction over the UC to the benzene fraction over the FTP:

$$ADJ_{BNZ,UC/FTP} = x_{BNZ,UC}/x_{BNZ,FTP}$$

$$ADJ_{BNZ,UC/FTP} = 0.07/0.05 = 1.4.$$

Based on the Toxic-TOG curve approach described above (in which the FTP-based TOG emission rate is used to establish the FTP-based toxic emission rate), determining the FTP-based toxic emission rate is the first step in the overall calculation of in-use toxic emission rates. Thus, in the example presented here, the starting point would be BNZ_{FTP} = 0.030 g/mi. This value would then need to be corrected for aggressive driving behavior (both for the TOG mass increase and the differential mass fraction between the FTP and the UC), as shown below.

$$BNZ_{UC} = BNZ_{FTP} * ADJ_{\text{Aggressive Driving}} * ADJ_{BNZ,UC/FTP}$$

$$BNZ_{UC} = 0.030 \text{ g/mi} * 1.14 * 1.4$$

$$BNZ_{UC} = 0.048 \text{ g/mi}$$

which corresponds with the "in-use" benzene emission rate in the example presented above.

Using data collected by CARB in which vehicles were tested on both the FTP and the UC, off-cycle toxics adjustment factors were developed for benzene, acetaldehyde, formaldehyde, 1,3-butadiene, and MTBE based on the ratio of the toxic mass fraction over the UC to the toxic mass fraction over the FTP. A complete description of the database provided by CARB and the analysis performed for this study is contained in Appendix G, and a summary of the results follows.

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[*](...continued)
is converted to a multiplicative factor within MOBTOX5b. In this example, the FTP-based emission rate is 0.6 g/mi and the offset is 0.086 g/mi. Thus, the off-cycle multiplicative correction factor is (0.6+0.086)/0.6, or 1.14.

Summary of Analysis of CARB Off–Cycle Data - CARB provided speciated data for 18 FTP and UC test "pairs." The 18 test pairs reflect test results for a total of 13 vehicles while operating on one or more of three test fuels (Indolene, commercial unleaded gasoline, and California Phase 2 reformulated gasoline). Test results for one vehicle were eliminated from all off-cycle toxics analyses because the FTP and UC test fuels were not the same. Furthermore, to ensure that analysis results were not unduly biased by any one particular vehicle, all test pairs applicable to a single vehicle were collapsed into a single test pair by arithmetically averaging individual FTP and UC test results. With one exception, test fuel sensitivities were not considered in the off-cycle analysis (i.e., all test fuels were treated as a group) due to insufficient data. However, since analysis results are expressed in a normalized form as the ratio of UC data to FTP data, most fuel-related distinctions should be controlled. A single exception was made for MTBE emissions, where test results for zero MTBE content fuels (i.e., Indolene and one commercial unleaded gasoline) were excluded from the estimation of UC to FTP ratios (for MTBE only). Following this approach, the CARB database was collapsed into eight normal total hydrocarbon (THC) emitter test pairs (seven for MTBE) and four high THC emitter test pairs.

Basic statistical regression analysis was performed on the CARB test data, primarily as a quality assurance tool. The size of the normal and high emitter databases was sufficiently small to prohibit the development of robust UC/FTP relationships through detailed statistical analysis. Nevertheless, regression analysis was undertaken to check for data consistency and the likelihood of an additive component (i.e., an emissions offset) in UC/FTP relationships. For all species subjected to regression analysis (TOG, benzene, 1,3–butadiene, MTBE, formaldehyde, and acetaldehyde), the intercept terms in regressions of UC emissions versus FTP emissions were not significant at the 95 percent confidence level. Moreover, regression of the UC toxics fraction of TOG versus the FTP toxics fraction of TOG for all five toxics species yielded similar results (i.e., insignificant intercepts). Based on these results, it is unlikely that an additive component exists, and the ratio of average UC test results to average FTP test results should provide a reasonable estimation of UC/FTP emissions relationships. Therefore, the required UC/FTP off–cycle toxics adjustment factors ($ADJ_{UC/FTP}$, as described above) were calculated as the ratio of the mean of the toxics fractions over the UC to the mean of the toxics fractions over the FTP. Appendix G provides additional detail on the basis for the use of means, but in general calculated mean ratios were consistent with zero-intercept regression coefficients to within an error of ±5 percent. Table 4-7 presents the specific normal and high emitter off–cycle adjustment factors used for the toxics emissions analysis.

Table 4-7
Ratio of UC Toxics Fraction to FTP Toxics Fraction

Toxic Species	Normal THC Emitters	High THC Emitters
Benzene	1.315	1.126
1,3-Butadiene	1.037	0.708

MTBE	0.825	0.965
Formaldehyde	1.163	0.894
Acetaldehyde	1.020	0.919

Off-cycle adjustment factor development was obviously hampered by the limited amount of data available for analysis. Ideally, separate adjustment factors would be developed for the different vehicle technologies and classes represented in the fleet as well as the different fuels encountered in-use. However, independent adjustment factor development was not possible given that only eight normal emitter test pairs (six LDVs and two LDTs covering the 1984 through 1996 model years) and four high emitter test pairs (three LDVs and one LDT covering the 1982 through 1987 model years) were available for analysis. As a result, there was little alternative but to treat the database in the aggregate, and develop a single set of adjustment factors for normal and high emitters which could subsequently be weighted to develop unique model-year- and vehicle-class-specific adjustments. Before this aggregate treatment, however, a basic regression analysis was conducted on the 12 test pairs to determine whether a significant age-based relationship was evident in the test data. The resulting regression coefficients were not significant for any of the five emissions species examined; therefore, the aggregate treatment was deemed acceptable and the normal and high emitter adjustment factors presented in Table 4-7 were used without change for all 1981 and later gasoline-powered vehicles.

Because no data were available with which to generate factors for pre-1981 vehicles, two different approaches were considered. First, because most of the pre-1981 model year vehicles in the emissions analyses performed for this study would be high emitters based on their HC emission rates, one possibility is to simply assign pre-1981 vehicles the high-emitter factor. Alternatively, because no data exist on pre-1981 vehicles, it can also be argued that a factor of 1.0 is appropriate. Because of the uncertainty involved in this analysis, pre-1981 model year vehicles were assigned a value of 1.0 for the off-cycle toxics factor.

For 1981 and later model year vehicles, the normal and high emitter adjustment factors in Table 4-7 were weighted according to the anticipated contribution of normals and highs to the FTP-based HC emission rate. Because this is dependent on the calendar year of analysis and whether an I/M program is in effect, a series of different factors were developed. This was accomplished by forecasting the HC base emission rate equations provided by EPA using the odometer level expected in 1990, 1996, 2007, and 2020. (The BERs are discussed in detail in Section 3 of this report.) The methodology used to perform this analysis is similar to that described in Section 3 for the implementation of normal and high emitter CO oxygenate impacts; an example of the calculation follows.

The mean HC emission rate of the normal and high emitters in the FTP/UC sample was 0.23 g/mi and 1.77 g/mi, respectively. A 1984 model year vehicle, evaluated in 1996, would have an average emission rate of 1.4 g/mi. Thus, the fraction of normals (using the FTP/UC sample definition) can be calculated from the equation shown below.

$$1.4 \text{ g/mi} = 0.23*N + 1.77*(1-N)$$

Solving for N, one arrives at 24% normals and 76% highs, with normals contributing 3.9% to the 1.4 g/mi emission rate (i.e., (0.23*0.24)/1.4). Thus, for this case, the weighted UC/FTP factor for benzene would be:

$$ADJ_{BNZ,UC/FTP} = 0.039*1.315 + 0.961*1.126 = 1.133$$

This methodology was used to develop the UC/FTP toxics factors for 1981 and later model year light-duty vehicles for 1990, 1996, 2007, and 2020.

<u>Code Changes Required to Implement the Revised Exhaust Emissions Methodology</u> - The original T2ATTOX code provided by EPA was modified to implement the methodologies described above. The original code structure ran the model for one toxic emission factor at a time. We modified the structure so that all toxic emission factors could be generated within the same run. This change was made to the subroutine HCCALX. In addition, the original code required that a multiplicative factor be input for each toxic so that the ratio reflected the toxic emission rate per TOG exhaust emission rate (i.e., it was structured to perform estimates by applying the toxic fraction to the calculated TOG emission rates). This factor was used for all emission levels for a particular model year and vehicle type. In the version of the model developed in this study, the toxic-TOG relationship was described separately for low and high emitters in terms of mg/mi toxic versus g/mi TOG. The TOG emission factor developed for a particular run was then used to interpolate between the two relationships. This change was implemented in the TOXADJ subroutine.

Other code changes were made to the GETTX2 routine to read in the toxic-TOG curves, the aggressive driving factors, and the air conditioning factors. The OFFCYC subroutine was modified to perform the aggressive driving and air conditioning corrections described above. The BEF subroutine was modified to add calls to the TOXADJ and OFFCYC subroutines. Two output routines (OUTDT3 and OUTDT4) were modified so that all the toxic emission factors could be printed for each run. Subroutines SAVER and ADJUST were modified so that the new toxic emission factors could be saved and corrected for cases in which July runs were requested. For July runs the model is run twice, once with the preceding Calendar year and then with the succeeding year. The two runs need to be saved and averaged for the July output. A listing of the subroutines modified for this effort is presented in Appendix H, along with a description of how the model is run.

For acetaldehyde, formaldehyde, and 1,3-butadiene, crankcase emissions from tampered vehicles are included in the exhaust emissions. For benzene and MTBE, the crankcase emissions are calculated with hot-soak and diurnal emissions. Crankcase emissions from correctly operating vehicles are zero, but for vehicles with inoperable PCV valves, emissions need to be estimated. These emissions are calculated for all toxic compounds and occur as combustion gases blow by the piston into the engine crankcase, so these emissions are similar to exhaust emissions. The exhaust toxic fractions are applied for estimating the toxic emission factors from crankcase emissions.

Evaporative Emissions

The only toxics included in the evaporative emissions estimates were benzene and MTBE. For this analysis, the methodology originally developed for the T2ATTOX model to estimate evaporative toxics estimates was used directly. In that method, the mass fraction of benzene and MTBE (as a percent of total TOG emissions) is applied to the evaporative TOG emissions estimates calculated by the MOBILE model.

The toxics fractions used in this analysis were based on the fuel property data specific to each area and control scenario and the toxic-to-evaporative emissions relationships provided by EPA (which came from the Complex model). A summary of the equations relating fuel parameters to evaporative toxics fractions is given in Table 4-8 for each of the evaporative processes modeled by MOBILE. Since the Complex model does not calculate resting loss emissions, it was assumed that the benzene and MTBE fractions were equal to those of diurnal emissions. Note that two sets of equations are given for MTBE. That is because a “high” and “low” evaporative MTBE estimate is included in the MTBE model developed by EPA. Based on direction from EPA, the “high” MTBE fractions were used in this analysis.

Table 4-8
Evaporative Benzene and MTBE Fraction Equations from the Complex Model and EPA’s MTBE Model

Pollutant	Process	Toxic Fraction Equation (% of TOG)
Benzene	Hot Soak	(-0.03420*OXY - 0.080274*RVP + 1.4448)*BNZ
	Diurnal	(-0.02895*OXY - 0.080274*RVP + 1.3758)*BNZ
	Running	(-0.03420*OXY - 0.080274*RVP + 1.4448)*BNZ
	Resting	(-0.02895*OXY - 0.080274*RVP + 1.3758)*BNZ
	Refueling	(-0.02955*OXY - 0.081507*RVP + 1.3972)*BNZ
MTBE (High)	Hot Soak	(24.205 - 1.746*RVP)*MTBE/10
	Diurnal	(22.198 - 1.746*RVP)*MTBE/10
	Running	(17.8538 - 1.6622*RVP)*MTBE/10
	Resting	(22.198 - 1.746*RVP)*MTBE/10
	Refueling	1.743*MTBE*(-0.02955*OXY - 0.081507*RVP + 1.3972)

MTBE (Low)	Hot Soak Diurnal Running Resting Refueling	((31.442 - 1.746*RVP)/1.8029)*MTBE/10 ((31.442 - 1.746*RVP)/2.3191)*MTBE/10 ((31.412 - 1.6622*RVP)/4.9963)*MTBE/10 ((31.442 - 1.746*RVP)/2.3191)*MTBE/10 1.743*MTBE*(-0.02955*OXY - 0.081507*RVP + 1.3972)

Note: OXY = wt% oxygen
RVP = Reid vapor pressure in psi
BNZ = vol% benzene
MTBE = vol% MTBE

As with the exhaust emission factors, evaporative emission factors developed above were read into the MOBTOX5b model through subroutine GETTX2. The evaporative fractions were developed for benzene and MTBE for each of the evaporative components described above. These fractions were then used to develop the evaporative toxic emission factors in the subroutine EVPADJ. EVPADJ is called from the subroutine HCCALX for each of the evaporative processes and for each toxic. The primary change in the new model is that the evaporative emission factors for both the toxics are calculated in the same run, rather than in separate runs.

Diesel Particulate Emissions

Estimating Diesel particulate matter (PM) emission rates proved to be a much more straightforward process than for the other toxic compounds considered in this study. For this analysis, EPA's PART5 model was used directly. PART5 is similar in structure and function to the MOBILE series of models, calculating exhaust and non-exhaust (e.g., road dust) particulate emissions for each vehicle class included in the MOBILE models. Only exhaust PM emission rates from Diesel vehicles were included in this analysis, and a particle size cut-off of 10 µm was specified in the model inputs. As explained in more detail later in this report, a number of control scenarios required modifications to the base emission rate equations. Because this is not possible with simple changes to the input file structure, the code had to be modified to implement these changes.

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5. SCENARIO DESCRIPTIONS

As outlined in the Introduction, this study developed estimates of on-road motor vehicle air toxics emissions, exposure, and cancer risk for ten urban areas consisting of Atlanta, Chicago, Denver, Houston, Minneapolis, New York City, Philadelphia, Phoenix, Spokane, and St. Louis. Emissions modeling was also performed for an additional 16 geographic regions to reflect the range of potential fuels, temperatures, and I/M programs observed in the U.S. These regional estimates were used in conjunction with the urban area analyses to prepare national level emissions, exposure, and risk estimates. Modeling was performed for 1990, 1996, 2007, and 2020.

In addition to the baseline model runs, there were a total of nine different control scenarios investigated in this effort. Because of the large number of control scenarios, it is useful to devote a separate section of this report to defining those scenarios. In that way, the reader will have ready access to scenario descriptions without having to search for them imbedded in a separate sections throughout the report. Below is a brief description of each of the scenarios evaluated in this study.

<u>Scenario 0</u> - Baseline fuels and emission rates, assuming the implementation of a National Low-Emission Vehicle (NLEV) program and RFG where applicable. This scenario was evaluated for all calendar years and areas investigated in this effort.

<u>Scenario1</u> - Baseline emission factors with an assumed national gasoline regulation limiting sulfur levels to 30 ppm. This scenario was run for 2007 and 2020 only.

<u>Scenario 2</u> - Scenario 1 with more stringent tailpipe hydrocarbon emission standards for light-duty cars and trucks (i.e., reflecting Tier 2 emission standards) and more stringent particulate standards for light-duty Diesel cars and trucks. This was also run only for 2007 and 2020.

<u>Scenario 3</u> - Scenario 2 with an assumed increase in light-duty Diesel vehicle penetration rates. By 2020, light-duty Diesel trucks were assumed to make up 12.6% of the total fleet VMT, while light-duty Diesel vehicles were assumed to make up 2.5% of the total fleet VMT. It should be noted that increased light-duty Diesel sales were assumed to continue beyond 2015 in this scenario. In the Tier 2 final rule, it was assumed that there would be no additional increases after 2015.

<u>Scenario 4</u> - Tier 2 emission standards with a national gasoline regulation capping benzene content at 1%. For modeling purposes, it was assumed that this would result in an in-use benzene content of 0.95%. This scenario was run for 2007 and 2020 for a

limited number of areas (Atlanta, Minneapolis, Seattle, Eau Claire, Kansas City, Cleveland, and Pittsburgh) because of the difficulty in predicting fuel specifications under this scenario.

Scenario 5 - Tier 2 emission standards with a national gasoline regulation requiring compliance with a 25% toxics reduction performance standard. This reduction was based on using the 1990 national-average baseline fuel in conjunction with the Complex model. This scenario was run for the same areas as Scenario 4.

Scenario 6 - More stringent light-duty vehicle emission standards equivalent to 0.055 g/mi non-methane hydrocarbon (NMHC) coupled with a national 30 ppm sulfur cap. These emission standards were assumed to apply in model year 2004.

Scenario 7 - Scenario 2 with more stringent heavy-duty gasoline vehicle emission standards that were assumed to be phased in beginning with the 2004 model year. These standards were proposed by EPA in an October 1999 Notice of Proposed Rulemaking.

Scenario 8 - Scenario 2 with more stringent heavy-duty Diesel vehicle PM emission standards (equivalent to 0.01 g/bhp-hr). These standards were assumed to apply beginning with the 2007 model year.

Scenario 9 - Scenario 2 with more stringent heavy-duty Diesel vehicle PM emission standards (equivalent to 0.05 g/bhp-hr). These standards were assumed to apply beginning with the 2007 model year.

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6. DEVELOPMENT OF AREA-SPECIFIC MODEL INPUTS

The next step in estimating toxic exposure and risk estimates was to run the modified MOBTOX5b model. This required the development of input files specific to each area, calendar year, season, and control scenario. As outlined above, 10 specific urban areas and 16 regional areas were evaluated in this study. Four calendar years were analyzed, and a total of 10 control scenarios were evaluated. For each modeling run, it was necessary to determine the inputs needed and develop input files for the MOBTOX5b model. Because of the large number of modeling runs, it was necessary to automate the process of constructing the input files as much as possible to minimize potential errors in developing those inputs.

The input files for the revised MOBTOX5b model include the same information required in a standard MOBILE5b run. Some of the inputs that were important to determine for each area included in this study were the registration distributions, inspection and maintenance program parameters (start year, stringency level, program type and frequency, and vehicles tested), fuel RVP levels, and temperatures.

Selection of Modeled Areas

The emissions and exposure estimates prepared for this study were generated for 10 specific urban areas that were defined by EPA in the scope of work. In addition, toxics emissions and exposure were to be calculated on a nationwide basis as well. To perform the nationwide calculations, an approach was taken in which each county was "mapped" to an area based on similarities in fuel parameters, I/M parameters, and ambient temperatures. Thus, additional areas were selected to best characterize the different combinations of model inputs needed to prepare accurate nationwide toxics emissions and exposure estimates. Because it was impossible to treat each county of the U.S. individually in this effort, nationwide estimates had to be based on a technique in which each county of the U.S. was "mapped" to a modeled area on the basis of similarities in fuels, temperatures, and control programs.

Based on a review of fuel parameter availability (i.e., surveys conducted by the National Institute for Petroleum and Energy Research (NIPER) and the American Automobile Manufacturers Association (AAMA)), as well as the MOBILE inputs developed for the national "Trends" inventories, Sierra identified an additional 16 regional areas that were thought to best characterize on-road motor vehicle toxic emissions throughout the U.S. In general, these areas encompass large geographic areas with similar fuels, temperatures, and control programs, and are not specific urban areas. These were intended to fill in the areas that could not be reasonably mapped to the 10 specific urban areas that were to be analyzed in this effort. It is felt that this approach gave the best estimates of national toxics emissions and inventories, while maintaining the autonomy of the 10 urban areas for which toxics exposure estimates were generated.

A listing of the modeled areas evaluated in this work assignment is contained in Table 6-1. For completeness, the urban areas modeled in the previous study (WA#0-07) are also included in that table. For the most part, the geographic regions used fuel parameter data from the NIPER surveys (which cover fairly broad geographic regions), while the city-specific analyses used AAMA fuel parameter data. For a complete listing of the mapping strategy used to generate the nationwide estimates (i.e., a listing of the modeled area to which each county was mapped), please refer to Section 9 of this report.

Specific MOBILE Inputs for This Study

To determine all of the necessary input parameters for each area, several sources were used. The first source of information was a group of input files developed by E. H. Pechan (called the Trends input files[13]) which were provided to Radian/ERG and Sierra by EPA. The Trends MOBILE5b input files were developed for several areas for calendar years 1990 and 1996. The Trends files were developed for several counties across the United States. For the ten urban areas, only one file per area was desired. Therefore, it was necessary to choose one county from each of the Trends files that best represented the city considered for the study. For those ten urban areas, the county chosen was the county in which the main portion of the urban area was located. If that county was not included in the Trends files, then the county closest to the urban area was chosen. Table 6-2 shows the ten urban areas considered in this study and the counties that were selected from the Trends input files for each of these cities.

For the 16 geographical regions included in this study, a different approach was used to determine which Trends file should provide input information. Since the geographical regions spanned several states and counties, several files were chosen to represent the particular region. For example, in the Western Washington and Oregon region, all the Trends files for the states of Oregon and Washington were examined to see which of the files matched with the I/M program outlined in this study for that area. Any of the Trends files that were from a non-I/M area were not chosen for consideration. Table 6-3 shows the 16 geographical areas and the counties that were selected from the Trends files to determine MOBILE5 input information.

Table 6-1
Areas Included in Toxics Emissions Modeling

Area	Source of Fuel Data	I/M Program	Comments
Specific Urban Areas			
Chicago	AAMA	Yes	Included in original analysis
Denver	AAMA	Yes	Included in original analysis
Houston	AAMA	No/Yes	Included in original analysis
Minneapolis	AAMA	No/Yes	Included in original analysis
New York	AAMA	Yes	Included in original analysis
Philadelphia	AAMA	Yes	Included in original analysis
Phoenix	AAMA	Yes	Included in original analysis
Spokane	AAMA	Yes	Included in original analysis
St. Louis	AAMA	Yes	Included in original analysis
Atlanta	AAMA	Yes	Specifically requested for this study
Additional Geographic Regions			
Western Washington/Oregon	NIPER Dist. 13	Yes	Used to model Seattle, Portland, etc.
Northern California	AAMA - SF	Yes	San Francisco AAMA data to be used
Southern California	NIPER Dist. 15	Yes	Used for Southern California
Idaho/Montana/Wyoming	NIPER Dist. 9	No	NW Idaho mapped to Spokane
Utah/New Mexico/Nevada	NIPER Dist. 10	Yes	Colorado mapped to Denver
ND/SD/NB/IA/KS/Western MO	NIPER Dist. 7	No	Eastern MO mapped to St. Louis
Southeast -- AR/MS/AL/SC/Northern LA/etc.	NIPER Dist. 3	No	Southern LA (New Orleans) mapped to Atlanta
Florida	NIPER Dist. 4	Yes	Use regional fuel data rather than AAMA - Miami
Northeast states -- non-I/M and non-RFG	NIPER Dist. 1	No	Use for Northeast areas without I/M and RFG
Northeast states -- non-I/M and with RFG	NIPER Dist. 2	No	Use for Northeast areas without I/M but with RFG
Northeast states -- with I/M and non-RFG	NIPER Dist. 1	Yes	Use for Northeast areas with I/M but w/o RFG
Ohio Valley -- non-I/M and non-RFG	NIPER Dist. 6	No	Use for IN/OH/WV/KY areas without I/M and RFG
Ohio Valley -- with I/M and non-RFG	NIPER Dist. 6	Yes	Use for IN/OH/WV/KY areas with I/M but w/o RFG
Ohio Valley -- with I/M and with RFG	NIPER Dist. 6	Yes	KY areas with RFG and I/M; Chicago used for NW Indiana
West Texas	NIPER Dist. 11	No	Use for West Texas and Oklahoma
Northern MI/WI	NIPER Dist. 5	No	Milwaukee mapped to Chicago; Detroit mapped to Ohio Valley

Table 6-2 **Trend Files and Counties Selected for Each Modeled Urban Area**			
Urban Area	Counties Within Trends Files	County Chosen	Name of Selected Trends File
Atlanta	Cobb	Cobb	M9618067.IN
Chicago	Cook, DuPage, and Lake Counties	Cook	M9617031.IN
Denver	Adams, Arapahoe, Boulder, Denver, and Jefferson Counties	Adams	M9608001.IN
Houston	Harris County	Harris	M9648201.IN
Minneapolis	Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington Counties	Anoka	M9627003.IN
New York City	Bronx, Kings, Nassau, New York, Queens, Richmond, Rockland, Suffolk, and Westchester Counties	Bronx	M9636005.IN
Philadelphia	Bucks, Chester, Delaware, Montgomery, and Philadelphia Counties	Bucks	M9642017.IN
Phoenix	Maricopa County	Maricopa	M9604013.IN
Spokane	Spokane County	Spokane	M9653063.IN
St. Louis	Jefferson, St. Charles, St. Louis Counties, and St. Louis City	Jefferson	M9629099.IN

Table 6-3 **Trends Files and Counties for Each Modeled Geographical Area**			
Geographical Region	States in Region	Counties Used	Name of Selected Trends Files
Western Washington / Oregon	Oregon	Clackamas	M9641005.IN
	Washington	King	M9653033.IN
Idaho / Montana / Wyoming	Idaho	Adams	M9616003.IN
	Montana	Beaverhead	M9630001.IN
		Missoula	M9630063.IN
	Wyoming	Albany	M9656001.IN
Utah / New Mexico / Nevada	Nevada	Clark	M9632003.IN
		Washoe	M9632031.IN
	New Mexico	Bernalillo	M9635001.IN
	Utah	Davis	M9649011.IN
		Salt Lake	M9649035.IN
		Utah	M9649049.IN
		Weber	M9649057.IN
ND/SD/NB/IA/KS/Western MO	Iowa	Adair	M9619001.IN
	Kansas	Allen	M9620001.IN
	Missouri	Adair	M9629001.IN
		Franklin	M9629071.IN
	Nebraska	Adams	M9631001.IN

Table 6-3 Trends Files and Counties for Each Modeled Geographical Area			
Geographical Region	States in Region	Counties Used	Name of Selected Trends Files
	North Dakota	Adams	M9638001.IN
	South Dakota	Aurora	M9646003.IN
Southeast States – AR/MS/AL/SC/Northern LA	Alabama	Autauga	M9601001.IN
	Arkansas	Arkansas	M9605001.IN
	Louisiana	Acadia	M9622001.IN
		Ascension	M9622005.IN
	Mississippi	Adams	M9628001.IN
	South Carolina	Abbeville	M9645001.IN
Florida	Florida	Broward	M9612011.IN
Northeast States - No I/M, No RFG	Maine	Aroostook	M9623003.IN
	New Hampshire	Belknap	M9633001.IN
	New York	Albany	M9636001.IN
	Pennsylvania	Armstrong	M9642005.IN
		Berks	M9642011.IN
		Erie	M9642049.IN
	Vermont	Addison	M9650001.IN
Northeast States - I/M, No RFG	Pennsylvania	Allegeheny	M9642003.IN
		Lehigh	M9642077.IN
Ohio Valley - No I/M, No RFG	Indiana	Adams	M9618001.IN
	Kentucky	Adair	M9621001.IN
	Ohio	Adams	M9639001.IN
	West Virginia	Barbour	M9654001.IN
Ohio Valley - I/M, No RFG	Indiana	Clark	M9618019.IN
	Ohio	Clark	M9639023.IN
		Clermont	M9639025.IN
Ohio Valley - I/M, RFG	Indiana	Lake	M9618089.IN
	Kentucky	Jefferson	M9621111.IN
Northern MI/WI	Michigan	Alcona	M9626001.IN
		Kent	M9626081.IN
		Livingston	M9626093.IN
		Muskegon	M9626121.IN
		Ottawa	M9626139.IN
	Wisconsin	Adams	M9655001.IN
		St. Croix	M9655109.IN
Northern California	There were no Trends files for the California areas. Instead the input information was determined from a review of the California Air Resources Board’s MVEI7G emissions model.		
Southern California			
Northeast - No I/M, RFG	Maine	Androscoggin	M9623001.IN
	New Hampshire	Hillsborough	M9633011.IN
	New York	Dutchess	M9636027.IN
		Orange	M9636071.IN
West Texas	Texas	El Paso	M9648141.IN

Radian/ERG used the Trends input files and other information provided by EPA to determine the area-specific input parameters. These parameters included registration fractions, mileage accumulation rates, VMT mix, alternate basic emission rates (discussed in Section 3), inspection and maintenance program parameters, Stage II refueling controls, and local area parameter record inputs (fuel RVP and calendar year of evaluation). The Trends input files were used for all areas considered in this analysis except Northern and Southern California. The information for California registration distributions, temperatures, and inspection and maintenance program came from a review of the California Air Resources Board's MVEI7G emissions model. Summarized below are the specific inputs used in this analysis.

Registration Fractions and Mileage Accumulation Rates - The registration fractions were determined for each area from two sources. For the 1990 and 1996 modeling runs, the information provided for each area in the Trends input files was used. For the 16 geographical areas, all of the Trends files within that area were examined to determine the registration distributions that were used most frequently, and those registration distributions were used in the MOBTOX5b input files. The exception to this was for the Northeast area modeling runs. For those runs, the registration distributions for Albany county in New York were used.

For the 2007 and 2020 modeling runs, the registration fractions were provided by EPA. The mileage accumulation rates for 1996, 2007, and 2020 were also provided by EPA.[14] In general, the revised registration fractions reflect the fact that vehicles are lasting longer in customer service than reflected in the MOBILE5b registration fractions (which were based on calendar year 1990). The revised mileage accumulation rates reflect faster mileage accumulation than the default MOBILE5b values. These input parameters were selected based on EPA's current views on what is likely to be used in MOBILE6.

VMT Mix - For the 1990 calendar year runs, the MOBILE5b default VMT mix was used. For the 1996 runs, EPA provided alternate VMT fractions.[*] The VMT mixes for the baseline runs in 2007 and 2020 were calculated from projected sales data provided by EPA. These baseline VMT mix numbers for 2007 and 2020 were used for all scenarios except the increased light-duty Diesel truck penetration scenario. For the increased light-duty Diesel truck penetration scenario in 2007 and 2020, the VMT fractions were also calculated from projected sales volumes provided by EPA. This analysis assumed that the increase in light-duty Diesel sales would continue beyond 2015. However, the Tier 2 final rule assumed that there would be no additional increase after 2015. Table 6-4 shows the VMT fractions for each of the calendar years and scenarios.

[*] Note that the 1996 VMT fractions for LDDVs and LDDTs used in this modeling are lower than the estimates used in the Tier 2 final rule. For the final rule, the LDDV fraction was assumed to be 0.008 and the LDDT fraction was assumed to be 0.003.

Table 6-4
VMT Fractions Used for the Toxics Analysis

Year	Scenario	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC
1996	Baseline	0.556	0.269	0.089	0.021	0.003	0.002	0.055	0.005
2007	Baseline	0.395	0.383	0.127	0.023	0.000	0.002	0.065	0.005
2020	Baseline	0.300	0.448	0.146	0.025	0.000	0.005	0.071	0.005
2007	Increased Diesel	0.394	0.368	0.120	0.023	0.001	0.024	0.065	0.005
2020	Increased Diesel	0.275	0.359	0.114	0.025	0.025	0.126	0.071	0.005

Alternate TOG BERs - As discussed in Section 3, alternate BERs were provided by EPA for all modeling runs. Separate BER files were created for each control scenario and broad-based area (e.g., Ozone Transport Region (OTR) vs. non-OTR). The first three letters of the BER file describes the area. “NTR” indicates a non-OTR region, “OTR” indicates an OTR region, “HAL” indicates a high-altitude region, and “CA” indicates California. The next letters in the prefix of the BER file describe whether it is an area with an inspection and maintenance program. Table 6-5 indicates which of these area and I/M prefixes are used for each urban area and geographical region in this study, while Table 6-16 presented later in this section shows which alternate BER file suffixes (i.e., the “*” in Table 6-5) were used for each year and control scenario. Copies of the BER files are given in Appendix A.

For model year 2001 and later light-duty vehicles, three sets of BERs were developed for each level of control: (1) baseline (including NLEV for LDGVs and LDGT1s), (2) Tier 2 standards, and (3) more stringent standards reflective of a 0.055 g/mi NMHC standard. These emission rates, which were provided by EPA, are summarized in Table 6-6 for an I/M case. That table also shows the BERs for the two HDGV cases: (1) baseline (reflecting a combined 2.5 g/bhp-hr HC+NOx standard in 2004), and (2) a control case (i.e., Scenario 7). The HDGV base emission rates assume that the impacts of I/M are included in the 2004+ model year BERs, and that off-cycle and sulfur effects are also included in the BERs. Thus, no separate adjustment was made for these effects when modeling HDGV emissions. Finally, the HDGV control case assumed that this class would be certified to evaporative emission standards equivalent to LDGT2s. Thus, evaporative emission rates from LDGT2s were assigned to the HDGV category when evaluating the impacts of the control case.

Table 6-5
BER Input File Prefix Used for Each Study Area

Urban / Geographical Area	2020 BER File Prefix
Atlanta	NTR_IM*.BER
Chicago	NTR_IM*.BER
Denver	DNV_IM*.BER
Houston	NTR_IM*.BER
Minneapolis	NTR_NO*.BER (for 1996 only, used NTR_IM*.BER)
New York	OTR_IM*.BER
Philadelphia	OTR_IM*.BER
Phoenix	NTR_IM*.BER
Spokane	NTR_IM*.BER
St. Louis	NTR_IM*.BER
Western Washington / Oregon	NTR_IM*.BER
Idaho / Montana / Wyoming	HAL_NO*.BER
Utah / New Mexico / Nevada	HAL_IM*.BER
ND/SD/NB/IA/KS/Western MO	NTR_NO*.BER
OK/AR/MS/AL/SC/Northern LA	NTR_NO*.BER
Florida	NTR_IM*.BER (for 1990, used NTR_NO*.BER)
Northeast States - No I/M, No RFG	OTR_NO*.BER
Northeast States - I/M, No RFG	OTR_IM*.BER
Ohio Valley - No I/M, No RFG	NTR_NO*.BER
Ohio Valley - I/M, No RFG	NTR_IM*.BER
Ohio Valley - I/M, RFG	NTR_IM*.BER
Northern MI/WI	NTR_NO*.BER
Northern California	CA_IM*.BER
Southern California	CA_IM*.BER
Northeast - No I/M, RFG	OTR_NO*.BER
West Texas	NTR_NO*.BER

Insert Table 6-6

Inspection and Maintenance (I/M) Program Parameters - For LDGVs and LDGTs, the I/M program benefit for 1981 and newer vehicles is included in the alternate BERs. Therefore, it was only necessary to determine the I/M parameters in 1990 and 1996 for the LDGVs and LDGTs. (These vehicles are no longer in the fleet in the 2007 and 2020 modeling runs.) For HDGVs, the I/M program benefit for 2004 and newer vehicles is included in the alternate BERs. The I/M program parameters were determined from several sources. The first source was the Trends input files developed by E.H. Pechan. Two pieces of information were also provided by EPA, including the following:

- An internal document listing I/M test type for each city and calendar year;[15] and

- A table outlining primary modeling elements for operating I/M programs throughout the U.S.[16]

These three sources of information were used to determine the I/M program parameters for this study. The I/M program parameters included the start year of the program, test type, model years tested, vehicles tested, test frequency, test facility, waiver rates, and compliance rate.

Table 6-6
Revised FTP-Based NMHC BERs Used for Control Cases
I/M Areas -- "0.055" Case and HDGV Control Case Reflect 30 ppm Sulfur Fuel

Vehicle Class	Control Case	Model Year	ZM (g/mi)	DR1 (g/mi/10K)	DR2 (g/mi/10K)	Flex Point (10,000 mi)
LDGV	Base/NLEV	2001+	0.055	0.012	0.013	14.636
	Tier 2	2004+	0.055	0.012	0.013	14.636
	"0.055"	2004+	0.024	0.008	0.011	13.198
LDGT1	Base/NLEV	2001+	0.062	0.013	0.015	17.195
	Tier 2	2004+	0.055	0.012	0.014	16.611
	"0.055"	2004+	0.024	0.008	0.011	16.611
LDGT2	Base	1997+	0.181	0.029	0.024	13.926
	Tier 2	2004	0.085	0.016	0.017	13.046
		2005	0.089	0.017	0.017	12.593
		2006	0.083	0.016	0.017	13.593
		2007	0.077	0.015	0.016	14.450
		2008	0.066	0.014	0.015	16.333
		2009+	0.055	0.012	0.014	17.989
	"0.055"	2004+	0.024	0.008	0.012	16.777
HDGV	Base	1998-2003	0.533	0.024	Note that the HDGV base emission rates are in terms of g/bhp-hr for the ZM and g/bhp-hr/10K for the DR.	
		2004-2006	0.156	0.010		
		2007+	0.117	0.007		
	Control (Sc#7)	1998-2003	0.507	0.023		
		2004-2006	0.129	0.009		
		2007+	0.097	0.006		

Start year - For the ten urban areas, the Trends input files for the original I/M program start year were used to determine the I/M program start year. The only exception was for Minnesota's I/M program. According to the Trends input files, the program started in 1990; however, it was determined, based on information from the Minnesota DEQ, that the program actually started in July 1991. For each city, the same I/M program start year was used for all four calendar years of evaluation.

For the 16 geographical areas, the start year was also determined from the Trends input files. Each of the Trends files within an area was examined to determine the start year. If the start years differed, an average start year was determined between them. For example, the start year in Oregon was 1976 and the start year in Washington was 1983; therefore, the average program start year was determined to be 1980.

Test type - For the ten urban areas, information provided by EPA was used to determine the test type. The only change to this information is in Minneapolis for calendar year 1990. According to information from EPA, there was an I/M program in 1990. However, as noted above, the I/M program did not start until July 1991. Thus, the 1990 runs performed for this analysis did not include an I/M program. For the 16 geographical areas, the Trends files were used to determine the test type. Wherever the test types disagreed with each other, the EPA information was consulted to determine which test type to use. Table 6-7 shows the I/M test types used in this analysis. The table shows the test type used for the 1980 and older LDGVs and LDGTs in 1990 and 1996 as well as the test type used for 2003 and older HDGVs in the areas that had a program for HDGVs.

Model years tested - For the model years covered in each I/M program, the information provided in the Trends files was used. However, for LDGVs and LDGTs newer than 1980, the I/M program benefit was included in the alternate BERs. Therefore, the I/M program in these input files was specified to include only 1980 and older LDGVs and LDGTs. Similarly, I/M program impacts were included in the alternate BERs for 2004 and newer model year HDGVs. Thus, for areas that have HDGVs in the I/M program, the MOBILE input files were structured such that the newest model year tested for this vehicle class was 2003. Pre-2004 model years were assigned the default I/M benefits calculated by MOBILE.

Test facility, test frequency, and vehicles tested - For these three parameters, the information was determined from the Trends input files. For the 16 geographical areas, there was occasionally a discrepancy between the parameters in the files for each area. When this occurred, EPA's sources of I/M information were consulted to determine the parameters.

Stringency, waiver rates, and compliance rates - The Trends input files were the only source of information that contained any specific information about these three input parameters. Again, for the 16 geographical areas, there were sometimes differences among those parameters. When this was the case, an average value was calculated for these parameters.

Table 6-7
I/M Test Type Information

Area	1990 LDGV/Ts	1990 HDGVs	1996 LDGV/Ts	1996 HDGVs	2007 HDGVs	2020 HDGVs
Atlanta	No I/M	No I/M	No I/M	No I/M	No I/M	No I/M
Chicago	Idle	Idle	Idle	Idle	Idle	Idle
Denver	Idle	Idle	Idle	Idle	Idle	Idle
Houston	No I/M	No I/M	No I/M	No I/M	Idle	Idle
Minneapolis	No I/M	No I/M	Idle	Idle	No I/M	No I/M
New York	Idle	Idle	Idle	Idle	Idle	Idle
Philadelphia	Idle	No I/M	Idle	No I/M	No I/M	No I/M
Phoenix	Idle	Idle	Idle	Idle	Idle	Idle
Spokane	Idle	Idle	Idle	Idle	Idle	Idle
St. Louis	Idle	No I/M	Idle	No I/M	No I/M	No I/M
Western WA/OR	Idle	Idle	Idle	Idle	Idle	Idle
ID/MT/ WY	No I/M	No I/M	No I/M	No I/M	No I/M	No I/M
UT/NM/ NV	Idle	Idle	Idle	Idle	Idle	Idle
ND/SD/NB/IA/KS/ Western MO	No I/M	No I/M	No I/M	No I/M	No I/M	No I/M
AR/MS/AL/SC/ Northern LA	No I/M	No I/M	No I/M	No I/M	No I/M	No I/M
Florida	No I/M	No I/M	Idle	No I/M	No I/M	No I/M
Northeast States - No I/M, No RFG	No I/M	No I/M	No I/M	No I/M	No I/M	No I/M
Northeast States - I/M, No RFG	Idle	No I/M	Idle	No I/M	No I/M	No I/M
Ohio Valley - No I/M, No RFG	No I/M	No I/M	No I/M	No I/M	No I/M	No I/M
Ohio Valley - I/M, No RFG	Idle	Idle	Idle	Idle	Idle	Idle
Ohio Valley - I/M, RFG	Idle	No I/M	Idle	No I/M	No I/M	No I/M
Northern MI/WI	No I/M	No I/M	No I/M	No I/M	No I/M	No I/M
Northern California	2-Speed Idle	2-Speed Idle	2-Speed Idle	2-Speed Idle	2-Speed Idle	2-Speed Idle
Southern California	2-Speed Idle	2-Speed Idle	2-Speed Idle	2-Speed Idle	2-Speed Idle	2-Speed Idle
Northeast - No I/M, RFG	No I/M	No I/M	No I/M	No I/M	No I/M	No I/M
West Texas	No I/M	No I/M	No I/M	No I/M	No I/M	No I/M

Table 6-8 summarizes the source of information that determined each of the I/M program parameters for this study. The I/M parameters for 2007 and 2020 are only for HDGVs because all of the LDGVs and LDGTs I/M benefits are included in the alternate BERs.

Table 6-8
I/M Program Parameters Information Sources by Calendar Year

Parameter	Calendar Years	Source
Model Years Covered	1990, 1996, 2007, and 2020	Trends input files and information from EPA memo concerning alternate credit files and alternate BERs.[13]
Test type	1990, 1996, 2007, and 2020	Trends files and information provided by Dave Sosnowski.[14]
Start Year, Stringency, Waiver Rates, and Compliance Rate	1990, 1996, 2007, and 2020	Trends input files.
Test Facility, Test Frequency, and Vehicles Tested	1990	Trends input files.
	1996	Trends input files and information provided by Buddy Polovick [15]
	2007 and 2020	Information provided by Buddy Polovick[15]

Evaporative System Functional Checks - One aspect of I/M that has been evolving over the last several years is related to evaporative system functional checks. The practical implementation of pressure and purge functional checks has had mixed success, and many areas of the country are now considering a functional check of only the gas cap, instead of the entire evaporative system.

For this study, evaporative control system functional checks in each area were modeled as shown in Table 6-9. That table shows a breakdown of pressure, purge, and gas cap tests for each city and calendar year used in this modeling. Two model year distinctions are made in the table. That is because 1997 and newer model year vehicles are equipped with enhanced evaporative control systems and onboard diagnostic (OBD) systems. (The phase-in of these requirements actually spans several model years – 1997 was chosen as a midpoint.) For this analysis, it was assumed that OBD would result in the identification and repair of malfunctioning evaporative control systems that would be on par with the pressure and purge test. At this point, however, this assumption is very subjective and may overstate the benefits of the OBD system. Currently, very few data exist on the in-use performance of OBD systems and the response of consumers to malfunction identification. In addition, it is likely that the failure rates of vehicles certified to the

Table 6-9
I/M Evap Checks by Year and Study Area

Area	Model Year	Functional Evap Checks by Calendar Year			
		1990	1996	2007	2020
Chicago	Pre-97	None	None	Cap	Cap
	1997+	None	None	Pressure/Purge	Pressure/Purge
Denver	Pre-97	None	None	Cap	Cap
	1997+	None	None	Pressure/Purge	Pressure/Purge
Houston	Pre-97	None	None	Cap	Cap
	1997+	None	None	Pressure/Purge	Pressure/Purge
Minneapolis	Pre-97	None	None	None	None
	1997+	None	None	None	None
New York City	Pre-97	None	None	Cap	Cap
	1997+	None	None	Pressure/Purge	Pressure/Purge
Philadelphia	Pre-97	None	None	Pressure	Pressure
	1997+	None	None	Pressure/Purge	Pressure/Purge
Phoenix	Pre-97	None	None	Pressure	Pressure
	1997+	None	None	Pressure/Purge	Pressure/Purge
Spokane	Pre-97	None	None	Cap	Cap
	1997+	None	None	Pressure/Purge	Pressure/Purge
Atlanta	Pre-97	None	None	Cap	Cap
	1997+	None	None	Pressure/Purge	Pressure/Purge
Washington / Oregon	Pre-97	None	None	Cap	Cap
	1997+	None	None	Pressure/Purge	Pressure/Purge
Northern California	Pre-97	None	None	Cap	Cap
	1997+	None	None	Pressure/Purge	Pressure/Purge
Southern California	Pre-97	None	None	Cap	Cap
	1997+	None	None	Pressure/Purge	Pressure/Purge
Idaho / Montana / Wyoming	Pre-97	None	None	None	None
	1997+	None	None	None	None
Utah / New Mexico / Nevada	Pre-97	None	None	Cap	Cap
	1997+	None	None	Pressure/Purge	Pressure/Purge
ND / SD / NB / IA / KS / Western MO	Pre-97	None	None	None	None
	1997+	None	None	None	None
AR / MS / AL / SC / Northern LA	Pre-97	None	None	None	None
	1997+	None	None	None	None
Florida	Pre-97	None	None	None	None
	1997+	None	None	Pressure/Purge	Pressure/Purge
Northeast - No I/M, No RFG	Pre-97	None	None	None	None
	1997+	None	None	None	None
Northeast - I/M, No RFG	Pre-97	None	None	Cap	Cap
	1997+	None	None	Pressure/Purge	Pressure/Purge
Northeast - No I/M, RFG	Pre-97	None	None	None	None
	1997+	None	None	None	None

Table 6-9 I/M Evap Checks by Year and Study Area					
Area	Model Year	Functional Evap Checks by Calendar Year			
		1990	1996	2007	2020
Ohio Valley - No I/M, No RFG	Pre-97	None	None	None	None
	1997+	None	None	None	None
Ohio Valley - I/M, No RFG	Pre-97	None	None	Cap	Cap
	1997+	None	None	Pressure/Purge	Pressure/Purge
Ohio Valley - I/M, RFG	Pre-97	None	None	Cap	Cap
	1997+	None	None	Pressure/Purge	Pressure/Purge
Northern MI / WI	Pre-97	None	None	None	None
	1997+	None	None	None	None
West Texas	Pre-97	None	None	None	None
	1997+	None	None	None	None

enhanced evaporative emission standards will decrease relative to the default values in MOBILE5b. Again, however, no data exist on the in-use performance of these systems. For areas without an I/M program in the future it was assumed that there is no benefit conferred by OBD.

For pre-1997 vehicles, a gas cap only or pressure test is specified in Table 6-9, which is based on information received from EPA.[15] A gas cap test was modeled as a 40% benefit of a full pressure test. The test frequency for both the pressure and purge tests was modeled as annual or biennial, depending on the inspection frequency of the I/M program modeled for the area.

Stage II Refueling Controls - Consistent with the MOBILE5b model, MOBTOX5b requires the user to input efficiency levels for areas that have Sage II refueling controls. Although on-board refueling vapor recovery systems will be in place on the majority of vehicles in the 2007 and 2020 runs, it is important to properly characterize Stage II efficiency in the 1990 and 1996 runs, as that is the only means of refueling control in those calendar years. Information on Stage II programs and effectiveness was provided by Sierra based on a study performed for the American Automobile Manufacturers Association in 1993.[17] Table 6-10 summarizes the Stage II program efficiencies for each city and calendar year that were used in the input files for this study.

Local Area Parameter Record and Scenario Record Inputs - The information for the parameters in the LAP record and the scenario record in each input file came from several sources. The minimum and maximum daily temperatures were taken from the Trends input files for 1990 and 1996. The 1996 temperatures were used for 2007 and 2020 as well as for 1996. For the 16 geographical areas, an average minimum and maximum temperature was calculated based on the temperature values in all of the Trends files considered for an area. (The only exception is the UT/NM/NV geographical area. The temperatures from the Nevada Trends files were not used in the minimum and maximum average calculations because of the very high summer temperatures in Southern Nevada. Since that area was mapped to Phoenix for the nationwide calculations, it was not used to establish temperatures for the UT/NM/NV region.)

Table 6-10
Stage II Efficiencies by City and Calendar Year
Estimated Stage II Vapor Recovery Efficiency (%)

	Estimated Stage II Vapor Recovery Efficiency (%)			
Area	1990	1996	2007	2020
Chicago	0.0	85.5	85.5	85.5
Denver	0.0	0.0	0.0	0.0
Houston	0.0	76.7	85.5	85.5
Minneapolis	1.0	0.0	0.0	0.0
New York	82.6	85.5	85.5	85.5
Philadelphia	0.0	80.2	80.2	80.2
Phoenix	0.0	80.2	80.2	80.2
Spokane	0.0	0.0	0.0	0.0
St. Louis	85.5	85.5	85.5	85.5
Atlanta	0.0	85.5	85.5	85.5
Washington / Oregon	0.0	80.2	80.2	80.2
Idaho	0.0	0.0	0.0	0.0
Utah	0.0	0.0	0.0	0.0
North Dakota	0.0	0.0	0.0	0.0
Oklahoma	0.0	0.0	0.0	0.0
Florida	0.0	57.8	57.8	57.8
Northeast - No I/M, No RFG	0.0	80.2	80.2	80.2
Northeast - I/M, No RFG	0.0	80.2	80.2	80.2
Northeast - No I/M, RFG	0.0	80.2	80.2	80.2
Ohio Valley - No I/M, No RFG	0.0	80.2	80.2	80.2
Ohio Valley - I/M, No RFG	0.0	80.2	80.2	80.2
Ohio Valley - I/M, RFG	0.0	80.2	80.2	80.2
Michigan	0.0	85.5	85.5	85.5
Northern California	91.5	91.5	91.5	91.5
Southern California	92.0	92.0	92.0	92.0
West Texas	0.0	76.7	76.7	76.7

Based on correspondence with EPA, it was determined that the temperatures for Winter, Spring, Summer, and Fall came from the Trends runs for January, April, July, and October for each year, respectively. The spring and summer months were evaluated for the current calendar year (e.g., 1990 for 1990, 1996 for 1996) using a July-based run; the winter evaluation was performed for the current calendar year based on a January evaluation date; and the fall evaluation was performed for the next calendar year (e.g., 1991 for 1990, 1997 for 1996) using a January evaluation date.

The RVP levels were determined from the fuel properties provided to Sierra by EPA. These RVP levels were provided for each area and year. An average speed of 19.6 mph was used in consultation with EPA. Finally, the operating mode fractions for VMT accumulated by non-catalyst vehicles in cold start mode, catalyst-equipped vehicles in hot-start mode, and catalyst-equipped vehicles in cold-start mode were determined from the Trends input files.

Area-Specific Toxic-TOG Curves

In addition to the standard MOBILE inputs described above, the toxic-TOG curves described in Section 4 of this report had to be generated for each fuel and control scenario. Toxic-TOG curves were generated for the following:

- Baseline fuel for 1990, 1996, and 2007/2020;
- 30 ppm sulfur fuel for 2007/2020;
- Benzene cap and 25% toxics reduction performance standard control scenarios for 2007/2020;
- Summer vs. winter;
- 10 modeled urban areas; and
- 16 geographic regions.

As described in Section 4, the toxic-TOG curves for each fuel were based on relationships developed by EPA and on results from the Complex model. The fuel parameters used in this analysis were provided by EPA and are summarized in Table 6-11 for the 1996 base year. The remaining fuel parameters used in this study are included in Appendix I of this report, and Appendix J contains a description (provided by EPA) of how these parameters were developed. From these fuel specifications, TOG and toxic emission rates were developed for normal- and high-emitting vehicles as a function of technology type, and a FORTRAN routine was written to compile the technology-based results into model-year-specific factors for use in the MOBTOX5b model. A sample output from that routine is given in Appendix K for the 2007 Phoenix baseline summertime fuel scenario.

EPA compiled the fuel parameters in Table 6-11 and Appendix I from a number of different sources. For the 1990 and 1996 calendar years, the fuel properties for Atlanta, Chicago, Denver, Minneapolis, New York, Philadelphia, Phoenix, and St. Louis came from fuel surveys conducted by the American Automobile Manufacturers Association (AAMA). The Houston fuel properties were from surveys conducted by the National Institute for Petroleum and Energy Research (NIPER). For Spokane, AAMA survey results from Billings, Montana, were used as a surrogate, and it was assumed that the Spokane oxygenated fuel requirement in 1996 was met by splash blending with ethanol. For the 16 regions evaluated in this study, the fuel parameter data were compiled from NIPER survey data.

Projections for future years were based on refinery modeling performed by EPA using the 1996 fuel properties in each area as a basis. If no new fuel programs were implemented, the baseline 2007 and 2020 fuels were assumed to be the same as 1996. For RFG areas,

Table 6-11

1996 Baseline Fuel Specifications

Area	Abbrev.	Year	Season	Scenario	RVP, psi	Aromatics	Olefins	Benzene %	Sulfur	E200 %	E300 %	MTBE %	ETBE %	EtOH %	TAME %
Atlanta	AT	1996	Summer	Baseline	7.2	32.1	11.2	0.87	343	36.9	79.8	0.7	0.0	0.0	0.0
Atlanta	AT	1996	Winter	Baseline	12.4	24.8	13.0	0.77	447	51.2	82.7	0.3	0.0	0.0	0.0
Chicago	CH	1996	Summer	Baseline	7.9	26.0	9.7	0.96	492	50.2	80.8	0.0	0.0	9.0	0.0
Chicago	CH	1996	Winter	Baseline	14.0	22.4	7.8	0.80	523	58.0	83.9	0.0	0.0	9.0	0.0
Denver	DN	1996	Summer	Baseline	8.8	27.1	8.8	1.33	296	50.1	83.1	0.0	0.0	0.0	0.0
Denver	DN	1996	Winter	Baseline	13.6	21.9	9.2	0.94	350	62.1	88.1	0.0	0.0	8.4	0.0
Houston	HS	1996	Summer	Baseline	7.1	27.4	13.0	0.71	261	47.8	79.8	9.8	0.0	0.0	0.0
Houston	HS	1996	Winter	Baseline	12.8	21.1	12.8	0.70	224	59.9	83.8	7.9	0.0	0.0	0.0
Minneapolis	MN	1996	Summer	Baseline	9.6	28.2	7.3	1.81	121	59.4	84.6	0.0	0.0	9.4	0.0
Minneapolis	MN	1996	Winter	Baseline	14.9	23.4	5.3	1.65	70	62.3	89.1	0.0	0.0	8.0	0.0
New York	NY	1996	Summer	Baseline	8.0	28.6	17.1	0.51	231	49.8	81.5	10.6	0.0	0.0	0.0
New York	NY	1996	Winter	Baseline	13.2	23.3	16.6	0.47	267	57.5	85.7	14.5	0.0	0.0	0.0
Philadelphia	PA	1996	Summer	Baseline	7.9	29.0	12.3	0.80	367	51.2	81.8	11.3	0.0	0.0	0.0
Philadelphia	PA	1996	Winter	Baseline	13.5	25.4	10.2	0.63	337	59.3	85.9	8.8	0.0	0.0	0.0
Phoenix	PX	1996	Summer	Baseline	6.8	36.1	6.8	1.07	118	45.7	76.2	0.8	0.0	0.0	0.0
Phoenix	PX	1996	Winter	Baseline	8.7	34.3	7.1	1.40	216	50.2	82.6	0.0	0.0	10.2	0.0
Spokane	SP	1996	Summer	Baseline	8.7	28.5	8.3	1.32	412	45.0	81.4	0.0	0.0	0.0	0.0
Spokane	SP	1996	Winter	Baseline	14.8	18.6	6.9	0.97	350	59.8	87.1	0.0	0.0	9.3	0.0
St. Louis	SL	1996	Summer	Baseline	6.8	29.9	12.0	0.70	492	39.0	78.8	0.0	0.0	0.0	0.0
St. Louis	SL	1996	Winter	Baseline	13.6	23.8	11.4	0.89	535	52.7	82.6	0.0	0.0	0.0	0.0
Western WA/OR - Win 95/96	WA	1996	Summer	Baseline	8.0	35.7	6.7	2.17	256	44.0	82.4	0.1	0.0	0.0	0.0
Western WA/OR - Win 95/96	WA	1996	Winter	Baseline	13.6	27.5	6.3	1.81	342	58.8	84.5	0.0	0.0	4.3	0.0
Western WA/OR - Win 96/97	WB	1996	Summer	Baseline	8.0	35.7	6.7	2.17	256	44.0	82.4	0.1	0.0	0.0	0.0
Western WA/OR - Win 96/97	WB	1996	Winter	Baseline	13.4	29.4	5.8	1.81	345	52.7	84.0	0.0	0.0	1.3	0.0
Northern California	CN	1996	Summer	Baseline	6.9	24.4	3.5	0.56	26	49.3	89.9	9.1	0.0	0.0	0.0
Northern California	CN	1996	Winter	Baseline	10.5	20.1	2.1	0.52	30	54.4	90.8	10.5	0.0	0.0	0.0
Southern California	CS	1996	Summer	Baseline	7.0	20.7	4.3	0.52	10	51.0	86.8	11.0	0.0	0.0	0.0
Southern California	CS	1996	Winter	Baseline	10.6	17.7	3.5	0.57	31	56.3	88.6	11.6	0.0	0.0	0.0
ID/MT/WY	ID	1996	Summer	Baseline	8.5	28.3	8.1	1.64	318	46.8	84.6	0.5	0.0	0.0	0.0
ID/MT/WY	ID	1996	Winter	Baseline	13.5	22.8	6.4	1.40	252	53.7	84.6	0.5	0.0	0.0	0.0
UT/NM/NV	UT	1996	Summer	Baseline	8.0	30.7	10.6	1.75	207	45.2	83.6	1.1	0.0	0.0	0.0
UT/NM/NV	UT	1996	Winter	Baseline	14.4	20.4	8.3	1.14	106	72.2	85.2	0.0	0.0	10.3	0.0
ND/SD/NE/IA/KS/Western MO	ND	1996	Summer	Baseline	8.3	29.0	8.0	1.33	229	45.4	81.8	0.1	0.0	1.7	0.0
ND/SD/NE/IA/KS/Western MO	ND	1996	Winter	Baseline	13.4	22.4	6.8	1.12	224	56.0	85.0	0.4	0.0	1.8	0.0
AR/MS/AL/SC/Northern LA	SE	1996	Summer	Baseline	7.7	30.7	13.2	0.84	349	38.8	78.1	0.5	0.0	0.0	0.0
AR/MS/AL/SC/Northern LA	SE	1996	Winter	Baseline	12.2	24.5	13.0	0.81	271	50.5	82.3	0.4	0.0	0.0	0.0
Florida	FL	1996	Summer	Baseline	7.6	33.6	10.1	0.79	280	40.3	79.4	0.5	0.0	0.0	0.0
Florida	FL	1996	Winter	Baseline	12.1	24.6	12.8	0.82	289	50.5	82.7	0.4	0.0	0.0	0.0
Northeast-NoRFG	NN	1996	Summer	Baseline	8.6	28.1	12.4	1.03	308	43.2	80.7	1.5	0.0	0.0	0.0
Northeast-NoRFG	NN	1996	Winter	Baseline	13.2	23.8	16.2	0.73	222	52.2	83.3	0.8	0.0	0.0	0.0
Northeast-RFG	NR	1996	Summer	Baseline	7.9	24.7	11.7	0.65	234	50.5	82.4	10.9	0.0	0.0	0.0
Northeast-RFG	NR	1996	Winter	Baseline	12.5	19.7	9.6	0.66	265	59.1	87.0	10.5	0.0	0.0	0.0
Ohio Valley-NoRFG	ON	1996	Summer	Baseline	8.7	30.2	10.4	1.24	334	45.3	80.3	0.9	0.0	1.5	0.0
Ohio Valley-NoRFG	ON	1996	Winter	Baseline	14.1	25.5	8.8	1.04	310	54.0	82.6	0.4	0.0	1.2	0.0
Ohio Valley-RFG	OR	1996	Summer	Baseline	7.8	27.3	8.1	0.99	300	45.5	81.1	9.5	0.0	0.0	0.0
Ohio Valley-RFG	OR	1996	Winter	Baseline	12.9	18.9	8.8	0.97	355	59.4	88.4	10.0	0.0	0.0	0.0
Northern MI/WI	MI	1996	Summer	Baseline	8.5	28.4	9.1	1.32	277	49.0	80.9	0.5	0.0	2.8	0.0
Northern MI/WI	MI	1996	Winter	Baseline	14.0	25.3	8.4	1.46	206	57.6	83.1	0.2	0.0	2.4	0.0

adjustments for the more stringent Phase II requirements (which begin in calendar year 2000) were made. To meet the Phase II RFG oxygen requirements (2.1 percent by weight), ethanol was assumed to be blended into gasoline at 6.1 volume percent, MTBE at 11.8 volume percent, or ETBE at 13.7 volume percent. Note that for older technology vehicles, ETBE-specific equations were not available, and equations developed for ethanol were used instead. This occurs only in the 2007 and 2020 summertime Chicago runs, and the impact is very slight, since older technology vehicles have been removed from the fleet by that time (except for the heavy-duty gasoline vehicle class). As noted above, a more complete description of the development of fuel specification data is contained in Appendix J of this report.

Area-Specific Evaporative Benzene and MTBE Fractions

The methodology described in Section 4 to determine benzene and MTBE evaporative fractions was applied to the fuel data in Table 6-11 and Appendix I. Because the same fractions are applied to all technologies, the evaporative input file for the MOBTOX5b runs consists of only two lines of data: one reflecting benzene fractions and one reflecting MTBE fractions. These fractions are applied to the TOG emissions from the appropriate evaporative process (e.g., hot soak, diurnal, etc.). A sample evaporative fraction input file for 2007 Phoenix baseline summertime fuel is provided in Appendix L.

Input File Development

All of the area-specific inputs (the MOBILE5 flags, registration fractions, VMT mix, I/M program parameters, etc.) were entered into a Microsoft Access database. Several different tables were created in the database, one for each group of input parameters (e.g., one table for input flags, another for I/M parameters). Once all values had been entered, each of the inputs was checked for accuracy.

Input File "Builder" Routine - In order to transfer the information from the Access table to the ASCII MOBTOX5b input files, Radian/ERG developed an input file "builder" routine in a Visual Basic module in Access. This Visual Basic module read in the information from each table, created an input file for each city, year, season, and control scenario, and wrote the relevant information from the Access tables into the correct format in the input file. The automated process of developing the input files reduced the number of times that parameters needed to be typed into an ASCII file and significantly reduced the risk of transcription errors. Appendix M shows an example input file (a selected file for Phoenix) that was developed by the input file "builder" routine.

Modeling Runs - Once the input files were built for each city, year, season, and control scenario, the modified MOBTOX5b model was run for each file. An output file from the model is contained in Appendix N, which shows the results based on the Phoenix input file presented in Appendix M. A FORTRAN program was developed to process the output files and condense the results into one large data file for later computation of toxics exposure described in Section 8 of this report.

PART5 Input Files

The PART5 input files were developed using many of the same sources that were used for the Toxics input files. The registration fractions used for the MOBTOX5b model were also used for the PART5 input files. The registration fractions and mileage accumulation rates for HDDVs were used for each of the heavy-duty vehicle classes in PART5.

The VMT mixes from the Toxics inputs were also used for the PART5 input files. The HDDV VMT fraction was broken down into the five VMT fractions (2BHDDV, LHDDV, MHDDV, HHDDV, and buses) using the ratios that were included in the examples in the PART5 User's Guide (i.e., standard model output). For example, the 1996 VMT fraction for HDDV was 0.055. This number was broken down into five VMT fractions based on the ratios of 15.8%, 1.6%, 22.2%, 54.0%, and 6.4% for 2BHDDV, LHDDV, MHDDV, HHDDV, and buses, respectively. The resulting VMT fractions were 0.009, 0.001, 0.012, 0.030, and 0.003 for each of these vehicle classes.

Results from the PART5 runs were also summarized into a single output file for later use in the exposure and risk analyses.

Revised BERs–Light-Duty Diesel Vehicles - Revised base emission rates were modified in the PART5 model based on information developed by EPA during the Tier 2 study. For light-duty Diesel vehicles, Radian/ERG modified the block data used in PART5 to incorporate the emission rates shown in Table 6-12. Emission factors for Tier 2 vehicles are summarized in Table 6-13. The model year designation variable, IDIEYR, and the emission factor variable, EPDPM, were modified in PART5 Block Data 4. Table 6-13 also shows the PM emission factors for light-duty trucks under the increased light-duty Diesel penetration scenario (Scenario 3). Table 6-14 shows the percentage of LDT1/2 (0 to 6,000 lbs GVW) and LDT3/4 (6,000 to 8,500 lbs GVW) assumed in the increased light-duty Diesel truck penetration scenario. In the base scenario, light-duty Diesel vehicles are considered to include only LDT 3/4s.

Table 6-12
Baseline LDDV and LDDT PM Emission Factors

Model Year	LDDV (g/mi)	LDDT (g/mi)
Pre-1980	0.675	0.670
1981	0.234	0.278
1982-1984	0.230	0.324
1985-1986	0.229	0.327
1987	0.109	0.303
1988-1990	0.109	0.261
1991	0.105	0.264
1992-1993	0.107	0.264
1994-1995	0.128	0.130

Table 6-12
Baseline LDDV and LDDT PM Emission Factors

1996	0.10	0.130
1997+	0.10	0.109

Table 6-13
Tier 2 LDDV and LDDT PM Emission Factors

Model Year	LDDV (g/mi)	LDDT (g/mi)	Inc. Diesel Penetration LDDT (g/mi)
2004	0.065	0.056	0.057
2005	0.030	0.043	0.047
2006	0.011	0.033	0.038
2007	0.011	0.022	0.017
2008	0.011	0.016	0.013
2009+	0.011	0.011	0.011

Table 6-14
Phase-In Schedule for Light-Duty Diesel Trucks

Model Year	LDDT1/2	LDDT3/4
Pre-2000	0%	100%
2001-2005	14%	86%
2006	36%	64%
2007	48%	52%
2008	54%	46%
2009+	62%	38%

Revised BERs–Heavy-Duty Diesel Vehicles - The PART5 model was modified to reflect the change in heavy-duty emission rates with the implementation of future emission standards. Table 6-15 shows the PART5 emission factor for various heavy-duty classes. The applicable 1994+ emission standard for the existing PART5 emission rates is 0.1 g/bhp-hr for all heavy-duty classes except buses, for which the rate is 0.07 g/bhp-hr. At the direction of the Work Assignment Manager, two sets of future emission standards for modeling heavy-duty Diesel PM emissions were selected: 0.05 g/bhp-hr and 0.01 g/bhp-hr starting in 2007. The emission rates in PART5 were modified by the ratio of the projected standard to the existing standard and are shown in Table 6-15.

Input File Summary

Table 6-16 summarizes, by task and by scenario, the individual files that were used to create the MOBTOX5b input files for this study. For each model run, separate files for base emission rates, off-cycle effects, toxic-TOG exhaust curves, and toxic-TOG evaporative curves had to be specified. In addition, different PART5 runs were needed for the various scenarios, as also outlined in Table 6-16. Although not discussed above, Section 13 of this report contains a sensitivity analysis of the modeling prepared for this study. The files and scenarios referred to under Task 8 in Table 6-16 were developed for the sensitivity analysis. Those scenarios are discussed at length in Section 13.

Table 6-15
Heavy-Duty Diesel PART5 Emission Factors (g/bhp-hr)
for Future Heavy-Duty Emission Standards
(2007+ Model Year)

Vehicle Type	Current BERs	0.05 g/bhp-hr Standard	0.01 g/bhp-hr Standard
2BHDDV	0.1011	0.0506	0.0101
LHDDV	0.1011	0.0506	0.0101
MHDDV	0.0948	0.0474	0.0095
HHDDV	0.0836	0.0418	0.0084
BUS	0.0591	0.0422	0.0084

Table 6-16

Summary of Scenarios and Files Used in Toxics Model Runs

Task	Scenario	Cal Year	BERs	Off-Cycle	Tox-TOG EXH	Tox-TOG EVP	Part5
1 and 2	B - Baseline	1990	*_b.BER	*90b.OFF	*90*b_b.EXH	*90*b.EVP	P5Base.exe
		1996	*_b.BER	*96b.OFF	*96*b_b.EXH	*96*b.EVP	P5Base.exe
		2007	*_b.BER	*07b.OFF	*07*b_b.EXH	*07*b.EVP	P5Base.exe
		2020	*_b.BER	*20b.OFF	*07*b_b.EXH	*07*b.EVP	P5Base.exe
	1 - 30 ppm S	2007	*_b.BER	*07b.OFF	*07*3_b.EXH	*07*3.EVP	P5Base.exe
		2020	*_b.BER	*20b.OFF	*07*3_b.EXH	*07*3.EVP	P5Base.exe
	2 - 30 ppm S + Tier 2	2007	*_c.BER	*07c.OFF	*07*3_t.EXH	*07*3.EVP	P5T2.exe
		2020	*_c.BER	*20c.OFF	*07*3_t.EXH	*07*3.EVP	P5T2.exe
	3 - Scen 2 with Inc. Diesel	2007	*_d.BER	*07c.OFF	*07*3_t.EXH	*07*3.EVP	P5T2dp.exe
		2020	*_d.BER	*20c.OFF	*07*3_t.EXH	*07*3.EVP	P5T2dp.exe
3	4 - Benzene Cap	2007	*_c.BER	*07c.OFF	*07*Z_t.EXH	*07*Z.EVP	---
		2020	*_c.BER	*20c.OFF	*07*Z_t.EXH	*07*Z.EVP	---
	5 - RFG Perf Std	2007	*_c.BER	*07c.OFF	*07*R_t.EXH	*07*3.EVP	---
		2020	*_c.BER	*20c.OFF	*07*R_t.EXH	*07*3.EVP	---
4	6 - 0.055 NMHC	2007	*_5.BER	*075.OFF	*07*3_5.EXH	*07*3.EVP	---
		2020	*_5.BER	*205.OFF	*07*3_5.EXH	*07*3.EVP	---
5	8 - HDDV 0.01 g/bhp-hr	2007	---	---	---	---	P5HD01.exe
		2020	---	---	---	---	P5HD01.exe
	9 - HDDV 0.05 g/bhp-hr	2007	---	---	---	---	P5HD05.exe
		2020	---	---	---	---	P5HD05.exe
6	7 - HDGV Std	2007	*_h.BER	*07c.OFF	*07*3_t.EXH	*07*3.EVP	---
		2020	*_h.BER	*20c.OFF	*07*3_t.EXH	*07*3.EVP	---
8	D - 2X Det. Rates	1990	*2XDR.BER	*90b.OFF	*90*b_b.EXH	*90*b.EVP	---
		1996	*2XDR.BER	*96b.OFF	*96*b_b.EXH	*96*b.EVP	---
		2007	*2XDR.BER	*07c.OFF	*07*3_t.EXH	*07*3.EVP	---
		2020	*2XDR.BER	*20c.OFF	*07*3_t.EXH	*07*3.EVP	---
	N - Minimum fuel parameters	1996	*_b.BER	*96b.OFF	*96*n_b.EXH	*96*n.EVP	---
	X - Maximum fuel parameters	1996	*_b.BER	*96b.OFF	*96*x_b.EXH	*96*x.EVP	---
	T - MVRATS Baseline	1990	*_b.BER	*90b.OFF	*90*b_b.ATS	*90*b.EVP	---
		1996	*_b.BER	*96b.OFF	*96*b_b.ATS	*96*b.EVP	---
		2007	*_b.BER	*07b.OFF	*07*b_b.ATS	*07*b.EVP	---
		2020	*_b.BER	*20b.OFF	*07*b_b.ATS	*07*b.EVP	---
	U - MVRATS 30 ppm S	2007	*_b.BER	*07b.OFF	*07*3_b.ATS	*07*3.EVP	---
		2020	*_b.BER	*20b.OFF	*07*3_b.ATS	*07*3.EVP	---
	V - MVRATS 30 ppm S + Tier 2	2007	*_c.BER	*07c.OFF	*07*3_t.ATS	*07*3.EVP	---
		2020	*_c.BER	*20c.OFF	*07*3_t.ATS	*07*3.EVP	---
	R - Default regs. 30 ppm S + Tier 2	2007	*_c.BER	*07c.OFF	*07*3_t.EXH	*07*3.EVP	---
		2020	*_c.BER	*20c.OFF	*07*3_t.EXH	*07*3.EVP	---
	M - Def. regs & mileage 30 ppm S + Tier 2	2007	*_c.BER	*07c.OFF	*07*3_t.EXH	*07*3.EVP	---
		2020	*_c.BER	*20c.OFF	*07*3_t.EXH	*07*3.EVP	---

###

7. URBAN AREA MOTOR VEHICLE TOXICS EMISSIONS ESTIMATES

Using the methodologies and models described above, estimates of on-road motor vehicle toxics emission rates were prepared for benzene, acetaldehyde, formaldehyde, 1,3-butadiene, MTBE, and Diesel PM. As described in the preceding section, emission rates were generated for each quarter and for each vehicle class. In addition, annual average estimates were prepared by taking the mean of the quarterly results. Consistent with the requirements of this study, toxics emissions estimates were prepared for (a) calendar years 1990, 1996, 2007, and 2020; (b) baseline emission factors and fuels (for all calendar years); (c) nine control scenarios (for 2007 and 2020); and (d) ten urban areas.

The results from the emissions modeling are presented below in three main sections: (1) gasoline sulfur and light-duty vehicle controls (Scenarios 1, 2, 3, and 6); (2) fuel controls (Scenarios 4 and 5); and (3) heavy-duty vehicle controls (Scenarios 7, 8, and 9).

Gasoline Sulfur and Light-Duty Vehicle Controls

Annual-Average Impacts - The first set of emissions results presented in this section include estimates of the impacts of a national cap on gasoline sulfur level and more stringent emission standards for light-duty vehicles (gasoline and Diesel). Annual average emission results for the fleet (i.e., all vehicle classes combined) are given in Tables 7-1 through 7-6 for benzene, acetaldehyde, formaldehyde, 1,3-butadiene, MTBE, and Diesel PM, respectively, for the following control scenarios:

- Scenario 0 - baseline emission factors (including the NLEV program) and fuels;
- Scenario 1 - baseline emission factors with a national 30 ppm gasoline sulfur limit;
- Scenario 2 - Scenario 1 with more stringent (i.e., Tier 2) emission standards for 2004 and later model year light-duty cars and trucks;
- Scenario 3 - Scenario 2 with increased Diesel light-duty truck and light-duty vehicle penetration; and

- Scenario 6 - Scenario 2 with even more stringent light-duty vehicle emission standards equivalent to 0.055 g/mi NMHC.

Table 7-1 and 7-2

Table 7-1
Annual Average On-Road Motor Vehicle Benzene Emission Rates for Atlanta and Chicago
(Units: mg/mi)

Area	Scenario	Calendar Year			
		1990	1996	2007	2020
Atlanta	Base	104.4	58.4	24.6	16.4
	Sc#1	---	---	21.8	14.3
	Sc#2	---	---	21.3	11.9
	Sc#3	---	---	20.9	10.5
	Sc#6	---	---	20.7	9.5
Chicago	Base	94.2	45.3	20.8	14.0
	Sc#1	---	---	19.5	12.9
	Sc#2	---	---	19.0	10.6
	Sc#3	---	---	18.6	9.3
	Sc#6	---	---	18.4	8.5

Table 7-2
Annual Average On-Road Motor Vehicle Acetaldehyde Emission Rates for Atlanta and Chicago
(Units: mg/mi)

Area	Scenario	Calendar Year			
		1990	1996	2007	2020
Atlanta	Base	17.5	9.1	3.6	2.8
	Sc#1	---	---	3.4	2.7
	Sc#2	---	---	3.3	2.4
	Sc#3	---	---	3.4	2.5
	Sc#6	---	---	3.3	2.2
Chicago	Base	15.1	14.0	6.9	4.9
	Sc#1	---	---	6.4	4.5
	Sc#2	---	---	6.2	3.9
	Sc#3	---	---	6.2	3.7
	Sc#6	---	---	6.1	3.4

Table 7-3
Annual Average On-Road Motor Vehicle Formaldehyde Emission Rates for Atlanta and Chicago
(Units: mg/mi)

Area	Scenario	Calendar Year			
		1990	1996	2007	2020
Atlanta	Base	57.2	28.1	9.6	7.5
	Sc#1	---	---	9.2	7.2
	Sc#2	---	---	9.1	6.6
	Sc#3	---	---	9.3	6.8
	Sc#6	---	---	8.9	6.1
Chicago	Base	48.1	22.4	10.8	8.3
	Sc#1	---	---	10.4	7.9
	Sc#2	---	---	10.2	7.2
	Sc#3	---	---	10.4	7.4
	Sc#6	---	---	10.0	6.5

Table 7-4
Annual Average On-Road Motor Vehicle 1,3-Butadiene Emission Rates for Atlanta and Chicago
(Units: mg/mi)

Area	Scenario	Calendar Year			
		1990	1996	2007	2020
Atlanta	Base	15.9	8.4	3.5	2.6
	Sc#1	---	---	3.1	2.3
	Sc#2	---	---	3.0	2.0
	Sc#3	---	---	3.0	1.9
	Sc#6	---	---	2.9	1.5
Chicago	Base	12.8	5.6	2.8	2.1
	Sc#1	---	---	2.5	1.9
	Sc#2	---	---	2.5	1.7
	Sc#3	---	---	2.5	1.6
	Sc#6	---	---	2.4	1.3

Table 7-5
Annual Average On-Road Motor Vehicle MTBE Emission Rates for Atlanta and Chicago
(Units: mg/mi)

		Calendar Year			
Area	Scenario	1990	1996	2007	2020
Atlanta	Base	0.0	3.7	1.3	0.8
	Sc#1	---	---	2.6	1.5
	Sc#2	---	---	2.6	1.5
	Sc#3	---	---	2.5	1.3
	Sc#6	---	---	2.6	1.5
Chicago	Base	0.0	0.0	0.0	0.0
	Sc#1	---	---	0.0	0.0
	Sc#2	---	---	0.0	0.0
	Sc#3	---	---	0.0	0.0
	Sc#6	---	---	0.0	0.0

Table 7-6
Annual Average On-Road Motor Vehicle Diesel PM Emission Rates for Atlanta and Chicago
(Units: mg/mi)

		Calendar Year			
Area	Scenario	1990	1996	2007	2020
Atlanta	Base	88.4	40.9	19.0	16.0
	Sc#1	---	---	19.0	16.0
	Sc#2	---	---	19.0	15.5
	Sc#3	---	---	20.7	17.3
	Sc#6	---	---	19.0	15.5
Chicago	Base	91.7	36.6	19.0	16.0
	Sc#1	---	---	19.0	16.0
	Sc#2	---	---	19.0	15.5
	Sc#3	---	---	20.7	17.3
	Sc#6	---	---	19.0	15.5

Because of the voluminous nature of these estimates, results are presented only for Atlanta (a non-RFG area) and Chicago (an RFG area); the complete set of toxics emission rates, including the vehicle-class-specific values and the seasonal estimates, is contained in Volume II of this report.

Reviewing the fleet-average toxics emission factors in Tables 7-1 to 7-6, the following observations can be made:

- Significant reductions in fleet-average toxics emissions are observed between 1990 and 2020 with no further vehicle or fuel controls. This is a result of fleet-turnover resulting in full implementation of the federal emission control regulations currently on the books.

- Because it is assumed that gasoline dispensed in Chicago will use either ETBE or ethanol as an oxygenate, MTBE emission rates are zero for all scenarios. Because only a small fraction of gasoline is assumed to contain MTBE in the Atlanta runs, the MTBE emission rates are very low.

- Implementation of Scenario 1, a 30 ppm national gasoline sulfur cap, resulted in a net decrease in all toxic emissions (except Diesel PM) for both Atlanta and Chicago. The impact was greater in Atlanta than in Chicago because Chicago was assumed to use federal RFG in the baseline case. In addition, the benefits of the 30 ppm sulfur cap are generally greater (on a percentage basis) for the 2020 runs because more LEV-category vehicles are in the fleet.

- The Tier 2 emission standards reflected in Scenario 2 also result in reductions in all pollutants. The benefits of Scenario 2 are greater for the 2020 runs because of the fleet turnover that occurs between 2007 and 2020. Only a small reduction in Diesel PM is observed because light-duty Diesel cars and trucks make up a very small fraction of the overall fleet VMT under this scenario.

- Implementation of Scenario 3 results in reductions in benzene, acetaldehyde (except Atlanta), 1,3-butadiene, and MTBE (where used). However, formaldehyde emissions show a slight increase. Diesel PM emissions increase substantially under this scenario.

- Implementation of Scenario 6, more stringent light-duty vehicle emission standards (0.055 g/mi NMHC), results in reductions beyond those achieved by the Tier 2 standards. For example, the Tier 2 standards result in a reduction in fleet-average benzene of 16% in Atlanta in 2020 (Scenario #2 vs. Scenario #1), while the 0.055 g/mi standards result in a 32% reduction (Scenario #6 vs. Scenario #1).

<u>Seasonal Impacts</u> - The results presented in Tables 7-1 to 7-6 reflect annual average emissions. However, there can be substantial differences in emissions estimates among seasons as a result of seasonal fuel differences and ambient temperatures. For example,

toxic emissions in Chicago are typically at a minimum in summer. This is a result of elevated exhaust hydrocarbon emissions (which are directly related to most toxics emissions rates) in winter and fall due to cold temperature. However, the opposite is true in warmer climates such as Phoenix. Because the fall and winter temperatures are relatively mild in Phoenix, large increases in exhaust hydrocarbon emissions as a result of cold temperature are not observed. In fact, the very high summer temperatures result in both increased evaporative emissions (causing increases in benzene and MTBE, when present in the fuel) and increased exhaust emissions (as a result of increased vapor from canister purge). A comparison of seasonal benzene emission rates for several urban areas evaluated in this study (Atlanta, Chicago, Houston, and Phoenix) is shown in Table 7-7 for Scenario #2 (30 ppm sulfur + Tier 2 emission standards) in calendar year 2007.

Table 7-7
Seasonal Benzene Emissions (mg/mi)
Calendar Year 2007 – Scenario #2

Area	Winter	Spring	Summer	Fall	Ann. Ave.
Atlanta	24.5	19.2	19.7	21.8	21.3
Chicago	24.5	18.4	15.1	17.9	19.0
Houston	20.9	15.8	17.4	17.3	17.9
Phoenix	15.5	14.7	17.9	13.8	15.5

Fuel Controls

In addition to the 30 ppm sulfur cap, two other fuel scenarios were evaluated in this study:

- Scenario 4 - a national gasoline regulation capping benzene content at 1% (for modeling purposes, a benzene content of 0.95% was assumed); and

- Scenario 5 - a national regulation requiring compliance with a 25% toxics reduction performance standard. This required a toxics reduction of 25% from the 1990 national-average baseline fuel using the Complex model.

Both of these scenarios were modeled assuming that Tier 2 emission standards were in place, and estimates were prepared for 2007 and 2020. Because of the difficulty in predicting fuel specifications for these scenarios, and because some areas would be relatively unaffected by these rules (e.g., areas that already had benzene levels below 0.95% would see no impact from Scenario 4), these scenarios were modeled only for the following areas: Atlanta, Cleveland, Eau Claire, Kansas City, Minneapolis, Pittsburgh, and Seattle. A summary of the fleet-average results for benzene is given in Table 7-8. The results for the remaining pollutants can be found in Volume II of this report.

Table 7-8
Fleet-Average Benzene Emission Rates for Fuel Control Scenarios

		Benzene (mg/mi)	
Area	Scenario	2007	2020
Atlanta	Sc#2 (30 ppm S)	21.3	11.9
	Sc#4 (Bnz Cap)	22.2	12.4
	Sc#5 (25% Red.)	19.1	10.7
Cleveland	Sc#2 (30 ppm S)	24.4	13.4
	Sc#4 (Bnz Cap)	23.3	12.8
	Sc#5 (25% Red.)	21.0	11.6
Eau Claire	Sc#2 (30 ppm S)	35.4	23.2
	Sc#4 (Bnz Cap)	31.7	20.7
	Sc#5 (25% Red.)	30.0	19.7
Kansas City	Sc#2 (30 ppm S)	34.0	22.5
	Sc#4 (Bnz Cap)	31.7	20.8
	Sc#5 (25% Red.)	30.4	20.0
Minneapolis	Sc#2 (30 ppm S)	41.4	27.6
	Sc#4 (Bnz Cap)	33.3	21.9
	Sc#5 (25% Red.)	33.0	21.7
Pittsburgh	Sc#2 (30 ppm S)	21.7	12.5
	Sc#4 (Bnz Cap)	22.2	12.7
	Sc#5 (25% Red.)	19.9	11.5
Seattle	Sc#2 (30 ppm S)	32.4	17.8
	Sc#4 (Bnz Cap)	24.8	13.7
	Sc#5 (25% Red.)	20.8	11.6

Note that emissions estimates for the seven areas evaluated for the fuel control scenarios were based on the following "mapping" to the area-specific and regional estimates that were described in Section 6 of this report:

- Atlanta – Atlanta
- Cleveland – Ohio Valley, non-RFG, I/M
- Eau Claire – Michigan/Wisconsin
- Kansas City – North Dakota/NB/KS/etc.
- Minneapolis – Minneapolis
- Pittsburgh – Northeast, non-RFG, I/M
- Seattle – Western Washington/Oregon

Several items are worth noting with respect to the results presented in Table 7-8. First, the benzene cap scenario does not impact all areas equally because the baseline fuel (i.e., the 30 ppm sulfur case) in each area has a different benzene level. In areas such as Seattle, which has a relatively high baseline benzene level (1.8% to 2.2%, depending on season), substantial reductions in benzene emission rates are observed for Scenario 4. However, scenario 4 resulted in a slight increase in benzene in Atlanta and Pittsburgh because the 30 ppm S fuel in those areas had annual average benzene levels that were below the 0.95% level, and the fuel parameters provided by EPA for the benzene cap was set at 0.95% for all areas. Under the 25% toxics reduction performance standard scenario, all areas were predicted to have reductions in benzene levels. Again, however, the extent of that reduction was dependent upon the specifications of the baseline fuel.

Heavy-Duty Vehicle Controls

A final set of emissions estimates that was prepared for this study involved changes to heavy-duty vehicles. Three separate scenarios were modeled in this case:

- Scenario 7 - Scenario 2 with more stringent heavy-duty gasoline vehicle emission standards (exhaust and evaporative) that were assumed to be phased in beginning with the 2004 model year.

- Scenario 8 - Scenario 2 with more stringent heavy-duty Diesel vehicle PM emission standards (equivalent to 0.01 g/bhp-hr). These standards were assumed to apply beginning with the 2007 model year.

- Scenario 9 - Scenario 2 with more stringent heavy-duty Diesel vehicle PM emission standards (equivalent to 0.05 g/bhp-hr). These standards were assumed to apply beginning with the 2007 model year.

The above scenarios were run for all urban areas (and geographic areas) modeled in this study for the 2007 and 2020 calendar years.

The results for Scenario 7 are summarized in Table 7-9, which shows class-specific emission rates in Atlanta and Chicago for benzene, acetaldehyde, formaldehyde, and 1,3-butadiene. Because HDGVs make up such a small fraction of the total VMT, the impact of this control measure on fleet-average emissions is very slight (about 0.8% in Atlanta in 2020). For the HDGV class, this control measure achieves a 13% to 15% reduction in benzene emissions in 2020. Similar reductions are observed for the other toxics as well. It is interesting to note that a significant reduction in HDGV emissions is observed between 2007 and 2020 without further controls. This is a result of the fact that compliance with the 2.5 g/bhp-hr HC + NOx standard beginning in 2004 is assumed to be in the baseline emission estimates.

A summary of the Diesel PM emissions estimates for Scenarios 8 and 9 is contained in Table 7-10. Based on the simple assumptions that were used in this analysis (e.g., no deterioration in PM emissions, even though trap technology would likely be required to meet these emission levels), significant emission reductions are achieved in the 2020 runs for both the 0.01 g/bhp-hr case and the 0.05 g/bhp-hr case. However, this represents a best-case scenario, and is not necessarily reflective of what would occur in customer

Table 7-9
<u>Class-Specific</u> Emission Rates for More Stringent Emission Standards for Heavy-Duty Gasoline Vehicles (Scenario 7)

Area	Year	Scenario	Emission Rate (mg/mi)			
			Bnz	Acet	Form	1,3-But
Atlanta	2007	Sc#2	59.0	7.4	30.0	5.7
		Sc#7	56.6	7.2	29.3	5.6
	2020	Sc#2	28.2	2.7	9.3	1.6
		Sc#7	24.5	2.5	8.6	1.5
Chicago	2007	Sc#2	40.1	15.6	28.2	4.9
		Sc#7	38.3	15.2	27.5	4.8
	2020	Sc#2	18.3	5.6	7.9	1.1
		Sc#7	15.5	5.2	7.3	1.0

Table 7-10
Fleet-Average Diesel PM Emission Rates for More Stringent Heavy-Duty Diesel PM Emission Standards (Scenarios 8 and 9)

Scenario	2007 (mg/mi)	2020 (mg/mi)
Sc#2 (Baseline)	19.0	15.5
Sc#8 (0.01 g/bhp-hr)	17.8	3.0
Sc#9 (0.05 g/bhp-hr)	18.2	8.7

service. Note that these results are not presented by area. That is because the PART5 model does not account for regional differences in fuels or temperatures in its estimates, and those parameters were not accounted for in this study.

###

8. URBAN AREA TOXICS EXPOSURE ESTIMATES

Using the urban area motor vehicle toxics emission rates described in the previous section of this report, CO exposure estimates prepared with the HAPEM-MS model, and the 1990 CO emission rates generated for each of the areas, exposure estimates were calculated for all study areas and scenarios evaluated in this effort. As described in Section 2, the approach used to estimate toxics exposure was based on the following formula:

$$TOX_{Exposure(\mu g/m3)} = [CO_{Exposure(\mu g/m3)}/CO_{EF(g/mi)}]_{1990} \times TOX_{EF(g/mi)}$$

where TOX reflects one of the six toxic pollutants considered in this study. Because some of the toxic pollutants evaluated in this study (e.g., 1,3-butadiene) have a different photochemical reactivity from CO, the exposure concentrations were adjusted to account for atmospheric transformation. In addition, because the CO ratios are based on the 1990 calendar year, an adjustment was made to account for the increase in VMT relative to 1990.

Details of the calculations performed to generate exposure estimates for this study are described below. Estimates were prepared for three specific demographic groups: outdoor workers, children 0 to 17 years of age, and the total population. These groups were selected because outdoor workers are generally the highest exposed demographic group, children 0 to 17 represent a very sensitive demographic group, and the total population gives an average exposure estimate.

1990 CO Exposure Estimates

The calendar year 1990 CO exposure estimates *related to on-road motor vehicles* were provided to Sierra by EPA. Those estimates, which are summarized in Table 8-1, were based on a recent study performed by Mantech Environmental Technology under contract to EPA.[18*] That study used the Hazardous Air Pollutant Exposure Model (HAPEM) to generate estimates of human exposure to ambient CO. The HAPEM model links human activity patterns with ambient CO concentration to arrive at average exposure estimates for 22 different demographic groups (e.g., outdoor workers, children 0 to 17, working men 18 to 44, women 65+, etc.) and for the total population. The model simulates the

[*] Note that the CO exposure estimates for Atlanta were provided to EPA by Mantech in a separate transmittal.

movement of individuals between home and work and through a number of different microenviroments (37 in total). The CO concentration in each microenvironment is

Table 8-1
1990 On-Road Motor Vehicle CO Exposure Estimates (µg/m³)

Urban Area	Demo Group	Quarter			
		1	2	3	4
Atlanta	Outdoor Workers	560	325	476	568
	Children 0–17	476	272	396	480
	Total Population	481	273	397	489
Chicago	Outdoor Workers	455	344	317	378
	Children 0–17	366	286	261	309
	Total Population	375	290	261	316
Denver	Outdoor Workers	696	358	364	628
	Children 0–17	556	289	294	508
	Total Population	569	295	297	518
Houston	Outdoor Workers	305	235	388	429
	Children 0–17	258	193	322	370
	Total Population	262	197	322	373
Minneapolis	Outdoor Workers	872	593	538	681
	Children 0–17	698	489	442	550
	Total Population	724	497	446	566
New York	Outdoor Workers	947	771	662	751
	Children 0–17	764	637	548	612
	Total Population	793	658	561	636
Philadelphia	Outdoor Workers	608	343	337	444
	Children 0–17	508	297	284	379
	Total Population	515	295	280	381
Phoenix	Outdoor Workers	685	360	449	757
	Children 0–17	591	308	378	649
	Total Population	596	310	374	654
Spokane	Outdoor Workers	795	458	713	745
	Children 0–17	636	367	568	592
	Total Population	651	370	566	606
St. Louis	Outdoor Workers	374	245	197	313

Table 8-1 1990 On-Road Motor Vehicle CO Exposure Estimates (μg/m³)					
	Children 0–17	302	204	166	268
	Total Population	309	205	165	269

determined by multiplying ambient concentration by a microenvironmental factor. For example, a factor of 0.38 is used for time spent in an office building, while a factor of 2.11 is used for time spent in a shopping mall.

With the CO exposure estimates generated by HAPEM model, EPA determined the fraction of exposure that was a result of on-road motor vehicles. This was accomplished by scaling the annual and quarterly exposure estimates prepared by Mantech (which reflect exposure to total ambient CO) by the fraction of the 1990 CO emissions inventory that was from on-road motor vehicles. The inventory estimates used for this purpose were prepared by E.H. Pechan under contract to EPA.[19*] A spreadsheet with the exposure results was provided to Sierra; the results were then summarized in an ASCII file that was used as an input to a FORTRAN routine that compiled the exposure data, CO emissions data, and the toxics emissions data to calculate toxics exposure and risk for each of the urban areas and scenarios included in this study. The exposure estimates given in Table 8-1 reflect the adjustment to account only for on-road motor vehicles.

CO Emissions Estimates

As outlined above, the calendar year 1990 fleet-average CO emission rate is used in the toxics exposure calculation. These CO estimates were prepared with a modified version of the MOBILE5b model, which is described in Section 3 of this report. (Changes to the current MOBILE5b inputs were made to account for revised base emission rates, off-cycle effects, and revised oxygenated fuels effects.) A summary of the calendar year 1990 fleet-average CO emission rates calculated for each area and quarter is given in Table 8-2. Note that only baseline numbers were calculated, since no alternative control programs were assumed in the 1990 runs.

Several points can be made in reference to Table 8-2:

- In general, CO emissions in the winter (i.e., quarter 1) are higher than in the other seasons because temperatures are lower, which results in elevated CO emissions from gasoline-fueled vehicles (primarily due to cold-start increases).

- The one area where CO emissions are lower in winter than in the other seasons is Phoenix. That is because Phoenix had a winter oxygenated fuels program in 1990, which resulted in CO emissions decreases. In addition, the winter

[*] Note that the CO fractions for Atlanta were provided to EPA by E.H. Pechan in a separate transmittal.

ambient temperatures in Phoenix are relatively mild (44° to 67°F diurnal temperature pattern), which mitigates the cold-start effects observed in some of the other communities. Because Phoenix is very hot in the summer (83° to 105°F diurnal temperature pattern), the impact of air conditioning use is maximized in the summer run (quarter 3), resulting in elevated CO emission rates in the summer.

Table 8-2
1990 On-Road Motor Vehicle CO Emissions Estimates by Urban Area and Quarter (g/mi)

Urban Area	Q1	Q2	Q3	Q4
Atlanta	50.2	40.7	48.3	46.2
Chicago	43.8	35.8	33.2	36.3
Denver	55.4	55.4	50.0	46.4
Houston	46.6	36.3	44.8	40.8
Minneapolis	61.8	47.8	41.5	47.3
New York	43.1	35.1	33.4	36.0
Philadelphia	54.6	44.7	43.4	45.4
Phoenix	29.3	31.4	42.3	31.6
Spokane	45.2	38.8	33.5	40.4
St. Louis	44.1	36.2	36.6	37.9

- Denver also had an oxygenated fuels program in 1990, which results in the winter CO emission rates being the same as in the spring (quarter 2) run, even though the temperature was lower in the winter run.

- Because the fall runs (quarter 4) were performed using a January 1991 evaluation date in the MOBILE input files, those results reflect an additional year of fleet turnover relative to the winter runs (which were based on a January 1990 evaluation date). The spring and summer runs assumed a July 1990 evaluation date, reflecting six months of additional fleet turnover relative to the winter runs.

Reactivity and VMT Adjustments

As outlined previously, unadjusted toxic exposure estimates can be determined from the following formula:

$$TOX_{Exposure(\mu g/m3)} = [CO_{Exposure(\mu g/m3)}/CO_{EF(g/mi)}]_{1990} \times TOX_{EF(g/mi)}$$

However, because some of the toxic pollutants evaluated in this study (i.e., formaldehyde, acetaldehyde, and 1,3-butadiene) have a different photochemical reactivity from CO, the exposure concentrations must be adjusted to account for atmospheric transformation. In addition, because the CO ratios are based on the 1990 calendar year, an adjustment must be made to account for the increase in VMT relative to 1990, i.e.,

$$TOX_{Exposure\text{-}Adj\ (\mu g/m3)} = TOX_{Exposure\text{-}Unadj\ (\mu g/m3)} \times Reactivity_{Adj} \times VMT_{Adj}$$

The specific adjustments to account for reactivity and VMT are described below.

Reactivity Adjustments - The reactivity adjustments used in this effort were provided to Sierra by EPA staff,[20] and are summarized as follows:

- *1,3-Butadiene* - Seasonal reactivity adjustments were estimated by EPA. These multiplicative factors are 0.44 for summer, 0.70 for spring and fall, and 0.96 for winter.

- *Benzene, MTBE, and Diesel PM* - These were assumed to be inert for the modeling performed in this study.

- *Formaldehyde and Acetaldehyde* - There is strong evidence to suggest that these species undergo substantive atmospheric transformation, both in terms of decay of primary (i.e., tailpipe) emissions and in the formation of secondary formaldehyde and acetaldehyde. However, because of the complexities involved in quantifying that effect, it was not addressed in this study. Thus, the calculations performed to generate the exposure estimates presented below treat these species as if they were inert, roughly assuming that removal of direct emissions in the afternoon would be offset by secondary formation.

VMT Adjustments - As discussed in Section 7, future-year on-road motor vehicle toxics emissions estimates are expected to decline significantly as a result of fleet turnover effects (i.e., older, high-emitting vehicles are replaced by newer-technology vehicles with more durable emissions control systems), improved I/M program designs, and the use of cleaner fuels. However, those reductions cannot be used directly to assess corresponding reductions in ambient concentrations because growth in VMT will partially offset the gains made in per-vehicle (or per-mile) reductions. That being the case, the toxics exposure estimates for future years need to be adjusted to account for VMT increases relative to the 1990 base year used to estimate CO exposure.

The VMT projections for each of the urban areas evaluated in this study were based on an evaluation of the "Trends" database performed by an EPA contractor.[21] The results of this analysis are presented in Table 8-3. Note that Sierra was provided VMT forecasts only for 1990, 1996, 2007, and 2010. The 2020 values shown in Table 8-3 were extrapolated from the 2010 numbers by applying the annualized growth rate observed between 2007 and 2010. For example, the estimated Chicago VMT in 2007 is 74,646,000 miles and in 2010 it is 78,428,000 miles. Thus the annualized growth over those three years is:

$$\text{Annual VMT Growth} = (78{,}428/74{,}646)^{1/3} - 1.0 = 0.0166$$

Table 8-3
VMT Forecasts by Urban Area
(1000s of Miles)

Urban Area	1990	1996	2007	2010	2020
Atlanta	29,136	47,402	63,791	68,257	85,506
Chicago	49,032	62,408	74,646	78,428	92,474
Denver	14,289	20,189	26,636	28,444	35,406
Houston	24,400	40,684	52,550	55,819	68,256
Minneapolis	17,798	22,506	28,350	29,958	36,008
New York	92,323	103,195	117,422	122,258	139,863
Philadelphia	36,612	43,286	52,169	54,711	64,114
Phoenix	18,762	25,017	33,295	35,788	45,531
Spokane	3,447	4,105	5,146	5,446	6,581
St. Louis	18,037	27,903	32,383	33,985	39,919

or 1.66%. This value was used in conjunction with the 2010 VMT forecast to arrive at a 2020 estimate:

$$VMT_{CH\text{ - }2020} = 78{,}428{,}000 \times (1.0166)^{10} = 92.5 \text{ million miles}$$

Using the VMT estimates shown in Table 8-3, VMT growth rate adjustment factors were generated for each urban area. These results are given in Table 8-4.

Modeled Urban Area Toxics Exposure Estimates

Using the methodology described above, toxics exposure estimates were prepared for each of the ten urban areas included in this study. These estimates were generated for calendar years 1990, 1996, 2007, and 2020, and estimates were prepared for each quarter as well as on an annual average basis. Finally, separate estimates were calculated for the three demographic groups discussed above, and the 2007 and 2020 runs include baseline control assumptions and the various control scenarios. Obviously, presenting the entire set of results within the text of this report is not viable. Only the highlights are discussed below; complete results by urban area and vehicle class can be found in Volume II of this report.

Table 8-4 **VMT Adjustment Factors by Urban Area Relative to 1990**				
Urban Area	1990	1996	2007	2020
Atlanta	1.000	1.627	2.189	2.935
Chicago	1.000	1.273	1.522	1.886
Denver	1.000	1.413	1.864	2.478
Houston	1.000	1.667	2.154	2.797
Minneapolis	1.000	1.265	1.593	2.023
New York	1.000	1.118	1.272	1.515
Philadelphia	1.000	1.182	1.425	1.751
Phoenix	1.000	1.333	1.775	2.427
Spokane	1.000	1.191	1.493	1.909
St. Louis	1.000	1.547	1.795	2.213

FORTRAN Model - Because of the large number of scenarios modeled in this effort, the compilation of toxics emissions data, CO emissions data, and CO exposure estimates was performed within a FORTRAN routine. As described later in this report, this also facilitated the calculation of national emissions and exposure estimates, as well as risk analysis (i.e., estimating the number of cancer incidences per million people and the overall number of cancer cases as a result of the various scenarios modeled in this study).

As an example of the calculation, the baseline Chicago 1996 winter benzene exposure for the total population demographic group was estimated as follows. Variables in the calculation are listed below.

$CO_{Exposure\text{ - }Win\ 90}$	$= 375\ \mu g/m^3$	(from Table 8-1)
$CO_{Emissions\text{-}Win\ 90}$	= 43.8 g/mi	(from Table 8-2)
$Benzene_{Emissions\text{-}Win\ 96}$	= 62.62 mg/mi	(See Section 7)
$VMT\ Growth_{1996}$	= 1.273	(from Table 8-4)

Using the equation described above, the winter 1996 Chicago benzene exposure in this case was then calculated as:

$$Bnz_{Exposure\text{-}Win\ 96} = (375\ \mu g/m^3 / 43.8\ g/mi) \times (62.62\ mg/mi / 1000) \times 1.273$$
$$Bnz_{Exposure\text{-}Win\ 96} = 0.682\ \mu g/m^3$$

Note that no transformation term was included in this calculation since benzene was assumed to be inert for the purposes of the exposure estimates. The same methodology was used to calculate benzene exposure for the remaining seasons, resulting in the following estimates:

$Bnz_{Exposure\text{-}Spr\ 96} = 0.436\ \mu g/m^3$
$Bnz_{Exposure\text{-}Sum\ 96} = 0.346\ \mu g/m^3$
$Bnz_{Exposure\text{-}Fall\ 96} = 0.462\ \mu g/m^3$

An annual average exposure estimate was calculated as the arithmetic mean of the four seasonal values. In this case, the annual average Chicago benzene exposure was calculated to be 0.482 $\mu g/m^3$.

At the request of the work assignment manager, exposure estimates were also generated by vehicle class. This was accomplished by multiplying the overall on-road motor vehicle exposure (calculated above) by the fractional contribution of each vehicle class to the fleet-average emission rate. For example, the LDGV (i.e., passenger car) benzene emission rate in the winter 1996 run was 57.69 mg/mi, with that vehicle class contributing 55.6% of overall VMT. Thus, this vehicle class contributed:

$$\text{Bnz Fraction}_{LDGV} = (57.69\ \text{mg/mi} \times 0.556)/62.62\ \text{mg/mi} = 0.512$$

where 62.62 mg/mi is the fleet-average emission rate. Using this value in conjunction with the overall 1996 Chicago winter benzene on-road motor vehicle exposure, the exposure as a result of the LDGV class was calculated as:

$$Bnz_{Exposure\text{-}Win\ 96\text{-}LDGV} = 0.682\ \mu g/m^3 \times 0.512 = 0.349\ \mu g/m^3$$

Consistent with the fleet-average calculations, annual-average exposure estimates for each vehicle class were prepared by taking the arithmetic mean of the quarterly results for each class.

Exposure Estimates–Gasoline Sulfur and Light-Duty Vehicle Controls - The first set of exposure results presented in this section include estimates of the impacts of a national cap on gasoline sulfur level and more stringent emission standards for light-duty vehicles (gasoline and Diesel). Annual average exposure results for the fleet (i.e., all vehicle classes combined) are given in Tables 8-5 through 8-10 for benzene, acetaldehyde, formaldehyde, 1,3-butadiene, MTBE, and Diesel PM, respectively, for the following control scenarios:

- Scenario 0 - baseline emission factors (including the NLEV program) and fuels;
- Scenario 1 - baseline emission factors with a national 30 ppm gasoline sulfur limit;

Table 8-5
Annual Average Exposure Results for Benzene
Total Population -- All On-Road Vehicles
(Units: ug/m3)

Area	Scenario	1990 CO Ratio	Calendar Year 1990	1996	2007	2020
Atlanta	Base	8.80	0.930	0.836	0.480	0.428
	Sc#1	8.80	---	---	0.424	0.374
	Sc#2	8.80	---	---	0.413	0.309
	Sc#3	8.80	---	---	0.406	0.272
	Sc#6	8.80	---	---	0.401	0.247
Chicago	Base	8.36	0.784	0.482	0.264	0.220
	Sc#1	8.36	---	---	0.248	0.204
	Sc#2	8.36	---	---	0.241	0.167
	Sc#3	8.36	---	---	0.237	0.147
	Sc#6	8.36	---	---	0.233	0.133

Table 8-6
Annual Average Exposure Results for Acetaldehyde
Total Population -- All On-Road Vehicles
(Units: ug/m3)

Area	Scenario	1990 CO Ratio	Calendar Year 1990	1996	2007	2020
Atlanta	Base	8.80	0.154	0.130	0.070	0.073
	Sc#1	8.80	---	---	0.065	0.069
	Sc#2	8.80	---	---	0.064	0.063
	Sc#3	8.80	---	---	0.065	0.064
	Sc#6	8.80	---	---	0.063	0.058
Chicago	Base	8.36	0.125	0.149	0.088	0.077
	Sc#1	8.36	---	---	0.081	0.071
	Sc#2	8.36	---	---	0.079	0.061
	Sc#3	8.36	---	---	0.079	0.059
	Sc#6	8.36	---	---	0.077	0.053

Table 8-7
Annual Average Exposure Results for Formaldehyde
Total Population -- All On-Road Vehicles
(Units: ug/m3)

Area	Scenario	1990 CO Ratio	Calendar Year 1990	1996	2007	2020
Atlanta	Base	8.80	0.503	0.403	0.187	0.195
	Sc#1	8.80	---	---	0.178	0.186
	Sc#2	8.80	---	---	0.175	0.170
	Sc#3	8.80	---	---	0.179	0.177
	Sc#6	8.80	---	---	0.172	0.158
Chicago	Base	8.36	0.400	0.238	0.137	0.131
	Sc#1	8.36	---	---	0.131	0.125
	Sc#2	8.36	---	---	0.129	0.113
	Sc#3	8.36	---	---	0.131	0.115
	Sc#6	8.36	---	---	0.127	0.103

Table 8-8
Annual Average Exposure Results for 1,3-Butadiene
Total Population -- All On-Road Vehicles
(Units: ug/m3)

Area	Scenario	1990 CO Ratio	Calendar Year 1990	1996	2007	2020
Atlanta	Base	8.80	0.101	0.087	0.049	0.049
	Sc#1	8.80	---	---	0.043	0.043
	Sc#2	8.80	---	---	0.042	0.038
	Sc#3	8.80	---	---	0.042	0.035
	Sc#6	8.80	---	---	0.041	0.028
Chicago	Base	8.36	0.078	0.044	0.027	0.025
	Sc#1	8.36	---	---	0.024	0.022
	Sc#2	8.36	---	---	0.023	0.019
	Sc#3	8.36	---	---	0.023	0.018
	Sc#6	8.36	---	---	0.022	0.015

Table 8-9
Annual Average Exposure Results for MTBE
Total Population -- All On-Road Vehicles
(Units: ug/m3)

Area	Scenario	1990 CO Ratio	Calendar Year 1990	1996	2007	2020
Atlanta	Base	8.80	0.000	0.050	0.026	0.020
	Sc#1	8.80	---	---	0.046	0.035
	Sc#2	8.80	---	---	0.046	0.035
	Sc#3	8.80	---	---	0.045	0.030
	Sc#6	8.80	---	---	0.046	0.035
Chicago	Base	8.36	0.000	0.000	0.000	0.000
	Sc#1	8.36	---	---	0.000	0.000
	Sc#2	8.36	---	---	0.000	0.000
	Sc#3	8.36	---	---	0.000	0.000
	Sc#6	8.36	---	---	0.000	0.000

Table 8-10
Annual Average Exposure Results for Diesel PM
Total Population -- All On-Road Vehicles
(Units: ug/m3)

Area	Scenario	1990 CO Ratio	Calendar Year 1990	1996	2007	2020
Atlanta	Base	8.80	0.775	0.582	0.365	0.411
	Sc#1	8.80	---	---	0.365	0.411
	Sc#2	8.80	---	---	0.363	0.399
	Sc#3	8.80	---	---	0.397	0.445
	Sc#6	8.80	---	---	0.363	0.399
Chicago	Base	8.36	0.761	0.387	0.240	0.250
	Sc#1	8.36	---	---	0.240	0.250
	Sc#2	8.36	---	---	0.239	0.243
	Sc#3	8.36	---	---	0.261	0.271
	Sc#6	8.36	---	---	0.239	0.243

- Scenario 2 - Scenario 1 with more stringent (i.e., Tier 2) emission standards for 2004 and later model year light-duty cars and trucks;

- Scenario 3 - Scenario 2 with increased Diesel light-duty truck and light-duty vehicle penetration; and

- Scenario 6 - Scenario 2 with even more stringent light-duty vehicle emission standards equivalent to 0.055 g/mi NMHC.

It is interesting to note that the motor vehicle air toxics exposures are estimated to decrease substantially between 1990 and 2020, even without additional controls on vehicles and fuels. This is a result of fleet turnover and the full implementation of federal regulations that are currently in place. However, for some pollutants for which heavy-duty Diesel vehicles are a large contributor (i.e., formaldehyde and Diesel PM), exposure <u>increases</u> between 2007 and 2020. This is a result of fleet VMT growing at a faster rate than the reduction in fleet emissions between 2007 and 2020.

As one might expect, the benefits of Scenario 1, a national gasoline rule limiting sulfur to 30 ppm, are greatest in areas that do not have a pre-existing reformulated gasoline program, such as Atlanta. Areas with an RFG program (e.g., Chicago) show more moderate decreases in motor vehicle toxics exposure, depending on the pollutant, as a result of a national gasoline sulfur limit. The more stringent light-duty vehicle exhaust emission standards included in Scenario 2 (Tier 2 standards) and Scenario 6 (0.055 g/mi NMHC standards) in general show greater decreases in toxics exposure than the other light-duty vehicle control scenarios modeled in this effort, particularly for the 2020 calendar year run. Finally, the increased light-duty Diesel penetration scenario modeled in Scenario 3 results in increased Diesel particulate exposure levels, although benzene exposure is decreased. It should be kept in mind that the exposure estimates for acetaldehyde and formaldehyde do not include any adjustments to account for atmospheric transformation.

As discussed above, exposure estimates were also prepared for three different demographic groups: total population, outdoor workers, and children 0–17 years of age. (The estimates given in Tables 8-5 to 8-10 are for the total population.) As with the CO exposure estimates shown in Table 8-1, the exposure to air toxics for outdoor workers is generally about 20% higher than for the total population, while exposure for children is typically slightly below the total population. This is observed in Table 8-11, which shows the annual-average benzene exposure for the three demographic groups analyzed in this study for Chicago under the control scenarios described above. As seen in the table, benzene exposure is highest for outdoor workers (which is the highest exposed demographic group), while children and the total population show similar results.

table 8-11

Exposure Estimates–Fuel Controls - In addition to the 30 ppm sulfur cap, two other fuel scenarios were evaluated in this study:

- Scenario 4 - A national gasoline regulation capping benzene content at 1% (for modeling purposes, a benzene content of 0.95% was assumed); and

- Scenario 5 - A national regulation requiring compliance with a 25% toxics reduction performance standard. This required a toxics reduction of 25% from the 1990 national-average baseline fuel using the Complex model.

As described in the last section of this report, both of these scenarios were modeled assuming that Tier 2 emission standards were in place, and estimates were prepared for 2007 and 2020. These scenarios were only modeled for the following areas: Atlanta, Cleveland, Eau Claire, Kansas City, Minneapolis, Pittsburgh, and Seattle. A summary of the fleet-average exposure results for benzene is given in Table 8-12. The results for the remaining pollutants can be found in Volume II of this report.

It should be noted that CO exposure estimates were not available for five of the seven cities included in Table 8-12. However, Sierra was instructed to make assumptions about CO exposure in these areas in order to prepare toxics exposure estimates. Thus, the following mapping was employed:

Table 8-11
Annual Average Exposure Results for Benzene in Chicago
by Demographic Group -- All On-Road Vehicles
(Units: ug/m3)

Demographic Group	Scenario	1990 CO Ratio	Calendar Year 1990	1996	2007	2020
Total Population	Base	8.36	0.784	0.482	0.264	0.220
	Sc#1	8.36	---	---	0.248	0.204
	Sc#2	8.36	---	---	0.241	0.167
	Sc#3	8.36	---	---	0.237	0.147
	Sc#6	8.36	---	---	0.233	0.133
Outdoor Workers	Base	10.05	0.944	0.580	0.318	0.265
	Sc#1	10.05	---	---	0.298	0.245
	Sc#2	10.05	---	---	0.289	0.201
	Sc#3	10.05	---	---	0.284	0.177
	Sc#6	10.05	---	---	0.280	0.160
Children 0 - 17 Years	Base	8.22	0.771	0.473	0.260	0.216
	Sc#1	8.22	---	---	0.243	0.200
	Sc#2	8.22	---	---	0.237	0.164
	Sc#3	8.22	---	---	0.232	0.144
	Sc#6	8.22	---	---	0.229	0.131

Table 8-12
Annual Average Benzene Exposure for Fuel Control Scenarios
All On-Road Vehicles – Total Population

Area	Scenario	Benzene Exposure (μg/m^3) 2007	2020
Atlanta	Sc#2 (30 ppm S) Sc#4 (Bnz Cap) Sc#5 (25% Red.)	0.413 0.432 0.369	0.309 0.323 0.279
Cleveland	Sc#2 (30 ppm S) Sc#4 (Bnz Cap) Sc#5 (25% Red.)	0.324 0.310 0.278	0.209 0.200 0.181
Eau Claire	Sc#2 (30 ppm S) Sc#4 (Bnz Cap) Sc#5 (25% Red.)	0.831 0.743 0.702	0.684 0.610 0.578
Kansas City	Sc#2 (30 ppm S) Sc#4 (Bnz Cap) Sc#5 (25% Red.)	0.286 0.268 0.257	0.238 0.222 0.213
Minneapolis	Sc#2 (30 ppm S) Sc#4 (Bnz Cap) Sc#5 (25% Red.	0.736 0.591 0.586	0.620 0.493 0.488
Pittsburgh	Sc#2 (30 ppm S) Sc#4 (Bnz Cap) Sc#5 (25% Red.)	0.268 0.275 0.245	0.184 0.188 0.169
Seattle	Sc#2 (30 ppm S) Sc#4 (Bnz Cap) Sc#5 (25% Red.)	0.733 0.562 0.471	0.540 0.415 0.352

- Atlanta – Atlanta
- Cleveland – Chicago
- Eau Claire – Minneapolis
- Kansas City – St. Louis
- Minneapolis – Minneapolis
- Pittsburgh – Philadelphia
- Seattle – Spokane

Because area-specific CO exposure estimates were not available for Cleveland, Eau Claire, Kansas City, Pittsburgh, and Seattle, the results in Table 8-12 are subject to some uncertainty. This should be kept in mind when evaluating the results of the exposure modeling.

Reviewing the results in Table 8-12, one finds that benzene exposure is generally estimated to be the highest in Eau Claire and Minneapolis. That is because 1990 CO exposure was relatively high in Minneapolis (which was also used for Eau Claire), these areas are predicted not to have I/M programs in the future, and both areas have relatively high aromatics content in their gasoline (which is a large contributor to exhaust benzene emissions). On the other hand, Pittsburgh and Cleveland were predicted to have the lowest benzene exposure for the fuel control scenarios because both areas were assumed to have an I/M program in place in the future and the 1990 CO exposure assumed for these areas was relatively low compared to Minneapolis and Eau Claire.

Exposure Estimates–Heavy-Duty Vehicle Controls - A final set of exposure estimates prepared for this study involved changes to heavy-duty vehicles. Three scenarios were modeled in this case:

- Scenario 7 - Scenario 2 with more stringent heavy-duty gasoline vehicle emission standards that were assumed to be phased in beginning with the 2004 model year.

- Scenario 8 - Scenario 2 with more stringent heavy-duty Diesel vehicle PM emission standards (equivalent to 0.01 g/bhp-hr). These standards were assumed to apply beginning with the 2007 model year.

- Scenario 9 - Scenario 2 with more stringent heavy-duty Diesel vehicle PM emission standards (equivalent to 0.05 g/bhp-hr). These standards were assumed to apply beginning with the 2007 model year.

The above scenarios were run for all urban areas (and geographic areas) modeled in this study for the 2007 and 2020 calendar years.

The exposure results for Scenario 7 are summarized in Table 8-13, which shows results for Atlanta and Chicago for benzene, acetaldehyde, formaldehyde, and 1,3-butadiene.

A summary of the Diesel PM exposure estimates for Scenarios 8 and 9 is contained in Table 8-14 for Atlanta and Chicago, along with estimates from Scenario 2. Based on the simple assumptions that were used in this analysis (e.g., no deterioration in PM emissions, even though trap technology would likely be required to meet these emission levels), significant reductions in exposure are achieved in the 2020 runs for both the 0.01 g/bhp-hr case and the 0.05 g/bhp-hr case. Under the baseline case assumed in Table 8-14 (i.e., Scenario 2), Diesel PM exposure is estimated to increase between 2007 and 2020. This is a result of VMT growth exceeding reductions in fleet-average emissions and is more pronounced in Atlanta than in Chicago.

Table 8-13
Annual Average Exposure Results for More Stringent Emission Standards for Heavy-Duty Gasoline Vehicles (Scenario 7)
All On-Road Vehicles – Total Population

Area	Year	Scenario	Exposure (μg/m^3)			
			Bnz	Acet	Form	1,3-But
Atlanta	2007	Sc#2 Sc#7	0.413 0.412	0.064 0.064	0.175 0.175	0.042 0.042
	2020	Sc#2 Sc#7	0.309 0.307	0.063 0.063	0.170 0.169	0.038 0.038
Chicago	2007	Sc#2 Sc#7	0.241 0.240	0.079 0.079	0.129 0.129	0.023 0.023
	2020	Sc#2 Sc#7	0.167 0.166	0.061 0.061	0.113 0.112	0.019 0.019

Table 8-14
Annual Average Diesel PM Exposure Results for More Stringent Heavy-Duty Diesel PM Emission Standards (Scenarios 8 and 9)
All On-Road Vehicles – Total Population

Area	Scenario	2007 (μg/m^3)	2020 (μg/m^3)
Atlanta	Sc#2 (Baseline) Sc#8 (0.01 g/bhp-hr) Sc#9 (0.05 g/bhp-hr)	0.363 0.340 0.349	0.399 0.077 0.224
Chicago	Sc#2 (Baseline) Sc#8 (0.01 g/bhp-hr) Sc#9 (0.05 g/bhp-hr)	0.239 0.224 0.230	0.243 0.047 0.136

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9. NATIONAL LEVEL TOXICS EMISSIONS INVENTORIES

Task 7 of this work assignment called for the preparation of nationwide toxics emissions inventories for benzene, 1,3-butadiene, formaldehyde, acetaldehyde, MTBE, and Diesel PM. The estimates were to be prepared for each of the control scenarios evaluated for the following areas:

- Each county in the U.S.;
- 47 states and the District of Columbia, with Alaska, California, and Hawaii excluded; and
- The entire 50 states.

For the nationwide emissions estimates prepared under Task 7 of this work assignment, two basic pieces of information are needed: toxic emission rates and VMT estimates. Because the toxic emission rates are calculated in terms of milligrams per mile (mg/mi), and VMT for each county has been compiled in terms of millions of miles per year, it is a simple matter to multiply the two numbers together to generate the needed inventory estimate. However, because it was not possible to estimate emission rates separately for each county, an approach was taken in which each county was "mapped" to one of the 26 modeled areas based on similarities in fuel parameters, I/M parameters, and ambient temperatures. A description of how the modeled areas were selected is summarized in Section 6 of this report, and the mapping strategy employed in this effort is briefly described below.

County-Level Toxics Emission Rates

The development of the toxics emission rates for each modeled area (10 urban areas and 16 geographic regions), calendar year, and scenario has been discussed at length in previous sections in this report. Those estimates, which are summarized in Volume II of this report, were used directly with the county-level VMT to arrive at nationwide emissions estimates (in tons per year) for this study. However, it was first necessary to assign each county an emission rate based on its similarity to one of the 26 modeled areas. Counties that fell within one of the 10 modeled urban areas were simply assigned the emission rate of that area. For most of the counties in the U.S., however, this was not the case. Those counties were assigned emission rates based on similarities in fuels, temperatures, and I/M programs. Much of the information needed to make these assignments came from documentation of the Trends database.[22] A complete listing of each county, along with the emissions mapping (and population and VMT estimates) is included in Appendix O.

VMT Estimates

The VMT estimates used in the nationwide toxics emissions calculations were supplied to Sierra by EPA. These estimates were provided for each county in the U.S., with separate estimates for each vehicle class. The county-level VMT was compiled as part of the development of the Trends database, and was generated by E.H. Pechan under contract to EPA. For this analysis, only the total VMT was used. Individual vehicle class estimates were based on applying the VMT mix (i.e., fraction of VMT by vehicle class) estimates used in the MOBTOX5b runs to the total VMT provided to Sierra.

Emissions Estimates

As outlined above, once the toxic emission rates for each county are determined, it is a simple matter to multiply the emission rates by annual VMT to arrive at annual average inventory estimates. As an example, consider benzene emissions from light-duty gasoline vehicles (LDGV) in Autauga County, Alabama in 2007 under Scenario 2. (This is the first county listed in the VMT file provided by EPA, with a state code of 01 and a county code of 001.) As noted in the county VMT table contained in Volume II, this county was mapped to the Southeast, which is denoted "SE." Based on output from the MOBTOX5b model, the following benzene emission rates are obtained:

Winter	28.28 mg/mi
Spring	21.08 mg/mi
Summer	21.78 mg/mi
Fall	26.41 mg/mi
Annual Average:	24.39 mg/mi

For this analysis, annual average emission rates were calculated as a simple mean of the seasonal estimates.

The 2007 annual VMT for all vehicles in Autauga County is estimated to be 568.1 million miles. Based on a LDGV fraction of 39.5%, this translates to 224.4 million miles attributable to LDGVs. Thus, the annual benzene inventory for LDGVs is:

$$BNZ_{LDGV} = [(24.39 \times 10^{-3} \text{ g/mi}) \times (224.4 \times 10^{6} \text{ mi/year})] \times [1 \text{ ton}/907{,}200 \text{ grams}]$$

$$BNZ_{LDGV} = 6.03 \text{ tons/year}$$

This same calculation was performed for each county and each toxic with a FORTRAN routine developed by Sierra, and the results were compiled for each county, state, the U.S., and the U.S. excluding Alaska, California, and Hawaii. The state-level results are contained in Volume II. The more detailed county-level results can be obtained from EPA in electronic form.

Table 9-1 contains the results of the inventory analysis for the following scenarios:*

- Scenario 0 - Baseline emission factors (including the NLEV program) and fuels;
- Scenario 1 - Baseline emission factors with a national 30 ppm gasoline sulfur limit;
- Scenario 2 - Scenario 1 with more stringent (i.e., Tier 2) emission standards for 2004 and later model year light-duty cars and trucks;
- Scenario 3 - Scenario 2 with increased Diesel light-duty truck and light-duty vehicle penetration;
- Scenario 6 - Scenario 2 with even more stringent light-duty vehicle emission standards equivalent to 0.055 g/mi NMHC;
- Scenario 7 - Scenario 2 with more stringent heavy-duty gasoline vehicle emission standards that were assumed to be phased in beginning with the 2004 model year;
- Scenario 8 - Scenario 2 with more stringent heavy-duty Diesel vehicle PM emission standards (equivalent to 0.01 g/bhp-hr); and
- Scenario 9 - Scenario 2 with more stringent heavy-duty Diesel vehicle PM emission standards (equivalent to 0.05 g/bhp-hr).

As observed in Table 9-1, significant emissions reductions are observed between 1990 and 2007; however, between 2007 and 2020, the reduction in emissions slows as a result of VMT growth. This is illustrated graphically in Figure 9-1, which shows nationwide annual benzene emissions for the light-duty gasoline vehicle control scenarios (i.e., Scenarios 0, 1, 2, and 6). As that figure illustrates, benzene emissions are predicted to drop by over 60% between 1990 and 2007, with much lower reductions observed between 2007 and 2020.

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* As noted previously, Scenarios 4 and 5 (i.e., the benzene cap and 25% toxics reduction performance standard regulations) were not evaluated on a nationwide basis. However, annual emissions inventories were prepared for the seven areas for which those scenarios were evaluated. Those results may be found in Volume II of this report.

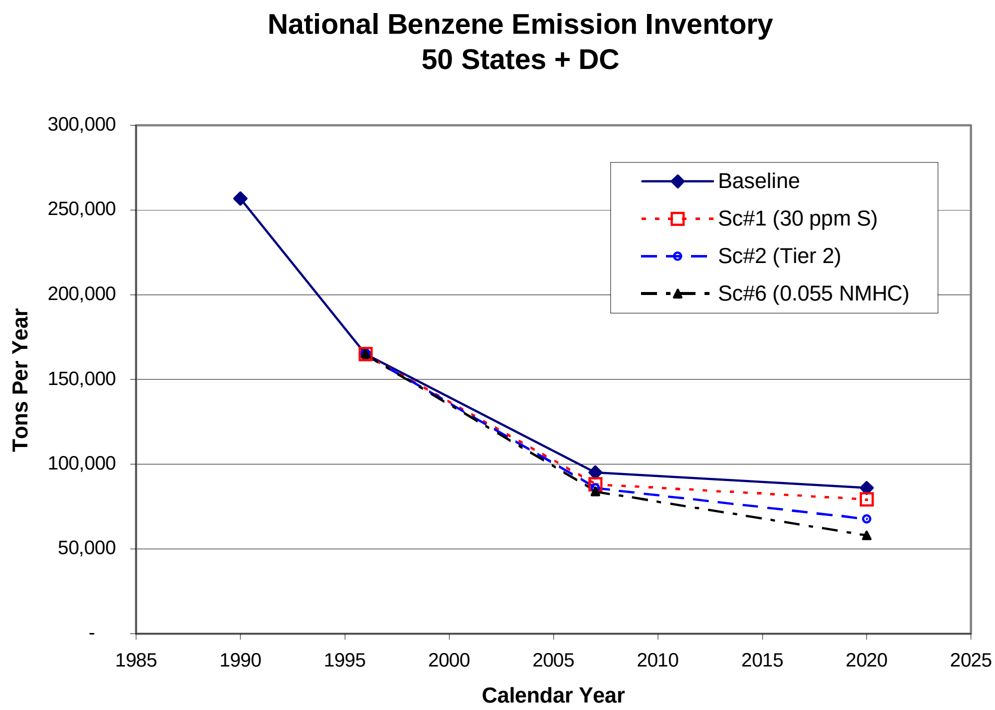
Insert Table 9-1

Figure 9-1

Table 9-1
Annual Toxics Emissions Summary for the Total U.S.

Calendar Year	Scenario	Annual Emissions (tons per year) Benzene	Acet.	Form.	Butadiene	MTBE	Diesel PM
1990	Base	256,761	40,912	138,607	36,396	54,584	202,265
1996	Base	165,023	27,411	80,262	22,206	64,611	111,530
2007	Base	95,101	15,366	37,455	12,762	23,506	65,462
	Sc#1 (30 ppm S)	88,158	14,887	36,461	11,471	25,408	65,462
	Sc#2 (Tier 2)	86,058	14,634	35,881	11,291	25,280	65,180
	Sc#3 (Inc. Diesel)	84,332	14,758	36,507	11,276	24,639	71,165
	Sc#6 (0.055 NMHC)	83,973	14,415	35,377	10,998	25,105	65,180
	Sc#7 (HDGV Stds)	85,850	14,612	35,815	11,282	25,064	65,180
	Sc#8 (0.01 HDDV PM)	86,058	14,634	35,881	11,291	25,280	61,047
	Sc#9 (0.05 HDDV PM)	86,058	14,634	35,881	11,291	25,280	62,660
2020	Base	85,930	15,182	37,181	12,718	18,032	69,693
	Sc#1 (30 ppm S)	79,160	14,701	36,139	11,406	19,611	69,693
	Sc#2 (Tier 2)	67,503	13,281	33,074	10,169	18,684	67,641
	Sc#3 (Inc. Diesel)	58,750	13,258	33,977	9,467	16,050	75,510
	Sc#6 (0.055 NMHC)	58,020	12,325	31,164	8,459	17,624	67,641
	Sc#7 (HDGV Stds)	67,017	13,250	32,978	10,156	17,872	67,641
	Sc#8 (0.01 HDDV PM)	67,503	13,281	33,074	10,169	18,684	12,983
	Sc#9 (0.05 HDDV PM)	67,503	13,281	33,074	10,169	18,684	37,945

Figure 9-1



National Benzene Emission Inventory
50 States + DC
300,000
250,000
200,000
150,000
100,000
50,000
-
Tons Per Year
1985
1990
1995
2000
2005
2010
2015
2020
2025
Calendar Year
Baseline
Sc#1 (30 ppm S)
Sc#2 (Tier 2)
Sc#6 (0.055 NMHC)

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10. NATIONAL-LEVEL TOXICS EXPOSURE ESTIMATES

As part of Task 10 of Work Assignment 1-06, Sierra was to estimate toxics exposure on a national basis by extrapolating the results from 26 modeled areas to the rest of the U.S. A complete description of the methodologies used to generate exposure estimates for the 10 urban areas evaluated in this study is contained in Section 8 of this report. This section presents the methodology developed by Sierra, in consultation with EPA, to estimate national toxics exposure by extrapolating emissions, and exposure results from the modeled areas to the rest of the United States.

1990 CO Exposure

In a previous study prepared by International Technology Corporation for EPA,[23] national toxics exposure was estimated by first mapping modeled HAPEM toxics exposure estimates (which were prepared for 13 cities) to non-modeled areas with geographically similar characteristics, based primarily on geographical proximity to the modeled city. The modeled toxics exposure was then adjusted for local conditions by applying a ratio of annual average ambient CO in the mapped area to annual average CO in the modeled area.

As an example of the above methodology, Phoenix (PHX) was a modeled area in the previous study, and HAPEM benzene exposure results from that city were used to estimate benzene exposure in Albuquerque, New Mexico (ALBQ). The modeled benzene exposure and annual average ambient CO levels used to perform this calculation are listed below.

$$BZ_{Exp\text{-}PHX} = 4.86\ \mu g/m^3$$
$$CO_{Amb\text{-}PHX} = 1.28\ ppm$$
$$CO_{Amb\text{-}ALBQ} = 1.15\ ppm$$

Using the above values, Albuquerque benzene exposure was estimated to be:

$$BZ_{Exp\text{-}ALBQ} = BZ_{Exp\text{-}PHX} \times (CO_{Amb\text{-}ALBQ} / CO_{Amb\text{-}PHX})$$
$$BZ_{Exp\text{-}ALBQ} = 4.86\ \mu g/m^3 \times (1.15\ ppm / 1.28\ ppm) = 4.37\ \mu g/m^3$$

During the course of the previous toxics evaluation (Work Assignment 0-07), the above approach was suggested as a means to estimate national CO exposure levels for each area of the U.S. from the most recent HAPEM results. However, EPA expressed concern that unless HAPEM estimates for a significant number of additional urban (and rural) areas were generated (on the order of 50 total areas), the national estimates would be subject to a large degree of uncertainty. This was not a viable option given budget and time constraints. As an alternative, a more simplistic approach was suggested that provides a general exposure estimate for urban areas and for rural areas. This also is subject to a large degree of uncertainty, so the results should be used cautiously.

The starting point for this calculation was the 1990 CO exposure estimates presented previously in Table 8-1. Those estimates were weighted by the population in each of the modeled areas to arrive at an average modeled area exposure for each quarter and for each demographic group. (The population estimates were provided by EPA and were based on 1990 census data.) Annual average ambient CO estimates for the modeled urban areas were also provided by EPA. These estimates were weighted by population, and the resulting annual average 1990 CO level was 1.32 ppm in the modeled urban areas. Quarterly ambient CO levels were also provided by EPA for each urban area in the United States. Sierra merged those data with the population of each area (again, based on 1990 census data), and a population-weighted annual average CO level in 1990 was estimated to be 1.22 ppm for all U.S. urban areas (including the areas modeled in this study). Thus, to estimate average urban area CO exposure in 1990, the population-weighted values from the modeled urban areas were scaled by the ratio 1.22 ppm / 1.32 ppm. (For the 47-state analysis, i.e., the U.S. excluding Alaska, California, and Hawaii, a factor of 1.16/1.32 was used.)

One shortcoming of the latest HAPEM exposure estimates used in this study is that no rural areas were analyzed. Thus, a slightly different method was used to estimate rural-area CO exposure. This was accomplished by reviewing the CO exposure estimates used in the 1993 MVRATS. That study listed the average urban area CO exposure as 842 $\mu g/m^3$ and the average rural area CO exposure as 470 $\mu g/m^3$. Thus, for this study, the U.S. average urban CO exposure estimates developed above were simply scaled by the ratio 470 $\mu g/m^3$ / 842 $\mu g/m^3$. Obviously, there is considerable uncertainty associated with these estimates, and they should be used only with that caveat in mind.

The resulting urban and rural CO exposure estimates developed using the methodologies described above are summarized in Table 10-1. As observed in that table, the same trends across quarters and demographic groups occur as seen in Table 8-1.

Urban and Rural Emission Rates

Average urban area and average rural area 1990 CO emission rates as well as toxics emission rates (all calendar years and scenarios) were generated next. These estimates were based on mapping each of the 26 modeled areas evaluated in this study to each county in the U.S., generally based on similarities in fuel parameters, ambient temperatures, and I/M programs. A more detailed description of the mapping strategy used in this evaluation was described in Section 9 of this report.

Table 10-1
1990 On-Road Motor Vehicle CO Exposure Estimates
for Average Urban and Average Rural Areas (μg/m³)

Urban/Rural	Demo Group	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual Average
Urban	Outdoor Workers	623	446	433	531	509
	Children 0–17	509	373	360	440	421
	Total Population	535	393	371	457	439
Rural	Outdoor Workers	348	249	242	297	284
	Children 0–17	284	208	201	246	235
	Total Population	299	219	207	255	245

Once each county was mapped to a modeled area, mean emission levels for average urban and average rural areas were compiled. This was accomplished by using the county-level VMT estimates to weight the 1990 CO and toxics emission rates. This calculation was performed for all counties in the U.S., for the four analysis years included in this study (1990, 1996, 2007, and 2020), and for all control scenarios.

The results of the above analysis are summarized in Volume II of this report, which presents fleet-average emission rates for benzene, acetaldehyde, formaldehyde, 1,3-butadiene, MTBE, and Diesel particulate. Annual average emission results are presented separately for urban areas, rural areas, and for the U.S. as a whole. In addition, results are presented for each control scenario considered in this study.

It should be noted that the urban, rural, and U.S. average emission rates calculated in this effort are subject to a moderate degree of uncertainty as a result of the mapping strategy employed in the calculations. In effect, the 26 modeled areas were used to represent all combinations of temperatures, fuels, and I/M programs throughout the U.S. This causes errors in the emissions estimated for a number of areas. However, the approach used in this study is considered more robust that the previous analysis (which used results from 9 areas) because emissions for an additional 17 areas were calculated and added to the mapping strategy.

Population Forecasts

The methodology to generate urban and rural population estimates relied on the 1990 and 1997 U.S. Census Bureau populations for each county in the U.S. as a starting point. Those counties were flagged as being either urban or rural based on the assignments used in EPA's draft urban air toxics strategy.[24] The 1996 population estimates were based on interpolating between the 1990 and 1997 values. Forecasts to 2007 and 2020 for each county were prepared by applying state-level population growth rates that were developed by the Census Bureau. The results of this analysis are given in Table 10-2, along with national population projections from the Census Bureau.[25] As observed in that table, there is reasonable agreement between the census projections and the modeled projections developed as described above.

Table 10-2
U.S. Population Assumptions Used to Estimate National Exposure (Millions)

Calendar Year	Modeled Population			Census Projections
	Urban	Rural	Total	
1990	206	42	248	249
1996	220	45	265	265
2007	241	49	290	291
2020	269	53	322	333

Toxic Exposure Estimates for Urban and Rural Areas

Using the same methodology described in Section 8 for the ten modeled urban areas, on-road motor vehicle air toxics exposures were estimated for "average" urban and rural areas as follows:

$$TOX_{Exposure\text{-}Unadj(\mu g/m3)} = [CO_{Exposure(\mu g/m3)}/CO_{EF(g/mi)}]_{1990} \times TOX_{EF(g/mi)}$$

$$TOX_{Exposure\text{-}Adj\ (\mu g/m3)} = TOX_{Exposure\text{-}Unadj\ (\mu g/m3)} \times Reactivity_{Adj} \times VMT_{Adj}$$

These calculations were performed within a FORTRAN model similar to that developed to generate exposure estimates for the ten modeled urban areas. The 1990 CO exposure estimates used in the calculations are those summarized above in Table 8-1, the reactivity adjustments (for 1,3-butadiene) are those used in the modeled urban areas, and the VMT adjustment was developed based on summing total urban and rural area VMT for the analysis years and generating a ratio using the 1990 results as the denominator.

The resulting annual-average exposure estimates for urban and rural areas are summarized in Table 10-3 to 10-8 (benzene, acetaldehyde, formaldehyde, 1,3-butadiene, MTBE, and Diesel PM, respectively) for the total population and for all on-road vehicles for Scenarios 0, 1, 2, 3, and 6 (i.e., the light-duty vehicle control measures). A complete listing of urban and rural exposure estimates (i.e., by vehicle class, season, and demographic group) is contained in Volume II of this report. In addition, U.S. average exposure estimates are presented in that volume. Those estimates were calculated as a population-weighted average of the urban and rural exposure results. A comparison of the results in Tables 10-3 to 10-8 to the exposure estimates for the modeled urban areas shows that the "average" U.S. urban exposure falls within the range of values calculated for the modeled urban areas. The rural exposure estimates shown in Table 10-3 to 10-8 are at the low end of the modeled urban area exposure estimates.

insert Table 10-3

Table 10-3 Annual Average Exposure Results for Benzene Total Population -- All On-Road Vehicles (Units: ug/m3)						
		1990	Calendar Year			
Area	Scenario	CO Ratio	1990	1996	2007	2020
Urban	Base	10.35	1.153	0.735	0.420	0.375
	Sc#1	10.35	---	---	0.390	0.346
	Sc#2	10.35	---	---	0.381	0.293
	Sc#3	10.35	---	---	0.373	0.256
	Sc#6	10.35	---	---	0.371	0.250
Rural	Base	5.42	0.648	0.433	0.261	0.243
	Sc#1	5.42	---	---	0.239	0.222
	Sc#2	5.42	---	---	0.233	0.193
	Sc#3	5.42	---	---	0.228	0.167
	Sc#6	5.42	---	---	0.228	0.170
50-State	Base	9.44	1.067	0.683	0.393	0.353
	Sc#1	9.44	---	---	0.364	0.326
	Sc#2	9.44	---	---	0.356	0.277
	Sc#3	9.44	---	---	0.348	0.241
	Sc#6	9.44	---	---	0.347	0.236

Table 10-4
Annual Average Exposure Results for Acetaldehyde
Total Population -- All On-Road Vehicles
(Units: ug/m3)

Area	Scenario	1990 CO Ratio	Calendar Year 1990	1996	2007	2020
Urban	Base	10.35	0.183	0.126	0.071	0.069
	Sc#1	10.35	---	---	0.068	0.067
	Sc#2	10.35	---	---	0.067	0.060
	Sc#3	10.35	---	---	0.068	0.061
	Sc#6	10.35	---	---	0.066	0.056
Rural	Base	5.42	0.105	0.067	0.037	0.037
	Sc#1	5.42	---	---	0.036	0.036
	Sc#2	5.42	---	---	0.035	0.032
	Sc#3	5.42	---	---	0.035	0.032
	Sc#6	5.42	---	---	0.035	0.030
50-State	Base	9.44	0.170	0.116	0.065	0.064
	Sc#1	9.44	---	---	0.063	0.062
	Sc#2	9.44	---	---	0.062	0.056
	Sc#3	9.44	---	---	0.062	0.056
	Sc#6	9.44	---	---	0.061	0.052

Table 10-5
Annual Average Exposure Results for Formaldehyde
Total Population -- All On-Road Vehicles
(Units: ug/m3)

Area	Scenario	1990 CO Ratio	Calendar Year 1990	1996	2007	2020
Urban	Base	10.35	0.618	0.368	0.172	0.170
	Sc#1	10.35	---	---	0.167	0.165
	Sc#2	10.35	---	---	0.164	0.151
	Sc#3	10.35	---	---	0.167	0.155
	Sc#6	10.35	---	---	0.162	0.142
Rural	Base	5.42	0.359	0.193	0.090	0.089
	Sc#1	5.42	---	---	0.087	0.087
	Sc#2	5.42	---	---	0.086	0.080
	Sc#3	5.42	---	---	0.087	0.081
	Sc#6	5.42	---	---	0.085	0.076
50-State	Base	9.44	0.574	0.338	0.158	0.157
	Sc#1	9.44	---	---	0.153	0.152
	Sc#2	9.44	---	---	0.151	0.139
	Sc#3	9.44	---	---	0.154	0.143
	Sc#6	9.44	---	---	0.149	0.131

Table 10-6
Annual Average Exposure Results for 1,3-Butadiene
Total Population -- All On-Road Vehicles
(Units: ug/m3)

Area	Scenario	1990 CO Ratio	Calendar Year 1990	1996	2007	2020
Urban	Base	10.35	0.119	0.073	0.041	0.040
	Sc#1	10.35	---	---	0.037	0.036
	Sc#2	10.35	---	---	0.036	0.032
	Sc#3	10.35	---	---	0.036	0.030
	Sc#6	10.35	---	---	0.035	0.026
Rural	Base	5.42	0.070	0.044	0.026	0.026
	Sc#1	5.42	---	---	0.023	0.024
	Sc#2	5.42	---	---	0.023	0.021
	Sc#3	5.42	---	---	0.023	0.019
	Sc#6	5.42	---	---	0.022	0.018
50-State	Base	9.44	0.111	0.068	0.038	0.038
	Sc#1	9.44	---	---	0.035	0.034
	Sc#2	9.44	---	---	0.034	0.030
	Sc#3	9.44	---	---	0.034	0.028
	Sc#6	9.44	---	---	0.033	0.025

Table 10-7
Annual Average Exposure Results for MTBE
Total Population -- All On-Road Vehicles
(Units: ug/m3)

Area	Scenario	1990 CO Ratio	Calendar Year 1990	1996	2007	2020
Urban	Base	10.35	0.234	0.349	0.128	0.098
	Sc#1	10.35	---	---	0.134	0.102
	Sc#2	10.35	---	---	0.134	0.097
	Sc#3	10.35	---	---	0.130	0.083
	Sc#6	10.35	---	---	0.133	0.091
Rural	Base	5.42	0.164	0.049	0.017	0.014
	Sc#1	5.42	---	---	0.024	0.021
	Sc#2	5.42	---	---	0.024	0.020
	Sc#3	5.42	---	---	0.023	0.018
	Sc#6	5.42	---	---	0.024	0.020
50-State	Base	9.44	0.222	0.298	0.109	0.084
	Sc#1	9.44	---	---	0.116	0.089
	Sc#2	9.44	---	---	0.115	0.084
	Sc#3	9.44	---	---	0.112	0.073
	Sc#6	9.44	---	---	0.114	0.079

Table 10-8
Annual Average Exposure Results for Diesel PM
Total Population -- All On-Road Vehicles
(Units: ug/m3)

Area	Scenario	1990 CO Ratio	Calendar Year 1990	1996	2007	2020
Urban	Base	10.35	0.918	0.518	0.303	0.322
	Sc#1	10.35	---	---	0.303	0.322
	Sc#2	10.35	---	---	0.301	0.313
	Sc#3	10.35	---	---	0.329	0.349
	Sc#6	10.35	---	---	0.301	0.313
Rural	Base	5.42	0.482	0.244	0.146	0.155
	Sc#1	5.42	---	---	0.146	0.155
	Sc#2	5.42	---	---	0.146	0.151
	Sc#3	5.42	---	---	0.159	0.168
	Sc#6	5.42	---	---	0.146	0.151
50-State	Base	9.44	0.844	0.472	0.276	0.295
	Sc#1	9.44	---	---	0.276	0.295
	Sc#2	9.44	---	---	0.275	0.286
	Sc#3	9.44	---	---	0.300	0.319
	Sc#6	9.44	---	---	0.275	0.286

11. RISK ASSESSMENT

Using the on-road motor vehicle toxic exposure estimates generated in Sections 8 and 10, estimates of individual cancer risk can be calculated from the following formula:

$$CAN_{Ind} = TOX_{Exposure\text{-}Adj\ (\mu g/m3)} \times (UR / YPL)$$

where $TOX_{Exposure\text{-}Adj\ (\mu g/m3)}$ is the adjusted toxic exposure estimates generated in Section 8 for individual urban areas and in Section 10 for the U.S. average urban and rural areas; UR is the unit risk in cancer cases or deaths per person exposed in a lifetime to 1 $\mu g/m^3$ of the toxic compound of interest; and YPL is years per lifetime (typically assumed to be 70 years).

To calculate the total cancer cases for the population, the individual cancer risk defined above is simply multiplied by the population subject to the toxic compound exposure, i.e.,

$$CAN_{Pop} = CAN_{Ind} \times Population$$

Because EPA has not yet finalized revised unit risk estimates, Sierra was directed only to set up a methodology to calculate individual risk and cancer incidences. This was accomplished within several FORTRAN routines that were developed to generate exposure estimates. The models were structured to allow a user to input two estimates of unit risk for each pollutant (a lower bound and an upper bound), as well as alternative years per lifetime estimates. Individual risk is reported in terms of cancer cases per million people, and total cancer cases are calculated based on the population in each area. Estimates are prepared for each of the ten modeled urban areas under the entire suite of forecast years and control scenarios for which exposure is estimated. In addition, estimates can be made for the U.S. and for the seven areas that were used to evaluate the fuel control proposals defined in Scenarios 4 and 5.

A copy of the individual cancer risk output from the model is given in Table 11-1 for benzene for the ten urban areas modeled in this effort (performed for the total population and all vehicle classes). Note that the range of unit risk values used in this analysis was provided by EPA and was selected simply for calculational purposes. It is not necessarily reflective of the values EPA may ultimately use in its analyses.

Table 11-1

Sample Output from the Exposure Model
Benzene Cancer Incidences per Million People

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Cancer Incidences Per Million People for Benzene

Demographic Group: All
Vehicle Class: All Veh
Low-Range Unit Risk (per million): 2.180
High-Range Unit Risk (per million): 7.690
Assumed Years Per Lifetime: 70.0

		CY1990		CY1996		CY2007		CY2020	
Area	Scen	Low	High	Low	High	Low	High	Low	High
ATLANTA	Base	0.02896	0.10215	0.02604	0.09185	0.01496	0.05278	0.01333	0.04702
ATLANTA	Sc#1	---	---	---	---	0.01320	0.04658	0.01163	0.04103
ATLANTA	Sc#2	---	---	---	---	0.01287	0.04539	0.00964	0.03399
ATLANTA	Sc#3	---	---	---	---	0.01263	0.04456	0.00848	0.02993
CHICAGO	Base	0.02443	0.08616	0.01499	0.05289	0.00823	0.02904	0.00686	0.02420
CHICAGO	Sc#1	---	---	---	---	0.00771	0.02721	0.00634	0.02236
CHICAGO	Sc#2	---	---	---	---	0.00750	0.02645	0.00519	0.01832
CHICAGO	Sc#3	---	---	---	---	0.00737	0.02598	0.00458	0.01614
DENVER	Base	0.02356	0.08310	0.02216	0.07816	0.01354	0.04777	0.01177	0.04153
DENVER	Sc#1	---	---	---	---	0.01210	0.04269	0.01038	0.03660
DENVER	Sc#2	---	---	---	---	0.01181	0.04166	0.00869	0.03066
DENVER	Sc#3	---	---	---	---	0.01160	0.04091	0.00770	0.02715
HOUSTON	Base	0.02174	0.07668	0.01670	0.05892	0.00873	0.03080	0.00751	0.02650
HOUSTON	Sc#1	---	---	---	---	0.00837	0.02951	0.00710	0.02505
HOUSTON	Sc#2	---	---	---	---	0.00816	0.02877	0.00591	0.02085
HOUSTON	Sc#3	---	---	---	---	0.00802	0.02830	0.00524	0.01849
MINNEAPOLIS	Base	0.05151	0.18172	0.03452	0.12176	0.02467	0.08702	0.02337	0.08245
MINNEAPOLIS	Sc#1	---	---	---	---	0.02377	0.08385	0.02246	0.07924
MINNEAPOLIS	Sc#2	---	---	---	---	0.02324	0.08198	0.01968	0.06943
MINNEAPOLIS	Sc#3	---	---	---	---	0.02269	0.08005	0.01681	0.05929
NEW YORK	Base	0.05247	0.18507	0.02450	0.08644	0.01306	0.04608	0.01076	0.03795
NEW YORK	Sc#1	---	---	---	---	0.01249	0.04406	0.01016	0.03585
NEW YORK	Sc#2	---	---	---	---	0.01213	0.04278	0.00827	0.02918
NEW YORK	Sc#3	---	---	---	---	0.01193	0.04208	0.00732	0.02582
PHILADELPHIA	Base	0.02606	0.09193	0.01599	0.05640	0.00703	0.02480	0.00599	0.02113
PHILADELPHIA	Sc#1	---	---	---	---	0.00664	0.02344	0.00560	0.01975
PHILADELPHIA	Sc#2	---	---	---	---	0.00645	0.02276	0.00457	0.01611
PHILADELPHIA	Sc#3	---	---	---	---	0.00634	0.02237	0.00403	0.01421
PHOENIX	Base	0.05102	0.17996	0.03913	0.13804	0.01221	0.04306	0.01119	0.03946
PHOENIX	Sc#1	---	---	---	---	0.01282	0.04522	0.01172	0.04136
PHOENIX	Sc#2	---	---	---	---	0.01250	0.04411	0.00977	0.03447
PHOENIX	Sc#3	---	---	---	---	0.01232	0.04346	0.00871	0.03073
SPOKANE	Base	0.03664	0.12923	0.02841	0.10022	0.01638	0.05777	0.01383	0.04877
SPOKANE	Sc#1	---	---	---	---	0.01439	0.05075	0.01200	0.04232
SPOKANE	Sc#2	---	---	---	---	0.01402	0.04946	0.00997	0.03516
SPOKANE	Sc#3	---	---	---	---	0.01376	0.04855	0.00877	0.03095
ST LOUIS	Base	0.01698	0.05988	0.01453	0.05124	0.00776	0.02736	0.00637	0.02246
ST LOUIS	Sc#1	---	---	---	---	0.00715	0.02522	0.00578	0.02041

ST LOUIS	Sc#2	---	---	---	---	0.00695	0.02451	0.00473	0.01670
ST LOUIS	Sc#3	---	---	---	---	0.00682	0.02407	0.00417	0.01472

12. MODELED EXPOSURE vs. MONITORING DATA

As part of Task 11 of this work assignment, Radian/ERG was to compare the base case (calendar year 1996) exposure estimates for acetaldehyde, benzene, 1,3-butadiene, formaldehyde, MTBE, and Diesel particulate matter (PM) with annual average ambient measurement data obtained for the cities evaluated in this study. As explained below, a very limited amount of toxic measurement data were located for use in the comparison; in fact, no data for MTBE or Diesel PM were located for any cities used in the exposure study, consequently, no comparison could be conducted for these compounds.

Ambient Measurement Data

Ambient data used in this analysis were researched and provided by EPA. AIRS data were compiled for the modeled areas, as well as nationwide statistics. The AIRS data provided statistics by compound, city, and calendar year (1988 through 1997). These statistics included average concentration, standard deviation, and number of samples. Unfortunately, the AIRS ambient data provided a limited amount of useful data for the comparison study for a number of reasons:

- No ambient data were available for any compound for Phoenix or Spokane (Seattle was selected as a surrogate, but no data for the modeled compounds were found for this site either);

- No ambient data were available for any modeled area for MTBE or Diesel particulate; and

- No ambient data were available for some modeled areas for the year of interest (i.e., base case year 1996). As a result, years 1994-1997 were included.

In addition to these limitations, we assumed the average concentrations provided represented the annual average for the given year, since average number of samples for any given compound was approximately 60.

Results

Table 12-1 shows the comparison of the modeled base case exposure estimates versus the ambient data. (Note that the 1996 ambient measurements are in bold type to allow easier comparison to the exposure estimates, which were prepared for calendar year 1996.) Only compounds for which both modeled exposure estimates and ambient data exist are presented. At first glance, the base-case modeled exposure estimates appear considerably underestimated when compared to ambient measurements. However, the modeled estimates are for motor vehicle-related exposure only, whereas the ambient measurements represent all emission sources of the compound (i.e., industrial point and area sources, off-road mobile, as well as on-road mobile sources).

The "On-Road CO Fraction" column in Table 12-1 provides the city-specific CO exposure fraction for motor vehicles. The CO exposure numbers are calculated on the basis of how much time groups of individuals spend in different microenvironments, and the motor vehicle-related CO concentration in those microenvironments.[*] Thus, assuming that the motor vehicle-related CO level is lower indoors than out, exposure should be less than an outdoor average concentration from monitoring data. In the ten cities for which HAPEM exposure estimates were calculated, the 1990 population-weighted modeled CO exposure for motor vehicles only was 475 $\mu g/m^3$. The annual average CO concentration (from monitoring data) in those areas is about 1500 $\mu g/m^3$. Thus, the modeled exposure is about one-third the average ambient concentration. Assuming that two-thirds to three-fourths of ambient CO is from motor vehicles, then the modeled exposure is approximately half the ambient concentration (both on a motor vehicle basis).

Applying this rationale and looking at benzene in Chicago, one observes that Chicago has a modeled estimated exposure from motor vehicles of 0.48 $\mu g/m^3$ in 1996. The ambient data show an annual average concentration of 1.4 $\mu g/m^3$. Thus, the modeled exposure estimate is about one-third of the ambient benzene. This result appears very reasonable, particularly given all of the uncertainties in the analysis.

Some of the other areas look worse for some pollutants, but much of that can be explained. For example, most of the ambient benzene in Houston is not likely due to motor vehicles, although the on-road mobile CO fraction is 59%. In most urban areas, approximately 30% to 50% of ambient hydrocarbons are from motor vehicles, with Houston likely even less due to significant industrial sources in the region. If that were the case, then vehicle-related ambient benzene would be 0.58 and the exposure estimate 0.54, so the exposure estimate may be a little high.

Therefore, despite limited data, the above motor vehicle-related modeled exposure estimates appear to correspond reasonably well with ambient data. With the possible exception of 1,3-butadiene for Houston (where stationary source emissions for this compound may be high), the comparison shows that the modeled exposure and measured concentration are not orders of magnitude different.

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[*] Note that exposure estimates represent only exposure to “ambient” sources, not sources originating within microenvironments.

Table 12-1
Comparison of Ambient Concentration Measurements to Modeled 1996 Exposure Estimates ($\mu g/m^3$)

Pollutant	Urban Area	On-Road CO Fraction	1996 Exposure Estimate	Ambient Measurements			
				1994	1995	**1996**	1997
Benzene	Chicago	64%	0.482	4.3	2.1	**1.4**	1.3
	Houston	59%	0.536	4.5	3.9	**2.9**	2.5
	Minneapolis	72%	1.108	2.5	1.9	**1.9**	
	New York	74%	0.787		1.7	**1.9**	1.4
Acetaldehyde	Minneapolis	72%	0.269		1.3	**1.4**	
	New York	74%	0.146			**2.5**	2.3
	Philadelphia	70%	0.087	4.6			2.3
Formaldehyde	Minneapolis	72%	0.459	0.91	1.6	**2**	
	New York	74%	0.508			**3.1**	4.3
	Philadelphia	70%	0.305	5.1			5.2
1,3-Butadiene	Houston	59%	0.057	1.3	1.3	**1**	

###

13. SENSITIVITY ANALYSIS

As part of Task 8 of this work assignment, Sierra and Radian/ERG were to perform a sensitivity analysis of the emissions results prepared under Tasks 1 and 2. Based on input from the Work Assignment Manager, the following sensitivity cases were investigated in this effort:

- Deterioration rates for 1983 and later model year LDGVs and 1984 and later model year LDGTs were doubled;
- Emissions results for minimum and maximum values of specific fuel properties were evaluated to give a range of potential results in particular urban areas;
- Toxics fractions from the 1993 Motor Vehicle-Related Air Toxics Study[26] (MVRATS) for 1981 and later model year light-duty cars and trucks were used in place of those fractions developed from the Complex Model; and
- MOBILE5-based registration distributions and mileage accumulation rates were used in place of the draft MOBILE6 values used in the baseline analysis.

The discussion below summarizes the results of the sensitivity analysis.

Double Deterioration Rates

One of the concerns that has been expressed by reviewers of the draft MOBILE6 proposal for revisions to base emission rate equations is that the dramatically lower deterioration rates may understate emissions from late-model cars and light-duty trucks. Because the hydrocarbon (or, more correctly, TOG) base emission rate equations form the basis of the toxics emissions estimates prepared in this study, the same concern about potential underestimation of emissions also holds in the estimation of motor vehicle air toxics. As a result, one of the sensitivity cases assessed in this effort was to evaluate the impact of doubling the TOG deterioration rates for light-duty gasoline vehicles (LDGVs) and light-duty gasoline trucks (LDGT1 and LDGT2 categories). This assessment was performed for two areas included in the Task 1 and Task 2 evaluation: Ohio Valley I/M (e.g., Cleveland) and Philadelphia. TOG deterioration rates were revised for 1983 and newer model year LDGVs and for 1984 and newer model year LDGTs. The model was run for 1990, 1996, 2007, and 2020. The 1990 and 1996 runs conformed in every other respect with the baseline case, and the 2007 and 2020 runs conformed to the Scenario #2 case (i.e., 30 ppm national sulfur cap on gasoline plus Tier 2 emission standards).

The annual average emissions results from this evaluation are summarized in Table 13-1. As expected, doubling the TOG deterioration rates for cars and light-duty trucks results in an overall increase in fleet-average emissions for all toxics. The increase relative to the baseline deterioration rates is least pronounced (on a percentage basis) for the 1990 calendar year runs and most pronounced for the 2020 runs. This was expected because the 1990 and 1996 runs contain a large fraction of older vehicles that were not impacted by the deterioration rate change. By 2007, nearly all of the light-duty cars and trucks making up the modeled fleet are subject to the deterioration rate revision.

Table 13-1
Results of Sensitivity Case #1:
Double Deterioration Rates from 1983+ MY LDGVs and 1984+ MY LDGTs
(Annual Average Emissions for the Entire Fleet)

Area	Year	Scenario	Benzene (mg/mi)	Acet. (mg/mi)	Form. (mg/mi)	Butadiene (mg/mi)	MTBE (mg/mi)
Ohio Valley I/M e.g., Cleveland	1990	Base DRs	112.9	19.9	70.0	16.7	35.8
		2X DRs	122.6	20.8	72.0	18.2	36.3
	1996	Base DRs	64.2	10.2	30.3	8.1	8.0
		2X DRs	82.8	12.0	33.9	11.3	8.5
	2007	Base DRs	24.7	4.0	10.0	3.0	2.4
		2X DRs	38.2	5.4	12.7	5.5	2.6
	2020	Base DRs	13.4	2.8	7.0	2.0	1.1
		2X DRs	21.9	3.6	8.7	3.6	1.1
Philadelphia	1990	Base DRs	105.7	18.4	59.8	16.9	0
		2X DRs	116.0	19.3	61.7	18.9	0
	1996	Base DRs	54.7	9.2	32.6	7.3	67.8
		2X DRs	70.8	10.7	36.7	10.5	74.5
	2007	Base DRs	18.2	3.4	10.6	2.7	28.5
		2X DRs	28.5	4.3	13.4	4.7	35.7
	2020	Base DRs	10.5	2.5	7.4	1.8	16.7
		2X DRs	17.1	3.0	9.1	3.2	20.7

The trend line for benzene emissions is illustrated in Figure 13-1 for the base deterioration rate case (Base DRs) and the double deterioration rate case (2X DRs). As observed in that figure, substantial decreases in fleet-average benzene emissions are predicted between 1990 and 2020, even if the exhaust emissions deterioration rates are doubled. Similar results are seen for the other toxic pollutants, but the difference between the 2X DRs case and the Base DRs is less pronounced for MTBE emission rates. That is because evaporative emissions make up a larger fraction of MTBE emissions than exhaust emissions, and only exhaust emissions were impacted in this sensitivity case.

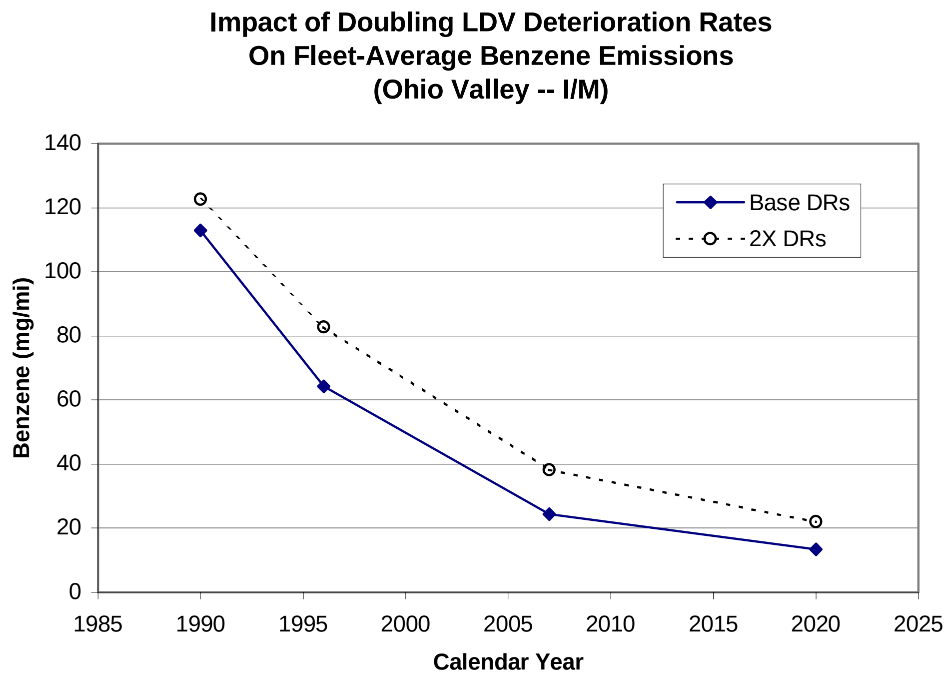
Figure 13-1

Minimum/Maximum Fuel Properties

The second sensitivity case investigated in this study was to evaluate toxics emission rates at the extremes of fuel parameter values for a limited number of urban areas. To perform this analysis, fuel data from the Summer 1996 AAMA fuel survey[27] were reviewed to identify areas that had a wide range of values for sulfur, aromatics, olefins, and benzene. Rather than simply assuming a range of fuel properties for this sensitivity case, this approach was selected to ensure that the fuel specifications analyzed represented "real" fuels. The review of the AAMA data resulted in the following areas being selected for analysis:

- Cleveland (sulfur ranged from 80 ppm to 820 ppm);
- Minneapolis (aromatics ranged from 5.2 vol% to 35.1 vol%);
- Philadelphia (olefins ranged from 7.0 vol% to 22.8 vol%); and
- Seattle (benzene ranged from 1.4 vol% to 4.2 vol%).

Figure 13-1



Impact of Doubling LDV Deterioration Rates
On Fleet-Average Benzene Emissions
(Ohio Valley -- I/M)
Benzene (mg/mi)
0
20
40
60
80
100
120
140
1985
1990
1995
2000
2005
2010
2015
2020
2025
Calendar Year
Base DRs
2X DRs

A summary of all fuel properties used in this analysis is given in Table 13-2, and the modeled results for calendar year 1996 (reported for light-duty gasoline vehicles only) are summarized in Table 13-3. For the Cleveland analysis, the impact of fuel sulfur was

Table 13-2

Specifications Used in the Minimum/Maximum Fuel Parameter Sensitivity Case (1996 Summer Fuel Properties)

Area	Scenario	Rvp (psi)	Aromatics (vol%)	Olefins (vol%)	Benzene (vol%)	Sulfur (ppm)	E200 (vol%)	E300 (vol%)	MTBE (vol%)	EtOH (vol%)	Oxygen (wt%)
Cleveland	Min S	8.5	27.8	11.5	1.5	80	39.1	78.3	0.0	0.0	0.0
Cleveland	Max S	8.6	31.4	10.4	1.7	820	44.0	82.2	0.0	0.0	0.0
Minneapolis	Min Aromatics	9.7	5.2	10.9	0.3	40	60.2	92.3	0.0	9.4	3.2
Minneapolis	Max Aromatics	9.2	35.1	5.1	1.5	40	38.6	86.0	0.0	9.8	3.4
Philadelphia	Min Olefins	8.0	24.3	7.0	0.6	150	55.8	82.7	11.6	0.0	2.1
Philadelphia	Max Olefins	7.6	25.8	22.8	0.5	210	50.4	81.3	12.0	0.0	2.1
Seattle	Min Benzene	9.3	36.9	3.1	1.4	240	37.2	81.3	0.0	9.4	3.2
Seattle	Max Benzene	8.2	55.6	6.9	4.2	10	33.3	87.5	0.0	0.0	0.0

Table 13-3
Results of Sensitivity Case #2:
Comparison of CY1996 Results Using
Minimum/Maximum Fuel Parameters in Four Urban Areas
(LDGV Summer Emissions)

Area	Parameter	Min/ Max	Parameter Value	Benzene (mg/mi)	Acet. (mg/mi)	Form. (mg/mi)	Butadiene (mg/mi)
Cleveland	Sulfur	Min Max	80 ppm 820 ppm	48.4 60.6	4.0 4.2	11.2 11.7	5.1 5.0
Minneapolis	Aromatics	Min Max	5.2 vol% 35.1vol%	17.2 52.6	8.9 8.7	11.7 11.1	3.6 3.4
Philadelphia	Olefins	Min Max	7.0 vol% 22.8 vol%	28.9 29.2	3.7 3.7	13.5 13.2	3.6 5.6
Seattle	Benzene	Min Max	1.4 vol% 4.2 vol%	55.0 147.3	8.9 3.2	11.5 9.0	3.5 3.8

most pronounced for benzene emissions. However, because this is a calendar year 1996 model run, the overall effect of sulfur is lower than for future years in which LEV vehicles are part of the fleet. (Recall that the sulfur impact is greatest for LEV-category vehicles.) The impact of aromatics content in the Minneapolis runs is very pronounced for benzene emissions. As observed in Table 13-3, benzene emissions increased by a factor of 3 when aromatics content was increased from 5.2% to 35.1%. However, this increased aromatic content was also accompanied by an increase in benzene content (from 0.3% to 1.5%). Thus, the large increase in benzene emissions is partially attributable to increased benzene in the gasoline. However, one would generally expect an increase in benzene content as the aromatic content of gasoline is increased. The Philadelphia runs demonstrate the emissions impact of the possible range of olefin content observed in gasoline in 1996. As seen in Table 13-3, 1,3-butadiene emissions are most significantly impacted by olefin content, with an increase of 56% percent as olefin content is increased from 7.0% to 22.8%. Finally, the Seattle runs illustrate the emissions impact of increased benzene content on toxics emissions. In that case, benzene content ranged from 1.4% to 4.2%, which resulted in nearly a three-fold increase in benzene emissions (evaporative and exhaust). It is interesting to note, however, that the fuel with the lower benzene content was oxygenated (9.4% ethanol), which resulted in increased levels of formaldehyde and acetaldehyde relative to the high-benzene fuel.

To serve as a comparison point with the results obtained from the toxics model developed in this study (MOBTOX5b), the fuel properties contained in Table 13-2 were run through the Complex model, and the results are reported in Table 13-4. Comparing Tables 13-3 and 13-4, it is interesting to note that the general trends are similar between the MOBTOX5b model and the Complex model. This was not unexpected, since the Complex model relationships were used for Tier 0 and newer vehicles in the MOBTOX5b model. What is surprising, however, is the similarity of numerical values between the two models. Given that the Complex model reflects an aged fleet of 1990 model year

Table 13-4
Evaluation of Sensitivity Case #2 Using the Complex Model

Area	Parameter	Min/ Max	Parameter Value	Benzene (mg/mi)	Acet. (mg/mi)	Form. (mg/mi)	Butadiene (mg/mi)
Cleveland	Sulfur	Min Max	80 ppm 820 ppm	47.7 74.2	4.5 5.1	10.1 9.6	10.9 10.0
Minneapolis	Aromatics	Min Max	5.2 vol% 35.1vol%	22.0 48.3	9.5 9.1	10.0 9.9	7.5 6.9
Philadelphia	Olefins	Min Max	7.0 vol% 22.8 vol%	31.9 32.4	4.1 4.1	11.8 9.2	7.4 13.9
Seattle	Benzene	Min Max	1.4 vol% 4.2 vol%	52.1 148.0	9.7 3.4	10.6 8.1	6.9 7.7

vehicles evaluated with MOBILE5 and the MOBTOX5b model reflects a 1996 calendar year fleet (reflecting 1972 to 1996 model year vehicles) with significant changes to model inputs to reflect revisions expected with MOBILE6, this result was purely chance. The largest difference in emissions estimates is for 1,3-butadiene, with the MOBTOX5b model predicting lower values. That is a result of revised base emission rate equations that assume a lower fraction of high-emitting vehicles in the fleet relative to MOBILE5 (there is a higher fraction of 1,3-butadiene in exhaust from higher-emitting vehicles than from lower-emitting vehicles).

Toxics Fractions Based on MVRATS

A third sensitivity case that was investigated in this study was to use toxics fractions developed in EPA’s 1993 MVRATS in place of those derived from the Complex model relationships for 1981 and later model year cars and light trucks. This was performed for two areas: Ohio Valley I/M, which is reflective of Cleveland and Philadelphia. The MOBTOX model was run for 1990, 1996, 2007, and 2020, and the results are presented in Table 13-5. The 2007 and 2020 runs assumed Scenario #2 controls were in effect, i.e., a 30 ppm national sulfur rule and Tier 2 exhaust emission standards. As observed in Table 13-5, the differences between the two approaches is relatively small, particularly given all of the uncertainties associated with this analysis. In general, the MVRATS fractions result in slightly lower 1,3-butadiene emissions and slightly higher emissions of formaldehyde and acetaldehyde. Benzene emissions using the MVRATS fractions are slightly lower in 1990 for both Cleveland and Philadelphia, while the opposite is true for the 1996 and later calendar years. (Because MTBE was not evaluated in MVRATS, it is not shown in Table 13-5.)

Table 13-5
Results of Sensitivity Case #3:
Use Toxics Fractions from MVRATS for MY 1981+ LDGVs and LDGTs
(Annual Average Emissions for the Entire Fleet)

Area	Year	Scenario	Benzene (mg/mi)	Acet. (mg/mi)	Form. (mg/mi)	Butadiene (mg/mi)
Ohio Valley I/M e.g., Cleveland	1990	Base (Sc#0) MVRATS	112.9 112.5	19.8 20.4	70.0 71.5	16.7 16.6
	1996	Base (Sc#0) MVRATS	64.2 67.0	10.2 10.9	30.3 31.2	8.1 8.1
	2007	Base (Sc#2) MVRATS	24.4 25.6	4.0 4.2	10.0 10.2	3.0 2.6
	2020	Base (Sc#2) MVRATS	13.4 13.5	2.8 2.8	7.0 7.0	2.0 1.6
Philadelphia	1990	Base (Sc#0) MVRATS	105.7 105.0	18.4 18.8	59.8 60.8	16.9 16.2
	1996	Base (Sc#0) MVRATS	54.7 58.6	9.2 10.1	32.6 35.3	7.3 7.3
	2007	Base (Sc#2) MVRATS	18.2 19.3	3.4 3.8	10.6 11.4	2.7 2.4
	2020	Base (Sc#2) MVRATS	10.5 10.7	2.5 2.6	7.4 7.7	1.8 1.5

MOBILE5-Based Registration Distributions and Mileage Accumulation Rates

Included in the MOBTOX model are the draft MOBILE6 revisions to registration distributions and mileage accumulation rates to better reflect current data on the motor vehicle fleet. In general, vehicles are more durable and are staying on the road longer than the 1990 fleet that is reflected in the MOBILE5 registration distributions. In addition, vehicles are accruing miles faster than the mileage accumulation rates reflected in MOBILE5. Both of these occurrences result in increased fleet-average emissions relative to MOBILE5. As a result, the final sensitivity analysis performed for this study investigated the impacts of retaining MOBILE5 registration fractions and mileage accumulation rates. Table 13-6 summarizes the results of that analysis, which was performed for 2007 and 2020. (Consistent with the sensitivity cases presented above, the “base” case in Table 13-6 is Tier 2 standards with 30 ppm sulfur fuel, i.e., Scenario 2.) As observed in the table, the impacts of the registration distribution and mileage accumulation rate changes are relatively moderate and do not have a large impact on fleet-average emissions. Accounting for both the registration distribution and mileage accumulation rate changes, emissions are impacted by less than 10%.

Table 13-6
Results of Sensitivity Case #4:
MOBILE5 Default Registration Distributions and Mileage Accumulation Rates
(Annual Average Emissions for the Entire Fleet)

Area	Year	Scenario	Benzene (mg/mi)	Acet. (mg/mi)	Form. (mg/mi)	Butadiene (mg/mi)	MTBE (mg/mi)
Ohio Valley I/M e.g., Cleveland	2007	Base (Sc#2)	24.4	4.0	10.0	3.0	2.4
		M5 Reg	23.8	3.9	9.8	2.9	2.3
		M5 Reg+MAR	22.8	3.9	9.9	2.7	2.5
	2020	Base (Sc#2)	13.4	2.8	7.0	2.0	1.1
		M5 Reg	13.6	2.8	7.0	1.9	1.1
		M5 Reg+MAR	12.3	2.7	6.9	1.8	1.1
Philadelphia	2007	Base (Sc#2)	18.2	3.4	10.6	2.7	28.5
		M5 Reg	17.9	3.3	10.4	2.6	28.5
		M5 Reg+MAR	17.3	3.4	10.5	2.4	28.7
	2020	Base (Sc#2)	10.5	2.5	7.4	1.8	16.7
		M5 Reg	10.3	2.5	7.4	1.8	16.6
		M5 Reg+MAR	9.7	2.4	7.2	1.6	16.6

Sensitivity Analysis Summary

Overall, the largest impact in toxics emission rates was observed when the minimum and maximum fuel parameter values were evaluated in an area. This was particularly evident for benzene emissions when a wide aromatics range was investigated as well as when a wide benzene range was evaluated. However, these estimates reflect only the range of potential emission rates in an area, and the average emission level is unlikely to occur at the extremes of the range. The sensitivity case that resulted in the most significant difference across all pollutants was the doubling of deterioration rates. This had the largest percentage impact for the 2020 runs. However, even with the deterioration rates doubled, substantial decreases in fleet-average toxics emissions are predicted to occur between 1990 and 2020. Finally, the use of toxics fractions from EPA’s 1993 MVRATS had a very small impact on fleet-average emissions, as did the use of MOBILE5 registration distributions and mileage accumulation rates.

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Appendix A

Revised TOG Inputs for MOBTOX5b Emissions Modeling

The following inputs and data are included in this appendix:

1. TOG/NMHC Ratios

2. Alternative TOG base emission rate equations.

   File Name Structure: aaa_bb_c.ber, where

   aaa = area
   bb = I/M or No IM
   c = control program

   Scenarios Modeled:

Areas	I/M	Control Program
OTR=Ozone Transport Region	NO=none	B=baseline (NLEV)
NTR=Non-OTR	IM=yes	C=LDV Tier 2 control
HAL=High Altitude		D=Inc. Diesel penetration
CA= California		5=0.055 NMHC LDV std
		H=HDGV control

3. Off-cycle TOG correction factors

   Sample files given for Non-OTR, I/M regions for baseline case in 1990, 1996, 2007 and 2020. The complete series of files used in the analysis can be obtained electronically from EPA.

TOG/NMHC Correction Factors by Model Year and Vehicle Class

MY	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC
1965	1.099	1.099	1.099	1.252	1.1094	1.1094	1.1294	1.099
1966	1.099	1.099	1.099	1.252	1.1094	1.1094	1.1294	1.099
1967	1.099	1.099	1.099	1.252	1.1094	1.1094	1.1294	1.099
1968	1.099	1.099	1.099	1.252	1.1094	1.1094	1.1294	1.099
1969	1.099	1.099	1.099	1.252	1.1094	1.1094	1.1294	1.099
1970	1.099	1.099	1.099	1.252	1.1094	1.1094	1.1294	1.099
1971	1.099	1.099	1.099	1.252	1.1094	1.1094	1.1294	1.099
1972	1.099	1.099	1.099	1.252	1.1094	1.1094	1.1294	1.099
1973	1.099	1.099	1.099	1.252	1.1094	1.1094	1.1294	1.099
1974	1.099	1.099	1.099	1.252	1.1094	1.1094	1.1294	1.099
1975	1.158	1.150	1.099	1.252	1.1094	1.1094	1.1294	1.099
1976	1.161	1.158	1.099	1.252	1.1094	1.1094	1.1294	1.099
1977	1.161	1.154	1.099	1.252	1.1094	1.1094	1.1294	1.099
1978	1.165	1.154	1.099	1.252	1.1094	1.1094	1.1294	1.099
1979	1.165	1.158	1.173	1.252	1.1094	1.1094	1.1294	1.099
1980	1.184	1.158	1.173	1.252	1.1094	1.1094	1.1294	1.099
1981	1.290	1.174	1.173	1.252	1.1094	1.1094	1.1294	1.099
1982	1.291	1.174	1.173	1.271	1.1094	1.1094	1.1294	1.099
1983	1.311	1.190	1.194	1.271	1.1094	1.1094	1.1294	1.099
1984	1.307	1.221	1.236	1.271	1.1094	1.1094	1.1294	1.099
1985	1.280	1.213	1.257	1.271	1.1094	1.1094	1.1294	1.099
1986	1.264	1.197	1.278	1.271	1.1094	1.1094	1.1294	1.099
1987	1.246	1.222	1.287	1.367	1.1094	1.1094	1.1294	1.099
1988	1.209	1.221	1.276	1.406	1.1094	1.1094	1.1294	1.099
1989	1.199	1.234	1.276	1.406	1.1094	1.1094	1.1294	1.099
1990	1.197	1.212	1.276	1.610	1.1094	1.1094	1.1294	1.099
1991	1.184	1.149	1.149	1.610	1.1094	1.1094	1.1294	1.099
1992	1.177	1.196	1.196	1.610	1.1094	1.1094	1.1294	1.099
1993	1.169	1.194	1.194	1.610	1.1094	1.1094	1.1294	1.099
1994	1.169	1.192	1.192	1.610	1.1094	1.1094	1.1294	1.099
1995	1.169	1.192	1.192	1.610	1.1094	1.1094	1.1294	1.099
1996	1.169	1.194	1.194	1.618	1.1094	1.1094	1.1294	1.099
1997	1.169	1.194	1.194	1.618	1.1094	1.1094	1.1294	1.099
1998	1.169	1.194	1.194	1.618	1.1094	1.1094	1.1294	1.099
1999	1.169	1.194	1.194	1.618	1.1094	1.1094	1.1294	1.099
2000	1.169	1.194	1.194	1.629	1.1094	1.1094	1.1294	1.099
2001	1.169	1.182	1.182	1.629	1.1094	1.1094	1.1294	1.099
2002	1.169	1.182	1.182	1.629	1.1094	1.1094	1.1294	1.099
2003	1.169	1.182	1.182	1.629	1.1094	1.1094	1.1294	1.099
2004	1.169	1.182	1.182	1.637	1.1094	1.1094	1.1294	1.099

TOG BERs - I/M OTR Baseline Case

```
0109             ZM    DR1    DR2 Flex Pt  File: OTR_IM_B.BER
1 1 1 65 67  7.488  0.186                        LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.491  0.165
1 1 1 75 75  1.068  0.282
1 1 1 76 77  1.071  0.283
1 1 1 78 79  1.074  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 81  0.464  0.120  0.005  14.63
1 1 1 82 82  0.460  0.119  0.006  14.63
1 1 1 83 83  0.336  0.064
1 1 1 84 84  0.346  0.061
1 1 1 85 85  0.350  0.057
1 1 1 86 86  0.358  0.046
1 1 1 87 87  0.360  0.045
1 1 1 88 88  0.228  0.036
1 1 1 89 89  0.231  0.037
1 1 1 90 90  0.228  0.036
1 1 1 91 93  0.224  0.035
1 1 1 94 94  0.197  0.031
1 1 1 95 95  0.169  0.028
1 1 1 96 98  0.156  0.026  0.024   9.05
1 1 1 99 99  0.103  0.019  0.019  12.29
1 1 1 00 00  0.075  0.015  0.017  13.97
1 1 1 01 50  0.064  0.014  0.016  14.64
1 2 1 65 67  7.488  0.186                        LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.470  0.176
1 2 1 75 75  1.802  0.270
1 2 1 76 76  1.813  0.272
1 2 1 77 78  1.807  0.271
1 2 1 79 80  0.876  0.282
1 2 1 81 82  1.406  0.086
1 2 1 83 83  1.423  0.087
1 2 1 84 84  0.495  0.061
1 2 1 85 85  0.485  0.061
1 2 1 86 86  0.456  0.062
1 2 1 87 87  0.446  0.066
1 2 1 88 88  0.334  0.049
1 2 1 89 89  0.333  0.047
1 2 1 90 90  0.319  0.045
1 2 1 91 91  0.293  0.044
1 2 1 92 93  0.313  0.042
1 2 1 94 94  0.264  0.037
1 2 1 95 95  0.216  0.033
1 2 1 96 98  0.192  0.031  0.027  11.84
1 2 1 99 99  0.122  0.022  0.021  15.01
1 2 1 00 00  0.087  0.017  0.018  16.62
1 2 1 01 50  0.073  0.015  0.017  17.20
1 3 1 65 69  9.885  0.186                        LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.887  0.286
1 3 1 81 81  1.404  0.086
1 3 1 82 82  1.404  0.086
1 3 1 83 83  1.427  0.088
1 3 1 84 84  0.501  0.061
1 3 1 85 85  0.502  0.063
1 3 1 86 86  0.487  0.067
1 3 1 87 87  0.470  0.069
1 3 1 88 88  0.349  0.051
1 3 1 89 89  0.344  0.048
1 3 1 90 90  0.336  0.048
1 3 1 91 91  0.293  0.044
1 3 1 92 92  0.313  0.042
```

1	3	1	93	95	0.312	0.042			
1	3	1	96	96	0.264	0.038			
1	3	1	97	97	0.216	0.034	0.029	13.93	
1	3	1	98	98	0.216	0.034	0.029	13.93	
1	3	1	99	99	0.216	0.034	0.029	13.93	
1	3	1	00	00	0.216	0.034	0.029	13.93	
1	3	1	01	50	0.214	0.034	0.028	13.93	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.862	0.039			
1	4	1	04	06	0.255	0.016			
1	4	1	07	50	0.192	0.011			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	50	0.281	0.027			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

TOG BERs - I/M OTR Tier 2 Control Case

0117					ZM	DR1	DR2	Flex Pt	File: OTR_IM_C.BER
1	1	1	65	67	7.488	0.186			LDGV
1	1	1	68	69	4.576	0.258			
1	1	1	70	71	3.099	0.382			
1	1	1	72	74	3.491	0.165			
1	1	1	75	75	1.068	0.282			
1	1	1	76	77	1.071	0.283			
1	1	1	78	79	1.074	0.284			
1	1	1	80	80	0.371	0.211			
1	1	1	81	81	0.464	0.120	0.005	14.63	
1	1	1	82	82	0.460	0.119	0.006	14.63	
1	1	1	83	83	0.336	0.064			
1	1	1	84	84	0.346	0.061			
1	1	1	85	85	0.350	0.057			
1	1	1	86	86	0.358	0.046			
1	1	1	87	87	0.360	0.045			
1	1	1	88	88	0.228	0.036			
1	1	1	89	89	0.231	0.037			
1	1	1	90	90	0.228	0.036			
1	1	1	91	93	0.224	0.035			
1	1	1	94	94	0.197	0.031			
1	1	1	95	95	0.169	0.028			
1	1	1	96	98	0.156	0.026	0.024	9.05	
1	1	1	99	99	0.103	0.019	0.019	12.29	
1	1	1	00	00	0.075	0.015	0.017	13.97	
1	1	1	01	50	0.064	0.014	0.016	14.64	
1	2	1	65	67	7.488	0.186			LDGT1
1	2	1	68	69	4.576	0.258			
1	2	1	70	71	3.099	0.382			
1	2	1	72	74	3.470	0.176			
1	2	1	75	75	1.802	0.270			
1	2	1	76	76	1.813	0.272			
1	2	1	77	78	1.807	0.271			
1	2	1	79	80	0.876	0.282			
1	2	1	81	82	1.406	0.086			
1	2	1	83	83	1.423	0.087			
1	2	1	84	84	0.495	0.061			
1	2	1	85	85	0.485	0.061			
1	2	1	86	86	0.456	0.062			
1	2	1	87	87	0.446	0.066			
1	2	1	88	89	0.334	0.049			
1	2	1	90	90	0.319	0.045			
1	2	1	91	91	0.293	0.044			
1	2	1	92	93	0.313	0.042			
1	2	1	94	94	0.264	0.037			
1	2	1	95	95	0.216	0.033			
1	2	1	96	98	0.192	0.031	0.027	11.84	
1	2	1	99	99	0.122	0.022	0.021	15.01	
1	2	1	00	00	0.087	0.017	0.018	16.62	
1	2	1	01	03	0.073	0.015	0.017	17.20	
1	2	1	04	50	0.065	0.014	0.016	16.61	
1	3	1	65	69	9.885	0.186			LDGT2
1	3	1	70	73	6.486	0.258			
1	3	1	74	78	6.486	0.176			
1	3	1	79	80	0.887	0.286			
1	3	1	81	82	1.404	0.086			
1	3	1	83	83	1.427	0.088			
1	3	1	84	84	0.501	0.061			
1	3	1	85	85	0.502	0.063			
1	3	1	86	86	0.487	0.067			
1	3	1	87	87	0.470	0.069			
1	3	1	88	88	0.349	0.051			
1	3	1	89	89	0.344	0.048			
1	3	1	90	90	0.336	0.048			
1	3	1	91	91	0.293	0.044			
1	3	1	92	92	0.313	0.042			
1	3	1	93	95	0.312	0.042			

1	3	1	96	96	0.264	0.038			
1	3	1	97	00	0.216	0.034	0.029	13.93	
1	3	1	01	03	0.214	0.034	0.028	13.93	
1	3	1	04	04	0.100	0.019	0.020	13.05	
1	3	1	05	05	0.105	0.020	0.020	12.59	
1	3	1	06	06	0.098	0.019	0.020	13.59	
1	3	1	07	07	0.090	0.018	0.019	14.45	
1	3	1	08	08	0.078	0.016	0.018	16.33	
1	3	1	09	50	0.065	0.014	0.017	17.99	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.862	0.039			
1	4	1	04	06	0.255	0.016			
1	4	1	07	50	0.192	0.011			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	03	0.281	0.027			
1	6	1	04	04	0.122	0.012			
1	6	1	05	05	0.111	0.011			
1	6	1	06	06	0.100	0.010			
1	6	1	07	07	0.089	0.009			
1	6	1	08	08	0.070	0.007			
1	6	1	09	50	0.052	0.005			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

TOG BERs - I/M OTR Tier 2 Control Case - Inc. LD Diesel Penetration

0117					ZM	DR1	DR2	Flex Pt	File: OTR_IM_D.BER
1	1	1	65	67	7.488	0.186			LDGV
1	1	1	68	69	4.576	0.258			
1	1	1	70	71	3.099	0.382			
1	1	1	72	74	3.491	0.165			
1	1	1	75	75	1.068	0.282			
1	1	1	76	77	1.071	0.283			
1	1	1	78	79	1.074	0.284			
1	1	1	80	80	0.371	0.211			
1	1	1	81	81	0.464	0.120	0.005	14.63	
1	1	1	82	82	0.460	0.119	0.006	14.63	
1	1	1	83	83	0.336	0.064			
1	1	1	84	84	0.346	0.061			
1	1	1	85	85	0.350	0.057			
1	1	1	86	86	0.358	0.046			
1	1	1	87	87	0.360	0.045			
1	1	1	88	88	0.228	0.036			
1	1	1	89	89	0.231	0.037			
1	1	1	90	90	0.228	0.036			
1	1	1	91	93	0.224	0.035			
1	1	1	94	94	0.197	0.031			
1	1	1	95	95	0.169	0.028			
1	1	1	96	98	0.156	0.026	0.024	9.05	
1	1	1	99	99	0.103	0.019	0.019	12.29	
1	1	1	00	00	0.075	0.015	0.017	13.97	
1	1	1	01	50	0.064	0.014	0.016	14.64	
1	2	1	65	67	7.488	0.186			LDGT1
1	2	1	68	69	4.576	0.258			
1	2	1	70	71	3.099	0.382			
1	2	1	72	74	3.470	0.176			
1	2	1	75	75	1.802	0.270			
1	2	1	76	76	1.813	0.272			
1	2	1	77	78	1.807	0.271			
1	2	1	79	80	0.876	0.282			
1	2	1	81	82	1.406	0.086			
1	2	1	83	83	1.423	0.087			
1	2	1	84	84	0.495	0.061			
1	2	1	85	85	0.485	0.061			
1	2	1	86	86	0.456	0.062			
1	2	1	87	87	0.446	0.066			
1	2	1	88	89	0.334	0.049			
1	2	1	90	90	0.319	0.045			
1	2	1	91	91	0.293	0.044			
1	2	1	92	93	0.313	0.042			
1	2	1	94	94	0.264	0.037			
1	2	1	95	95	0.216	0.033			
1	2	1	96	98	0.192	0.031	0.027	11.84	
1	2	1	99	99	0.122	0.022	0.021	15.01	
1	2	1	00	00	0.087	0.017	0.018	16.62	
1	2	1	01	03	0.073	0.015	0.017	17.20	
1	2	1	04	50	0.065	0.014	0.016	16.61	
1	3	1	65	69	9.885	0.186			LDGT2
1	3	1	70	73	6.486	0.258			
1	3	1	74	78	6.486	0.176			
1	3	1	79	80	0.887	0.286			
1	3	1	81	82	1.404	0.086			
1	3	1	83	83	1.427	0.088			
1	3	1	84	84	0.501	0.061			
1	3	1	85	85	0.502	0.063			
1	3	1	86	86	0.487	0.067			
1	3	1	87	87	0.470	0.069			
1	3	1	88	88	0.349	0.051			
1	3	1	89	89	0.344	0.048			
1	3	1	90	90	0.336	0.048			
1	3	1	91	91	0.293	0.044			
1	3	1	92	92	0.313	0.042			
1	3	1	93	95	0.312	0.042			

1	3	1	96	96	0.264	0.038			
1	3	1	97	00	0.216	0.034	0.029	13.93	
1	3	1	01	03	0.214	0.034	0.028	13.93	
1	3	1	04	04	0.100	0.019	0.020	13.05	
1	3	1	05	05	0.105	0.020	0.020	12.59	
1	3	1	06	06	0.098	0.019	0.020	13.59	
1	3	1	07	07	0.090	0.018	0.019	14.45	
1	3	1	08	08	0.078	0.016	0.018	16.33	
1	3	1	09	50	0.065	0.014	0.017	17.99	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.862	0.039			
1	4	1	04	06	0.255	0.016			
1	4	1	07	50	0.192	0.011			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	03	0.281	0.027			
1	6	1	04	04	0.112	0.011			
1	6	1	05	05	0.102	0.010			
1	6	1	06	06	0.083	0.008			
1	6	1	07	07	0.071	0.007			
1	6	1	08	08	0.060	0.006			
1	6	1	09	50	0.052	0.005			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

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TOG BERs - I/M OTR 0.055 NMHC Case
0118             ZM    DR1    DR2 Flex Pt  File: OTR_IM_5.BER
1 1 1 65 67  7.488  0.186                        LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.491  0.165
1 1 1 75 77  1.071  0.283
1 1 1 78 79  1.074  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 81  0.464  0.120  0.005  14.63
1 1 1 82 82  0.460  0.119  0.006  14.63
1 1 1 83 83  0.336  0.064
1 1 1 84 84  0.346  0.061
1 1 1 85 85  0.350  0.057
1 1 1 86 86  0.358  0.046
1 1 1 87 87  0.360  0.045
1 1 1 88 88  0.228  0.036
1 1 1 89 89  0.231  0.037
1 1 1 90 90  0.228  0.036
1 1 1 91 93  0.224  0.035
1 1 1 94 94  0.197  0.031
1 1 1 95 95  0.169  0.028
1 1 1 96 98  0.156  0.026  0.024   9.05
1 1 1 99 99  0.103  0.019  0.019  12.29
1 1 1 00 00  0.075  0.015  0.017  13.97
1 1 1 01 03  0.064  0.014  0.016  14.64
1 1 1 04 50  0.028  0.009  0.013  13.20
1 2 1 65 67  7.488  0.186                        LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.470  0.176
1 2 1 75 75  1.802  0.270
1 2 1 76 76  1.813  0.272
1 2 1 77 78  1.807  0.271
1 2 1 79 80  0.876  0.282
1 2 1 81 82  1.406  0.086
1 2 1 83 83  1.423  0.087
1 2 1 84 84  0.495  0.061
1 2 1 85 85  0.485  0.061
1 2 1 86 86  0.456  0.062
1 2 1 87 87  0.446  0.066
1 2 1 88 89  0.334  0.049
1 2 1 90 90  0.319  0.045
1 2 1 91 91  0.293  0.044
1 2 1 92 93  0.313  0.042
1 2 1 94 94  0.264  0.037
1 2 1 95 95  0.216  0.033
1 2 1 96 98  0.192  0.031  0.027  11.84
1 2 1 99 99  0.122  0.022  0.021  15.01
1 2 1 00 00  0.087  0.017  0.018  16.62
1 2 1 01 03  0.073  0.015  0.017  17.20
1 2 1 04 50  0.028  0.009  0.013  16.61
1 3 1 65 69  9.885  0.186                        LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.887  0.286
1 3 1 81 82  1.404  0.086
1 3 1 83 83  1.427  0.088
1 3 1 84 84  0.501  0.061
1 3 1 85 85  0.502  0.063
1 3 1 86 86  0.487  0.067
1 3 1 87 87  0.470  0.069
1 3 1 88 88  0.349  0.051
1 3 1 89 89  0.344  0.048
1 3 1 90 90  0.336  0.048
1 3 1 91 91  0.293  0.044
1 3 1 92 92  0.313  0.042
1 3 1 93 95  0.312  0.042
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1	3	1	96	96	0.264	0.038			
1	3	1	97	00	0.216	0.034	0.029	13.93	
1	3	1	01	03	0.214	0.034	0.028	13.93	
1	3	1	04	04	0.028	0.009	0.014	16.78	
1	3	1	05	05	0.028	0.009	0.014	16.78	
1	3	1	06	06	0.028	0.009	0.014	16.78	
1	3	1	07	07	0.028	0.009	0.014	16.78	
1	3	1	08	08	0.028	0.009	0.014	16.78	
1	3	1	09	50	0.028	0.009	0.014	16.78	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.862	0.039			
1	4	1	04	06	0.255	0.016			
1	4	1	07	50	0.192	0.011			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	03	0.057	0.006			
1	5	1	04	50	0.027	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	03	0.281	0.027			
1	6	1	04	04	0.027	0.006			
1	6	1	05	05	0.027	0.006			
1	6	1	06	06	0.027	0.006			
1	6	1	07	07	0.027	0.006			
1	6	1	08	08	0.027	0.006			
1	6	1	09	50	0.027	0.006			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

TOG BERs - I/M OTR Tier 2 Control + HDGV Case

0117					ZM	DR1	DR2	Flex Pt	File: OTR_IM_H.BER
1	1	1	65	67	7.488	0.186			LDGV
1	1	1	68	69	4.576	0.258			
1	1	1	70	71	3.099	0.382			
1	1	1	72	74	3.491	0.165			
1	1	1	75	75	1.068	0.282			
1	1	1	76	77	1.071	0.283			
1	1	1	78	79	1.074	0.284			
1	1	1	80	80	0.371	0.211			
1	1	1	81	81	0.464	0.120	0.005	14.63	
1	1	1	82	82	0.460	0.119	0.006	14.63	
1	1	1	83	83	0.336	0.064			
1	1	1	84	84	0.346	0.061			
1	1	1	85	85	0.350	0.057			
1	1	1	86	86	0.358	0.046			
1	1	1	87	87	0.360	0.045			
1	1	1	88	88	0.228	0.036			
1	1	1	89	89	0.231	0.037			
1	1	1	90	90	0.228	0.036			
1	1	1	91	93	0.224	0.035			
1	1	1	94	94	0.197	0.031			
1	1	1	95	95	0.169	0.028			
1	1	1	96	98	0.156	0.026	0.024	9.05	
1	1	1	99	99	0.103	0.019	0.019	12.29	
1	1	1	00	00	0.075	0.015	0.017	13.97	
1	1	1	01	50	0.064	0.014	0.016	14.64	
1	2	1	65	67	7.488	0.186			LDGT1
1	2	1	68	69	4.576	0.258			
1	2	1	70	71	3.099	0.382			
1	2	1	72	74	3.470	0.176			
1	2	1	75	75	1.802	0.270			
1	2	1	76	76	1.813	0.272			
1	2	1	77	78	1.807	0.271			
1	2	1	79	80	0.876	0.282			
1	2	1	81	82	1.406	0.086			
1	2	1	83	83	1.423	0.087			
1	2	1	84	84	0.495	0.061			
1	2	1	85	85	0.485	0.061			
1	2	1	86	86	0.456	0.062			
1	2	1	87	87	0.446	0.066			
1	2	1	88	89	0.334	0.049			
1	2	1	90	90	0.319	0.045			
1	2	1	91	91	0.293	0.044			
1	2	1	92	93	0.313	0.042			
1	2	1	94	94	0.264	0.037			
1	2	1	95	95	0.216	0.033			
1	2	1	96	98	0.192	0.031	0.027	11.84	
1	2	1	99	99	0.122	0.022	0.021	15.01	
1	2	1	00	00	0.087	0.017	0.018	16.62	
1	2	1	01	03	0.073	0.015	0.017	17.20	
1	2	1	04	50	0.065	0.014	0.016	16.61	
1	3	1	65	69	9.885	0.186			LDGT2
1	3	1	70	73	6.486	0.258			
1	3	1	74	78	6.486	0.176			
1	3	1	79	80	0.887	0.286			
1	3	1	81	82	1.404	0.086			
1	3	1	83	83	1.427	0.088			
1	3	1	84	84	0.501	0.061			
1	3	1	85	85	0.502	0.063			
1	3	1	86	86	0.487	0.067			
1	3	1	87	87	0.470	0.069			
1	3	1	88	88	0.349	0.051			
1	3	1	89	89	0.344	0.048			
1	3	1	90	90	0.336	0.048			
1	3	1	91	91	0.293	0.044			
1	3	1	92	92	0.313	0.042			
1	3	1	93	95	0.312	0.042			

1	3	1	96	96	0.264	0.038			
1	3	1	97	00	0.216	0.034	0.029	13.93	
1	3	1	01	03	0.214	0.034	0.028	13.93	
1	3	1	04	04	0.100	0.019	0.020	13.05	
1	3	1	05	05	0.105	0.020	0.020	12.59	
1	3	1	06	06	0.098	0.019	0.020	13.59	
1	3	1	07	07	0.090	0.018	0.019	14.45	
1	3	1	08	08	0.078	0.016	0.018	16.33	
1	3	1	09	50	0.065	0.014	0.017	17.99	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.820	0.037			
1	4	1	04	06	0.211	0.015			
1	4	1	07	50	0.159	0.010			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	03	0.281	0.027			
1	6	1	04	04	0.122	0.012			
1	6	1	05	05	0.111	0.011			
1	6	1	06	06	0.100	0.010			
1	6	1	07	07	0.089	0.009			
1	6	1	08	08	0.070	0.007			
1	6	1	09	50	0.052	0.005			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

```
TOG BERs - No I/M OTR Baseline Case
0112           ZM    DR1    DR2 Flex Pt  File: OTR_NO_B.BER
1 1 1 65 67  7.488  0.186                        LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.491  0.165
1 1 1 75 75  1.068  0.282
1 1 1 76 77  1.071  0.283
1 1 1 78 79  1.074  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 81  0.401  0.223  0.005  14.63
1 1 1 82 82  0.400  0.221  0.005  14.63
1 1 1 83 83  0.232  0.116
1 1 1 84 84  0.257  0.110
1 1 1 85 85  0.278  0.102
1 1 1 86 86  0.334  0.082
1 1 1 87 87  0.338  0.080
1 1 1 88 88  0.223  0.057
1 1 1 89 89  0.222  0.058
1 1 1 90 90  0.219  0.056
1 1 1 91 93  0.215  0.055
1 1 1 94 94  0.190  0.042
1 1 1 95 95  0.167  0.028
1 1 1 96 98  0.156  0.022  0.047   3.13
1 1 1 99 99  0.103  0.015  0.042   3.47
1 1 1 00 00  0.075  0.012  0.039   3.65
1 1 1 01 50  0.064  0.010  0.038   3.72
1 2 1 65 67  7.488  0.186                        LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.470  0.176
1 2 1 75 75  1.802  0.270
1 2 1 76 76  1.813  0.272
1 2 1 77 78  1.807  0.271
1 2 1 79 80  0.876  0.282
1 2 1 81 82  1.319  0.183
1 2 1 83 83  1.335  0.185
1 2 1 84 85  0.440  0.109
1 2 1 86 86  0.401  0.111
1 2 1 87 87  0.384  0.117
1 2 1 88 88  0.331  0.077
1 2 1 89 89  0.331  0.073
1 2 1 90 90  0.320  0.071
1 2 1 91 91  0.296  0.068
1 2 1 92 92  0.314  0.066
1 2 1 93 93  0.313  0.065
1 2 1 94 94  0.264  0.052
1 2 1 95 95  0.216  0.040
1 2 1 96 98  0.192  0.033  0.052   3.38
1 2 1 99 99  0.122  0.024  0.045   4.10
1 2 1 00 00  0.087  0.020  0.042   4.46
1 2 1 01 50  0.073  0.018  0.040   4.59
1 3 1 65 69  9.885  0.186                        LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.887  0.286
1 3 1 81 82  1.317  0.182
1 3 1 83 83  1.339  0.186
1 3 1 84 84  0.452  0.110
1 3 1 85 85  0.450  0.113
1 3 1 86 86  0.428  0.119
1 3 1 87 87  0.405  0.123
1 3 1 88 88  0.346  0.080
1 3 1 89 89  0.342  0.076
1 3 1 90 90  0.337  0.075
1 3 1 91 91  0.296  0.068
1 3 1 92 92  0.314  0.066
1 3 1 93 95  0.313  0.065
```

1	3	1	96	96	0.265	0.052			
1	3	1	97	97	0.216	0.040	0.055	3.38	
1	3	1	98	98	0.216	0.040	0.055	3.38	
1	3	1	99	99	0.216	0.040	0.055	3.38	
1	3	1	00	00	0.216	0.040	0.055	3.38	
1	3	1	01	50	0.214	0.039	0.054	3.38	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.863	0.039			
1	4	1	04	06	0.350	0.023			
1	4	1	07	50	0.275	0.016			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	97	0.281	0.027			
1	6	1	98	98	0.281	0.027			
1	6	1	99	99	0.281	0.027			
1	6	1	00	00	0.281	0.027			
1	6	1	01	50	0.281	0.027			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

```
TOG BERs - No I/M OTR Control (Tier 2) Case
0121            ZM    DR1    DR2 Flex Pt  File: OTR_NO_C.BER
1 1 1 65 67  7.488  0.186                         LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.491  0.165
1 1 1 75 75  1.068  0.282
1 1 1 76 77  1.071  0.283
1 1 1 78 79  1.074  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 81  0.401  0.223  0.005  14.63
1 1 1 82 82  0.400  0.221  0.005  14.63
1 1 1 83 83  0.232  0.116
1 1 1 84 84  0.257  0.110
1 1 1 85 85  0.278  0.102
1 1 1 86 86  0.334  0.082
1 1 1 87 87  0.338  0.080
1 1 1 88 88  0.223  0.057
1 1 1 89 89  0.222  0.058
1 1 1 90 90  0.219  0.056
1 1 1 91 93  0.215  0.055
1 1 1 94 94  0.190  0.042
1 1 1 95 95  0.167  0.028
1 1 1 96 98  0.156  0.022  0.047   3.13
1 1 1 99 99  0.103  0.015  0.042   3.47
1 1 1 00 00  0.075  0.012  0.039   3.65
1 1 1 01 50  0.064  0.010  0.038   3.72
1 2 1 65 67  7.488  0.186                         LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.470  0.176
1 2 1 75 75  1.802  0.270
1 2 1 76 76  1.813  0.272
1 2 1 77 78  1.807  0.271
1 2 1 79 80  0.876  0.282
1 2 1 81 82  1.319  0.183
1 2 1 83 83  1.335  0.185
1 2 1 84 85  0.440  0.109
1 2 1 86 86  0.401  0.111
1 2 1 87 87  0.384  0.117
1 2 1 88 88  0.331  0.077
1 2 1 89 89  0.331  0.073
1 2 1 90 90  0.320  0.071
1 2 1 91 91  0.296  0.068
1 2 1 92 93  0.314  0.066
1 2 1 94 94  0.264  0.052
1 2 1 95 95  0.216  0.040
1 2 1 96 98  0.192  0.033  0.052   3.38
1 2 1 99 99  0.122  0.024  0.045   4.10
1 2 1 00 00  0.087  0.020  0.042   4.46
1 2 1 01 03  0.073  0.018  0.040   4.59
1 2 1 04 50  0.065  0.016  0.038   4.65
1 3 1 65 69  9.885  0.186                         LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.887  0.286
1 3 1 81 82  1.317  0.182
1 3 1 83 83  1.339  0.186
1 3 1 84 84  0.452  0.110
1 3 1 85 85  0.450  0.113
1 3 1 86 86  0.428  0.119
1 3 1 87 87  0.405  0.123
1 3 1 88 88  0.346  0.080
1 3 1 89 89  0.342  0.076
1 3 1 90 90  0.337  0.075
1 3 1 91 91  0.296  0.068
1 3 1 92 92  0.314  0.066
1 3 1 93 95  0.313  0.065
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1	3	1	96	96	0.265	0.052			
1	3	1	97	00	0.216	0.040	0.055	3.38	
1	3	1	01	03	0.214	0.039	0.054	3.38	
1	3	1	04	04	0.100	0.024	0.044	5.13	
1	3	1	05	05	0.105	0.025	0.045	5.08	
1	3	1	06	06	0.098	0.024	0.044	5.15	
1	3	1	07	07	0.090	0.023	0.043	5.23	
1	3	1	08	08	0.078	0.021	0.041	5.36	
1	3	1	09	50	0.065	0.019	0.039	5.50	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.863	0.039			
1	4	1	04	06	0.350	0.023			
1	4	1	07	50	0.275	0.016			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	97	0.281	0.027			
1	6	1	98	98	0.281	0.027			
1	6	1	99	99	0.281	0.027			
1	6	1	00	00	0.281	0.027			
1	6	1	01	03	0.281	0.027			
1	6	1	04	04	0.122	0.012			
1	6	1	05	05	0.111	0.011			
1	6	1	06	06	0.100	0.010			
1	6	1	07	07	0.089	0.009			
1	6	1	08	08	0.070	0.007			
1	6	1	09	50	0.052	0.005			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

```
TOG BERs - No I/M OTR Control (Tier 2) Case + Inc. LD Diesel Penetration
0121           ZM    DR1    DR2 Flex Pt  File: OTR_NO_D.BER
1 1 1 65 67  7.488  0.186                           LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.491  0.165
1 1 1 75 75  1.068  0.282
1 1 1 76 77  1.071  0.283
1 1 1 78 79  1.074  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 81  0.401  0.223  0.005  14.63
1 1 1 82 82  0.400  0.221  0.005  14.63
1 1 1 83 83  0.232  0.116
1 1 1 84 84  0.257  0.110
1 1 1 85 85  0.278  0.102
1 1 1 86 86  0.334  0.082
1 1 1 87 87  0.338  0.080
1 1 1 88 88  0.223  0.057
1 1 1 89 89  0.222  0.058
1 1 1 90 90  0.219  0.056
1 1 1 91 93  0.215  0.055
1 1 1 94 94  0.190  0.042
1 1 1 95 95  0.167  0.028
1 1 1 96 98  0.156  0.022  0.047   3.13
1 1 1 99 99  0.103  0.015  0.042   3.47
1 1 1 00 00  0.075  0.012  0.039   3.65
1 1 1 01 50  0.064  0.010  0.038   3.72
1 2 1 65 67  7.488  0.186                           LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.470  0.176
1 2 1 75 75  1.802  0.270
1 2 1 76 76  1.813  0.272
1 2 1 77 78  1.807  0.271
1 2 1 79 80  0.876  0.282
1 2 1 81 82  1.319  0.183
1 2 1 83 83  1.335  0.185
1 2 1 84 85  0.440  0.109
1 2 1 86 86  0.401  0.111
1 2 1 87 87  0.384  0.117
1 2 1 88 88  0.331  0.077
1 2 1 89 89  0.331  0.073
1 2 1 90 90  0.320  0.071
1 2 1 91 91  0.296  0.068
1 2 1 92 93  0.314  0.066
1 2 1 94 94  0.264  0.052
1 2 1 95 95  0.216  0.040
1 2 1 96 98  0.192  0.033  0.052   3.38
1 2 1 99 99  0.122  0.024  0.045   4.10
1 2 1 00 00  0.087  0.020  0.042   4.46
1 2 1 01 03  0.073  0.018  0.040   4.59
1 2 1 04 50  0.065  0.016  0.038   4.65
1 3 1 65 69  9.885  0.186                           LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.887  0.286
1 3 1 81 82  1.317  0.182
1 3 1 83 83  1.339  0.186
1 3 1 84 84  0.452  0.110
1 3 1 85 85  0.450  0.113
1 3 1 86 86  0.428  0.119
1 3 1 87 87  0.405  0.123
1 3 1 88 88  0.346  0.080
1 3 1 89 89  0.342  0.076
1 3 1 90 90  0.337  0.075
1 3 1 91 91  0.296  0.068
1 3 1 92 92  0.314  0.066
1 3 1 93 95  0.313  0.065
```

1	3	1	96	96	0.265	0.052			
1	3	1	97	00	0.216	0.040	0.055	3.38	
1	3	1	01	03	0.214	0.039	0.054	3.38	
1	3	1	04	04	0.100	0.024	0.044	5.13	
1	3	1	05	05	0.105	0.025	0.045	5.08	
1	3	1	06	06	0.098	0.024	0.044	5.15	
1	3	1	07	07	0.090	0.023	0.043	5.23	
1	3	1	08	08	0.078	0.021	0.041	5.36	
1	3	1	09	50	0.065	0.019	0.039	5.50	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.863	0.039			
1	4	1	04	06	0.350	0.023			
1	4	1	07	50	0.275	0.016			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	97	0.281	0.027			
1	6	1	98	98	0.281	0.027			
1	6	1	99	99	0.281	0.027			
1	6	1	00	00	0.281	0.027			
1	6	1	01	03	0.281	0.027			
1	6	1	04	04	0.112	0.011			
1	6	1	05	05	0.102	0.010			
1	6	1	06	06	0.083	0.008			
1	6	1	07	07	0.071	0.007			
1	6	1	08	08	0.060	0.006			
1	6	1	09	50	0.052	0.005			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

```
TOG BERs - No I/M OTR 0.055 NMHC Case
0122           ZM    DR1    DR2 Flex Pt  File: OTR_NO_5.BER
1 1 1 65 67  7.488  0.186                       LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.491  0.165
1 1 1 75 77  1.071  0.283
1 1 1 78 79  1.074  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 81  0.401  0.223  0.005  14.63
1 1 1 82 82  0.400  0.221  0.005  14.63
1 1 1 83 83  0.232  0.116
1 1 1 84 84  0.257  0.110
1 1 1 85 85  0.278  0.102
1 1 1 86 86  0.334  0.082
1 1 1 87 87  0.338  0.080
1 1 1 88 88  0.223  0.057
1 1 1 89 89  0.222  0.058
1 1 1 90 90  0.219  0.056
1 1 1 91 93  0.215  0.055
1 1 1 94 94  0.190  0.042
1 1 1 95 95  0.167  0.028
1 1 1 96 98  0.156  0.022  0.047   3.13
1 1 1 99 99  0.103  0.015  0.042   3.47
1 1 1 00 00  0.075  0.012  0.039   3.65
1 1 1 01 03  0.064  0.010  0.038   3.72
1 1 1 04 50  0.028  0.006  0.034   3.93
1 2 1 65 67  7.488  0.186                       LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.470  0.176
1 2 1 75 75  1.802  0.270
1 2 1 76 76  1.813  0.272
1 2 1 77 78  1.807  0.271
1 2 1 79 80  0.876  0.282
1 2 1 81 82  1.319  0.183
1 2 1 83 83  1.335  0.185
1 2 1 84 85  0.440  0.109
1 2 1 86 86  0.401  0.111
1 2 1 87 87  0.384  0.117
1 2 1 88 88  0.331  0.077
1 2 1 89 89  0.331  0.073
1 2 1 90 90  0.320  0.071
1 2 1 91 91  0.296  0.068
1 2 1 92 93  0.314  0.066
1 2 1 94 94  0.264  0.052
1 2 1 95 95  0.216  0.040
1 2 1 96 98  0.192  0.033  0.052   3.38
1 2 1 99 99  0.122  0.024  0.045   4.10
1 2 1 00 00  0.087  0.020  0.042   4.46
1 2 1 01 03  0.073  0.018  0.040   4.59
1 2 1 04 50  0.028  0.012  0.034   4.94
1 3 1 65 69  9.885  0.186                       LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.887  0.286
1 3 1 81 82  1.317  0.182
1 3 1 83 83  1.339  0.186
1 3 1 84 84  0.452  0.110
1 3 1 85 85  0.450  0.113
1 3 1 86 86  0.428  0.119
1 3 1 87 87  0.405  0.123
1 3 1 88 88  0.346  0.080
1 3 1 89 89  0.342  0.076
1 3 1 90 90  0.337  0.075
1 3 1 91 91  0.296  0.068
1 3 1 92 92  0.314  0.066
1 3 1 93 95  0.313  0.065
```

1	3	1	96	96	0.265	0.052			
1	3	1	97	00	0.216	0.040	0.055	3.38	
1	3	1	01	03	0.214	0.039	0.054	3.38	
1	3	1	04	04	0.028	0.014	0.035	5.86	
1	3	1	05	05	0.028	0.014	0.035	5.86	
1	3	1	06	06	0.028	0.014	0.035	5.86	
1	3	1	07	07	0.028	0.014	0.035	5.86	
1	3	1	08	08	0.028	0.014	0.035	5.86	
1	3	1	09	50	0.028	0.014	0.035	5.86	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.863	0.039			
1	4	1	04	06	0.350	0.023			
1	4	1	07	50	0.275	0.016			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	03	0.057	0.006			
1	5	1	04	50	0.027	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	97	0.281	0.027			
1	6	1	98	98	0.281	0.027			
1	6	1	99	99	0.281	0.027			
1	6	1	00	00	0.281	0.027			
1	6	1	01	03	0.281	0.027			
1	6	1	04	04	0.027	0.006			
1	6	1	05	05	0.027	0.006			
1	6	1	06	06	0.027	0.006			
1	6	1	07	07	0.027	0.006			
1	6	1	08	08	0.027	0.006			
1	6	1	09	50	0.027	0.006			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

TOG BERs - No I/M OTR Control + HDGV Tier 2 Case

0121					ZM	DR1	DR2	Flex Pt	File: OTR_NO_H.BER
1	1	1	65	67	7.488	0.186			LDGV
1	1	1	68	69	4.576	0.258			
1	1	1	70	71	3.099	0.382			
1	1	1	72	74	3.491	0.165			
1	1	1	75	75	1.068	0.282			
1	1	1	76	77	1.071	0.283			
1	1	1	78	79	1.074	0.284			
1	1	1	80	80	0.371	0.211			
1	1	1	81	81	0.401	0.223	0.005	14.63	
1	1	1	82	82	0.400	0.221	0.005	14.63	
1	1	1	83	83	0.232	0.116			
1	1	1	84	84	0.257	0.110			
1	1	1	85	85	0.278	0.102			
1	1	1	86	86	0.334	0.082			
1	1	1	87	87	0.338	0.080			
1	1	1	88	88	0.223	0.057			
1	1	1	89	89	0.222	0.058			
1	1	1	90	90	0.219	0.056			
1	1	1	91	93	0.215	0.055			
1	1	1	94	94	0.190	0.042			
1	1	1	95	95	0.167	0.028			
1	1	1	96	98	0.156	0.022	0.047	3.13	
1	1	1	99	99	0.103	0.015	0.042	3.47	
1	1	1	00	00	0.075	0.012	0.039	3.65	
1	1	1	01	50	0.064	0.010	0.038	3.72	
1	2	1	65	67	7.488	0.186			LDGT1
1	2	1	68	69	4.576	0.258			
1	2	1	70	71	3.099	0.382			
1	2	1	72	74	3.470	0.176			
1	2	1	75	75	1.802	0.270			
1	2	1	76	76	1.813	0.272			
1	2	1	77	78	1.807	0.271			
1	2	1	79	80	0.876	0.282			
1	2	1	81	82	1.319	0.183			
1	2	1	83	83	1.335	0.185			
1	2	1	84	85	0.440	0.109			
1	2	1	86	86	0.401	0.111			
1	2	1	87	87	0.384	0.117			
1	2	1	88	88	0.331	0.077			
1	2	1	89	89	0.331	0.073			
1	2	1	90	90	0.320	0.071			
1	2	1	91	91	0.296	0.068			
1	2	1	92	93	0.314	0.066			
1	2	1	94	94	0.264	0.052			
1	2	1	95	95	0.216	0.040			
1	2	1	96	98	0.192	0.033	0.052	3.38	
1	2	1	99	99	0.122	0.024	0.045	4.10	
1	2	1	00	00	0.087	0.020	0.042	4.46	
1	2	1	01	03	0.073	0.018	0.040	4.59	
1	2	1	04	50	0.065	0.016	0.038	4.65	
1	3	1	65	69	9.885	0.186			LDGT2
1	3	1	70	73	6.486	0.258			
1	3	1	74	78	6.486	0.176			
1	3	1	79	80	0.887	0.286			
1	3	1	81	82	1.317	0.182			
1	3	1	83	83	1.339	0.186			
1	3	1	84	84	0.452	0.110			
1	3	1	85	85	0.450	0.113			
1	3	1	86	86	0.428	0.119			
1	3	1	87	87	0.405	0.123			
1	3	1	88	88	0.346	0.080			
1	3	1	89	89	0.342	0.076			
1	3	1	90	90	0.337	0.075			
1	3	1	91	91	0.296	0.068			
1	3	1	92	92	0.314	0.066			
1	3	1	93	95	0.313	0.065			

1	3	1	96	96	0.265	0.052			
1	3	1	97	00	0.216	0.040	0.055	3.38	
1	3	1	01	03	0.214	0.039	0.054	3.38	
1	3	1	04	04	0.100	0.024	0.044	5.13	
1	3	1	05	05	0.105	0.025	0.045	5.08	
1	3	1	06	06	0.098	0.024	0.044	5.15	
1	3	1	07	07	0.090	0.023	0.043	5.23	
1	3	1	08	08	0.078	0.021	0.041	5.36	
1	3	1	09	50	0.065	0.019	0.039	5.50	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.820	0.037			
1	4	1	04	06	0.304	0.020			
1	4	1	07	50	0.241	0.015			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	97	0.281	0.027			
1	6	1	98	98	0.281	0.027			
1	6	1	99	99	0.281	0.027			
1	6	1	00	00	0.281	0.027			
1	6	1	01	03	0.281	0.027			
1	6	1	04	04	0.122	0.012			
1	6	1	05	05	0.111	0.011			
1	6	1	06	06	0.100	0.010			
1	6	1	07	07	0.089	0.009			
1	6	1	08	08	0.070	0.007			
1	6	1	09	50	0.052	0.005			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

```
TOG BERs - I/M Non-OTR Baseline Case
0109               ZM    DR1    DR2 Flex Pt  File: NTR_IM_B.BER
1 1 1 65 67  7.488  0.186                          LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.491  0.165
1 1 1 75 75  1.068  0.282
1 1 1 76 77  1.071  0.283
1 1 1 78 79  1.074  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 81  0.464  0.120  0.005  14.63
1 1 1 82 82  0.460  0.119  0.006  14.63
1 1 1 83 83  0.336  0.064
1 1 1 84 84  0.346  0.061
1 1 1 85 85  0.350  0.057
1 1 1 86 86  0.358  0.046
1 1 1 87 87  0.360  0.045
1 1 1 88 88  0.228  0.036
1 1 1 89 89  0.231  0.037
1 1 1 90 90  0.228  0.036
1 1 1 91 91  0.224  0.035
1 1 1 92 92  0.226  0.035
1 1 1 93 93  0.224  0.035
1 1 1 94 94  0.197  0.031
1 1 1 95 95  0.169  0.028
1 1 1 96 00  0.156  0.026  0.024   9.05
1 1 1 01 50  0.064  0.014  0.016  14.64
1 2 1 65 67  7.488  0.186                          LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.470  0.176
1 2 1 75 75  1.802  0.270
1 2 1 76 76  1.813  0.272
1 2 1 77 78  1.807  0.271
1 2 1 79 80  0.876  0.282
1 2 1 81 81  1.406  0.086
1 2 1 82 82  1.406  0.086
1 2 1 83 83  1.423  0.087
1 2 1 84 84  0.495  0.061
1 2 1 85 85  0.485  0.061
1 2 1 86 86  0.456  0.062
1 2 1 87 87  0.446  0.066
1 2 1 88 88  0.334  0.049
1 2 1 89 89  0.333  0.047
1 2 1 90 90  0.319  0.045
1 2 1 91 91  0.293  0.044
1 2 1 92 92  0.313  0.042
1 2 1 93 93  0.312  0.042
1 2 1 94 94  0.264  0.037
1 2 1 95 95  0.216  0.033
1 2 1 96 00  0.192  0.031  0.027  11.84
1 2 1 01 50  0.073  0.015  0.017  17.20
1 3 1 65 69  9.885  0.186                          LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.887  0.286
1 3 1 81 81  1.404  0.086
1 3 1 82 82  1.404  0.086
1 3 1 83 83  1.427  0.088
1 3 1 84 84  0.501  0.061
1 3 1 85 85  0.502  0.063
1 3 1 86 86  0.487  0.067
1 3 1 87 87  0.470  0.069
1 3 1 88 88  0.349  0.051
1 3 1 89 89  0.344  0.048
1 3 1 90 90  0.336  0.048
1 3 1 91 91  0.293  0.044
1 3 1 92 95  0.313  0.042
```

1	3	1	96	96	0.264	0.038			
1	3	1	97	00	0.216	0.034	0.029	13.93	
1	3	1	01	50	0.214	0.034	0.028	13.93	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.862	0.039			
1	4	1	04	06	0.255	0.016			
1	4	1	07	50	0.192	0.011			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	97	0.281	0.027			
1	6	1	98	98	0.281	0.027			
1	6	1	99	99	0.281	0.027			
1	6	1	00	00	0.281	0.027			
1	6	1	01	50	0.281	0.027			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

TOG BERs - I/M Non-OTR Control (Tier 2) Case

0121					ZM	DR1	DR2	Flex Pt	File: NTR_IM_C.BER
1	1	1	65	67	7.488	0.186			LDGV
1	1	1	68	69	4.576	0.258			
1	1	1	70	71	3.099	0.382			
1	1	1	72	74	3.491	0.165			
1	1	1	75	75	1.068	0.282			
1	1	1	76	77	1.071	0.283			
1	1	1	78	79	1.074	0.284			
1	1	1	80	80	0.371	0.211			
1	1	1	81	81	0.464	0.120	0.005	14.63	
1	1	1	82	82	0.460	0.119	0.006	14.63	
1	1	1	83	83	0.336	0.064			
1	1	1	84	84	0.346	0.061			
1	1	1	85	85	0.350	0.057			
1	1	1	86	86	0.358	0.046			
1	1	1	87	87	0.360	0.045			
1	1	1	88	88	0.228	0.036			
1	1	1	89	89	0.231	0.037			
1	1	1	90	90	0.228	0.036			
1	1	1	91	91	0.224	0.035			
1	1	1	92	92	0.226	0.035			
1	1	1	93	93	0.224	0.035			
1	1	1	94	94	0.197	0.031			
1	1	1	95	95	0.169	0.028			
1	1	1	96	00	0.156	0.026	0.024	9.05	
1	1	1	01	50	0.064	0.014	0.016	14.64	
1	2	1	65	67	7.488	0.186			LDGT1
1	2	1	68	69	4.576	0.258			
1	2	1	70	71	3.099	0.382			
1	2	1	72	74	3.470	0.176			
1	2	1	75	75	1.802	0.270			
1	2	1	76	76	1.813	0.272			
1	2	1	77	78	1.807	0.271			
1	2	1	79	80	0.876	0.282			
1	2	1	81	82	1.406	0.086			
1	2	1	83	83	1.423	0.087			
1	2	1	84	84	0.495	0.061			
1	2	1	85	85	0.485	0.061			
1	2	1	86	86	0.456	0.062			
1	2	1	87	87	0.446	0.066			
1	2	1	88	88	0.334	0.049			
1	2	1	89	89	0.333	0.047			
1	2	1	90	90	0.319	0.045			
1	2	1	91	91	0.293	0.044			
1	2	1	92	92	0.313	0.042			
1	2	1	93	93	0.312	0.042			
1	2	1	94	94	0.264	0.037			
1	2	1	95	95	0.216	0.033			
1	2	1	96	00	0.192	0.031	0.027	11.84	
1	2	1	01	03	0.073	0.015	0.017	17.20	
1	2	1	04	50	0.065	0.014	0.016	16.61	
1	3	1	65	69	9.885	0.186			LDGT2
1	3	1	70	73	6.486	0.258			
1	3	1	74	78	6.486	0.176			
1	3	1	79	80	0.887	0.286			
1	3	1	81	81	1.404	0.086			
1	3	1	82	82	1.404	0.086			
1	3	1	83	83	1.427	0.088			
1	3	1	84	84	0.501	0.061			
1	3	1	85	85	0.502	0.063			
1	3	1	86	86	0.487	0.067			
1	3	1	87	87	0.470	0.069			
1	3	1	88	88	0.349	0.051			
1	3	1	89	89	0.344	0.048			
1	3	1	90	90	0.336	0.048			
1	3	1	91	91	0.293	0.044			
1	3	1	92	95	0.313	0.042			

1	3	1	96	96	0.264	0.038			
1	3	1	97	00	0.216	0.034	0.029	13.93	
1	3	1	01	03	0.214	0.034	0.028	13.93	
1	3	1	04	04	0.100	0.019	0.020	13.05	
1	3	1	05	05	0.105	0.020	0.020	12.59	
1	3	1	06	06	0.098	0.019	0.020	13.59	
1	3	1	07	07	0.090	0.018	0.019	14.45	
1	3	1	08	08	0.078	0.016	0.018	16.33	
1	3	1	09	50	0.065	0.014	0.017	17.99	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.862	0.039			
1	4	1	04	06	0.255	0.016			
1	4	1	07	50	0.192	0.011			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	97	0.281	0.027			
1	6	1	98	98	0.281	0.027			
1	6	1	99	99	0.281	0.027			
1	6	1	00	00	0.281	0.027			
1	6	1	01	03	0.281	0.027			
1	6	1	04	04	0.122	0.012			
1	6	1	05	05	0.111	0.011			
1	6	1	06	06	0.100	0.010			
1	6	1	07	07	0.089	0.009			
1	6	1	08	08	0.070	0.007			
1	6	1	09	50	0.052	0.005			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

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TOG BERs - I/M Non-OTR Control (Tier 2) Case
0121           ZM    DR1    DR2 Flex Pt  File: NTR_IM_C.BER
1 1 1 65 67  7.488  0.186                      LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.491  0.165
1 1 1 75 75  1.068  0.282
1 1 1 76 77  1.071  0.283
1 1 1 78 79  1.074  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 81  0.464  0.120  0.005  14.63
1 1 1 82 82  0.460  0.119  0.006  14.63
1 1 1 83 83  0.336  0.064
1 1 1 84 84  0.346  0.061
1 1 1 85 85  0.350  0.057
1 1 1 86 86  0.358  0.046
1 1 1 87 87  0.360  0.045
1 1 1 88 88  0.228  0.036
1 1 1 89 89  0.231  0.037
1 1 1 90 90  0.228  0.036
1 1 1 91 91  0.224  0.035
1 1 1 92 92  0.226  0.035
1 1 1 93 93  0.224  0.035
1 1 1 94 94  0.197  0.031
1 1 1 95 95  0.169  0.028
1 1 1 96 00  0.156  0.026  0.024   9.05
1 1 1 01 50  0.064  0.014  0.016  14.64
1 2 1 65 67  7.488  0.186                      LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.470  0.176
1 2 1 75 75  1.802  0.270
1 2 1 76 76  1.813  0.272
1 2 1 77 78  1.807  0.271
1 2 1 79 80  0.876  0.282
1 2 1 81 82  1.406  0.086
1 2 1 83 83  1.423  0.087
1 2 1 84 84  0.495  0.061
1 2 1 85 85  0.485  0.061
1 2 1 86 86  0.456  0.062
1 2 1 87 87  0.446  0.066
1 2 1 88 88  0.334  0.049
1 2 1 89 89  0.333  0.047
1 2 1 90 90  0.319  0.045
1 2 1 91 91  0.293  0.044
1 2 1 92 92  0.313  0.042
1 2 1 93 93  0.312  0.042
1 2 1 94 94  0.264  0.037
1 2 1 95 95  0.216  0.033
1 2 1 96 00  0.192  0.031  0.027  11.84
1 2 1 01 03  0.073  0.015  0.017  17.20
1 2 1 04 50  0.065  0.014  0.016  16.61
1 3 1 65 69  9.885  0.186                      LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.887  0.286
1 3 1 81 81  1.404  0.086
1 3 1 82 82  1.404  0.086
1 3 1 83 83  1.427  0.088
1 3 1 84 84  0.501  0.061
1 3 1 85 85  0.502  0.063
1 3 1 86 86  0.487  0.067
1 3 1 87 87  0.470  0.069
1 3 1 88 88  0.349  0.051
1 3 1 89 89  0.344  0.048
1 3 1 90 90  0.336  0.048
1 3 1 91 91  0.293  0.044
1 3 1 92 95  0.313  0.042
```

1	3	1	96	96	0.264	0.038			
1	3	1	97	00	0.216	0.034	0.029	13.93	
1	3	1	01	03	0.214	0.034	0.028	13.93	
1	3	1	04	04	0.100	0.019	0.020	13.05	
1	3	1	05	05	0.105	0.020	0.020	12.59	
1	3	1	06	06	0.098	0.019	0.020	13.59	
1	3	1	07	07	0.090	0.018	0.019	14.45	
1	3	1	08	08	0.078	0.016	0.018	16.33	
1	3	1	09	50	0.065	0.014	0.017	17.99	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.862	0.039			
1	4	1	04	06	0.255	0.016			
1	4	1	07	50	0.192	0.011			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	97	0.281	0.027			
1	6	1	98	98	0.281	0.027			
1	6	1	99	99	0.281	0.027			
1	6	1	00	00	0.281	0.027			
1	6	1	01	03	0.281	0.027			
1	6	1	04	04	0.122	0.012			
1	6	1	05	05	0.111	0.011			
1	6	1	06	06	0.100	0.010			
1	6	1	07	07	0.089	0.009			
1	6	1	08	08	0.070	0.007			
1	6	1	09	50	0.052	0.005			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

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TOG BERs - I/M Non-OTR Control (Tier 2) Case + Inc. Diesel Penetration
0121            ZM    DR1    DR2 Flex Pt  File: NTR_IM_D.BER
1 1 1 65 67  7.488  0.186                       LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.491  0.165
1 1 1 75 75  1.068  0.282
1 1 1 76 77  1.071  0.283
1 1 1 78 79  1.074  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 81  0.464  0.120  0.005  14.63
1 1 1 82 82  0.460  0.119  0.006  14.63
1 1 1 83 83  0.336  0.064
1 1 1 84 84  0.346  0.061
1 1 1 85 85  0.350  0.057
1 1 1 86 86  0.358  0.046
1 1 1 87 87  0.360  0.045
1 1 1 88 88  0.228  0.036
1 1 1 89 89  0.231  0.037
1 1 1 90 90  0.228  0.036
1 1 1 91 91  0.224  0.035
1 1 1 92 92  0.226  0.035
1 1 1 93 93  0.224  0.035
1 1 1 94 94  0.197  0.031
1 1 1 95 95  0.169  0.028
1 1 1 96 00  0.156  0.026  0.024   9.05
1 1 1 01 50  0.064  0.014  0.016  14.64
1 2 1 65 67  7.488  0.186                       LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.470  0.176
1 2 1 75 75  1.802  0.270
1 2 1 76 76  1.813  0.272
1 2 1 77 78  1.807  0.271
1 2 1 79 80  0.876  0.282
1 2 1 81 82  1.406  0.086
1 2 1 83 83  1.423  0.087
1 2 1 84 84  0.495  0.061
1 2 1 85 85  0.485  0.061
1 2 1 86 86  0.456  0.062
1 2 1 87 87  0.446  0.066
1 2 1 88 88  0.334  0.049
1 2 1 89 89  0.333  0.047
1 2 1 90 90  0.319  0.045
1 2 1 91 91  0.293  0.044
1 2 1 92 92  0.313  0.042
1 2 1 93 93  0.312  0.042
1 2 1 94 94  0.264  0.037
1 2 1 95 95  0.216  0.033
1 2 1 96 00  0.192  0.031  0.027  11.84
1 2 1 01 03  0.073  0.015  0.017  17.20
1 2 1 04 50  0.065  0.014  0.016  16.61
1 3 1 65 69  9.885  0.186                       LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.887  0.286
1 3 1 81 81  1.404  0.086
1 3 1 82 82  1.404  0.086
1 3 1 83 83  1.427  0.088
1 3 1 84 84  0.501  0.061
1 3 1 85 85  0.502  0.063
1 3 1 86 86  0.487  0.067
1 3 1 87 87  0.470  0.069
1 3 1 88 88  0.349  0.051
1 3 1 89 89  0.344  0.048
1 3 1 90 90  0.336  0.048
1 3 1 91 91  0.293  0.044
1 3 1 92 95  0.313  0.042
```

1	3	1	96	96	0.264	0.038			
1	3	1	97	00	0.216	0.034	0.029	13.93	
1	3	1	01	03	0.214	0.034	0.028	13.93	
1	3	1	04	04	0.100	0.019	0.020	13.05	
1	3	1	05	05	0.105	0.020	0.020	12.59	
1	3	1	06	06	0.098	0.019	0.020	13.59	
1	3	1	07	07	0.090	0.018	0.019	14.45	
1	3	1	08	08	0.078	0.016	0.018	16.33	
1	3	1	09	50	0.065	0.014	0.017	17.99	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.862	0.039			
1	4	1	04	06	0.255	0.016			
1	4	1	07	50	0.192	0.011			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	97	0.281	0.027			
1	6	1	98	98	0.281	0.027			
1	6	1	99	99	0.281	0.027			
1	6	1	00	00	0.281	0.027			
1	6	1	01	03	0.281	0.027			
1	6	1	04	04	0.112	0.011			
1	6	1	05	05	0.102	0.010			
1	6	1	06	06	0.083	0.008			
1	6	1	07	07	0.071	0.007			
1	6	1	08	08	0.060	0.006			
1	6	1	09	50	0.052	0.005			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

TOG BERs - I/M Non-OTR 0.055 NMHC Case

0122					ZM	DR1	DR2	Flex Pt	File: NTR_IM_5.BER
1	1	1	65	67	7.488	0.186			LDGV
1	1	1	68	69	4.576	0.258			
1	1	1	70	71	3.099	0.382			
1	1	1	72	74	3.491	0.165			
1	1	1	75	77	1.071	0.283			
1	1	1	78	79	1.074	0.284			
1	1	1	80	80	0.371	0.211			
1	1	1	81	81	0.464	0.120	0.005	14.63	
1	1	1	82	82	0.460	0.119	0.006	14.63	
1	1	1	83	83	0.336	0.064			
1	1	1	84	84	0.346	0.061			
1	1	1	85	85	0.350	0.057			
1	1	1	86	86	0.358	0.046			
1	1	1	87	87	0.360	0.045			
1	1	1	88	88	0.228	0.036			
1	1	1	89	89	0.231	0.037			
1	1	1	90	90	0.228	0.036			
1	1	1	91	91	0.224	0.035			
1	1	1	92	92	0.226	0.035			
1	1	1	93	93	0.224	0.035			
1	1	1	94	94	0.197	0.031			
1	1	1	95	95	0.169	0.028			
1	1	1	96	00	0.156	0.026	0.024	9.05	
1	1	1	01	03	0.064	0.014	0.016	14.64	
1	1	1	04	50	0.028	0.009	0.013	13.20	
1	2	1	65	67	7.488	0.186			LDGT1
1	2	1	68	69	4.576	0.258			
1	2	1	70	71	3.099	0.382			
1	2	1	72	74	3.470	0.176			
1	2	1	75	75	1.802	0.270			
1	2	1	76	76	1.813	0.272			
1	2	1	77	78	1.807	0.271			
1	2	1	79	80	0.876	0.282			
1	2	1	81	82	1.406	0.086			
1	2	1	83	83	1.423	0.087			
1	2	1	84	84	0.495	0.061			
1	2	1	85	85	0.485	0.061			
1	2	1	86	86	0.456	0.062			
1	2	1	87	87	0.446	0.066			
1	2	1	88	88	0.334	0.049			
1	2	1	89	89	0.333	0.047			
1	2	1	90	90	0.319	0.045			
1	2	1	91	91	0.293	0.044			
1	2	1	92	92	0.313	0.042			
1	2	1	93	93	0.312	0.042			
1	2	1	94	94	0.264	0.037			
1	2	1	95	95	0.216	0.033			
1	2	1	96	00	0.192	0.031	0.027	11.84	
1	2	1	01	03	0.073	0.015	0.017	17.20	
1	2	1	04	50	0.028	0.009	0.013	15.20	
1	3	1	65	69	9.885	0.186			LDGT2
1	3	1	70	73	6.486	0.258			
1	3	1	74	78	6.486	0.176			
1	3	1	79	80	0.887	0.286			
1	3	1	81	81	1.404	0.086			
1	3	1	82	82	1.404	0.086			
1	3	1	83	83	1.427	0.088			
1	3	1	84	84	0.501	0.061			
1	3	1	85	85	0.502	0.063			
1	3	1	86	86	0.487	0.067			
1	3	1	87	87	0.470	0.069			
1	3	1	88	88	0.349	0.051			
1	3	1	89	89	0.344	0.048			
1	3	1	90	90	0.336	0.048			
1	3	1	91	91	0.293	0.044			
1	3	1	92	95	0.313	0.042			

1	3	1	96	96	0.264	0.038			
1	3	1	97	00	0.216	0.034	0.029	13.93	
1	3	1	01	03	0.214	0.034	0.028	13.93	
1	3	1	04	04	0.028	0.009	0.014	16.78	
1	3	1	05	05	0.028	0.009	0.014	16.78	
1	3	1	06	06	0.028	0.009	0.014	16.78	
1	3	1	07	07	0.028	0.009	0.014	16.78	
1	3	1	08	08	0.028	0.009	0.014	16.78	
1	3	1	09	50	0.028	0.009	0.014	16.78	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.862	0.039			
1	4	1	04	06	0.255	0.016			
1	4	1	07	50	0.192	0.011			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	03	0.057	0.006			
1	5	1	04	50	0.027	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	97	0.281	0.027			
1	6	1	98	98	0.281	0.027			
1	6	1	99	99	0.281	0.027			
1	6	1	00	00	0.281	0.027			
1	6	1	01	03	0.281	0.027			
1	6	1	04	04	0.027	0.006			
1	6	1	05	05	0.027	0.006			
1	6	1	06	06	0.027	0.006			
1	6	1	07	07	0.027	0.006			
1	6	1	08	08	0.027	0.006			
1	6	1	09	50	0.027	0.006			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

```
TOG BERs - I/M Non-OTR Control (Tier 2) + HDGV Case
0121            ZM    DR1    DR2 Flex Pt  File: NTR_IM_H.BER
1 1 1 65 67  7.488  0.186                         LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.491  0.165
1 1 1 75 75  1.068  0.282
1 1 1 76 77  1.071  0.283
1 1 1 78 79  1.074  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 81  0.464  0.120  0.005  14.63
1 1 1 82 82  0.460  0.119  0.006  14.63
1 1 1 83 83  0.336  0.064
1 1 1 84 84  0.346  0.061
1 1 1 85 85  0.350  0.057
1 1 1 86 86  0.358  0.046
1 1 1 87 87  0.360  0.045
1 1 1 88 88  0.228  0.036
1 1 1 89 89  0.231  0.037
1 1 1 90 90  0.228  0.036
1 1 1 91 91  0.224  0.035
1 1 1 92 92  0.226  0.035
1 1 1 93 93  0.224  0.035
1 1 1 94 94  0.197  0.031
1 1 1 95 95  0.169  0.028
1 1 1 96 00  0.156  0.026  0.024   9.05
1 1 1 01 50  0.064  0.014  0.016  14.64
1 2 1 65 67  7.488  0.186                         LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.470  0.176
1 2 1 75 75  1.802  0.270
1 2 1 76 76  1.813  0.272
1 2 1 77 78  1.807  0.271
1 2 1 79 80  0.876  0.282
1 2 1 81 82  1.406  0.086
1 2 1 83 83  1.423  0.087
1 2 1 84 84  0.495  0.061
1 2 1 85 85  0.485  0.061
1 2 1 86 86  0.456  0.062
1 2 1 87 87  0.446  0.066
1 2 1 88 88  0.334  0.049
1 2 1 89 89  0.333  0.047
1 2 1 90 90  0.319  0.045
1 2 1 91 91  0.293  0.044
1 2 1 92 92  0.313  0.042
1 2 1 93 93  0.312  0.042
1 2 1 94 94  0.264  0.037
1 2 1 95 95  0.216  0.033
1 2 1 96 00  0.192  0.031  0.027  11.84
1 2 1 01 03  0.073  0.015  0.017  17.20
1 2 1 04 50  0.065  0.014  0.016  16.61
1 3 1 65 69  9.885  0.186                         LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.887  0.286
1 3 1 81 81  1.404  0.086
1 3 1 82 82  1.404  0.086
1 3 1 83 83  1.427  0.088
1 3 1 84 84  0.501  0.061
1 3 1 85 85  0.502  0.063
1 3 1 86 86  0.487  0.067
1 3 1 87 87  0.470  0.069
1 3 1 88 88  0.349  0.051
1 3 1 89 89  0.344  0.048
1 3 1 90 90  0.336  0.048
1 3 1 91 91  0.293  0.044
1 3 1 92 95  0.313  0.042
```

1	3	1	96	96	0.264	0.038			
1	3	1	97	00	0.216	0.034	0.029	13.93	
1	3	1	01	03	0.214	0.034	0.028	13.93	
1	3	1	04	04	0.100	0.019	0.020	13.05	
1	3	1	05	05	0.105	0.020	0.020	12.59	
1	3	1	06	06	0.098	0.019	0.020	13.59	
1	3	1	07	07	0.090	0.018	0.019	14.45	
1	3	1	08	08	0.078	0.016	0.018	16.33	
1	3	1	09	50	0.065	0.014	0.017	17.99	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.820	0.037			
1	4	1	04	06	0.211	0.015			
1	4	1	07	50	0.159	0.010			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	97	0.281	0.027			
1	6	1	98	98	0.281	0.027			
1	6	1	99	99	0.281	0.027			
1	6	1	00	00	0.281	0.027			
1	6	1	01	03	0.281	0.027			
1	6	1	04	04	0.122	0.012			
1	6	1	05	05	0.111	0.011			
1	6	1	06	06	0.100	0.010			
1	6	1	07	07	0.089	0.009			
1	6	1	08	08	0.070	0.007			
1	6	1	09	50	0.052	0.005			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

TOG BERs - Non-I/M Non-OTR Baseline Case

0108					ZM	DR1	DR2	Flex Pt	File: NTR_NO_B.BER
1	1	1	65	67	7.488	0.186			LDGV
1	1	1	68	69	4.576	0.258			
1	1	1	70	71	3.099	0.382			
1	1	1	72	74	3.491	0.165			
1	1	1	75	75	1.068	0.282			
1	1	1	76	77	1.071	0.283			
1	1	1	78	79	1.074	0.284			
1	1	1	80	80	0.371	0.211			
1	1	1	81	81	0.401	0.223	0.005	14.63	
1	1	1	82	82	0.400	0.221	0.005	14.63	
1	1	1	83	83	0.232	0.116			
1	1	1	84	84	0.257	0.110			
1	1	1	85	85	0.278	0.102			
1	1	1	86	86	0.334	0.082			
1	1	1	87	87	0.338	0.080			
1	1	1	88	88	0.223	0.057			
1	1	1	89	89	0.222	0.058			
1	1	1	90	90	0.219	0.056			
1	1	1	91	91	0.216	0.055			
1	1	1	92	92	0.214	0.055			
1	1	1	93	93	0.213	0.055			
1	1	1	94	94	0.190	0.042			
1	1	1	95	95	0.167	0.028			
1	1	1	96	00	0.156	0.022	0.047	3.13	
1	1	1	01	50	0.064	0.010	0.038	3.72	
1	2	1	65	67	7.488	0.186			LDGT1
1	2	1	68	69	4.576	0.258			
1	2	1	70	71	3.099	0.382			
1	2	1	72	74	3.470	0.176			
1	2	1	75	75	1.802	0.270			
1	2	1	76	76	1.813	0.272			
1	2	1	77	78	1.807	0.271			
1	2	1	79	80	0.876	0.282			
1	2	1	81	81	1.319	0.183			
1	2	1	82	82	1.319	0.183			
1	2	1	83	83	1.335	0.185			
1	2	1	84	84	0.446	0.109			
1	2	1	85	85	0.434	0.109			
1	2	1	86	86	0.401	0.111			
1	2	1	87	87	0.384	0.117			
1	2	1	88	88	0.331	0.077			
1	2	1	89	89	0.331	0.073			
1	2	1	90	90	0.320	0.071			
1	2	1	91	91	0.296	0.068			
1	2	1	92	92	0.314	0.066			
1	2	1	93	93	0.313	0.065			
1	2	1	94	94	0.264	0.052			
1	2	1	95	95	0.216	0.040			
1	2	1	96	00	0.192	0.033	0.052	3.38	
1	2	1	01	50	0.073	0.018	0.040	4.59	
1	3	1	65	69	9.885	0.186			LDGT2
1	3	1	70	73	6.486	0.258			
1	3	1	74	78	6.486	0.176			
1	3	1	79	80	0.887	0.286			
1	3	1	81	81	1.317	0.182			
1	3	1	82	82	1.317	0.182			
1	3	1	83	83	1.339	0.186			
1	3	1	84	84	0.452	0.110			
1	3	1	85	85	0.450	0.113			
1	3	1	86	86	0.428	0.119			
1	3	1	87	87	0.405	0.123			
1	3	1	88	88	0.346	0.080			
1	3	1	89	89	0.342	0.076			
1	3	1	90	90	0.337	0.075			
1	3	1	91	91	0.296	0.068			
1	3	1	92	92	0.314	0.066			

1	3	1	93	93	0.313	0.065			
1	3	1	94	94	0.313	0.065			
1	3	1	95	95	0.313	0.065			
1	3	1	96	96	0.265	0.052			
1	3	1	97	00	0.216	0.040	0.055	3.38	
1	3	1	01	50	0.214	0.039	0.054	3.38	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.863	0.039			
1	4	1	04	06	0.350	0.023			
1	4	1	07	50	0.275	0.016			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	50	0.281	0.027			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

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TOG BERs - Non-I/M Non-OTR Control (Tier 2) Case
0117             ZM    DR1    DR2 Flex Pt  File: NTR_NO_C.BER
1 1 1 65 67  7.488  0.186                        LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.491  0.165
1 1 1 75 75  1.068  0.282
1 1 1 76 77  1.071  0.283
1 1 1 78 79  1.074  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 81  0.401  0.223  0.005  14.63
1 1 1 82 82  0.400  0.221  0.005  14.63
1 1 1 83 83  0.232  0.116
1 1 1 84 84  0.257  0.110
1 1 1 85 85  0.278  0.102
1 1 1 86 86  0.334  0.082
1 1 1 87 87  0.338  0.080
1 1 1 88 88  0.223  0.057
1 1 1 89 89  0.222  0.058
1 1 1 90 90  0.219  0.056
1 1 1 91 91  0.216  0.055
1 1 1 92 92  0.214  0.055
1 1 1 93 93  0.213  0.055
1 1 1 94 94  0.190  0.042
1 1 1 95 95  0.167  0.028
1 1 1 96 00  0.156  0.022  0.047   3.13
1 1 1 01 50  0.064  0.010  0.038   3.72
1 2 1 65 67  7.488  0.186                        LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.470  0.176
1 2 1 75 75  1.802  0.270
1 2 1 76 76  1.813  0.272
1 2 1 77 78  1.807  0.271
1 2 1 79 80  0.876  0.282
1 2 1 81 82  1.319  0.183
1 2 1 83 83  1.335  0.185
1 2 1 84 84  0.446  0.109
1 2 1 85 85  0.434  0.109
1 2 1 86 86  0.401  0.111
1 2 1 87 87  0.384  0.117
1 2 1 88 88  0.331  0.077
1 2 1 89 89  0.331  0.073
1 2 1 90 90  0.320  0.071
1 2 1 91 91  0.296  0.068
1 2 1 92 92  0.314  0.066
1 2 1 93 93  0.313  0.065
1 2 1 94 94  0.264  0.052
1 2 1 95 95  0.216  0.040
1 2 1 96 00  0.192  0.033  0.052   3.38
1 2 1 01 03  0.073  0.018  0.040   4.59
1 2 1 04 50  0.065  0.016  0.038   4.65
1 3 1 65 69  9.885  0.186                        LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.887  0.286
1 3 1 81 82  1.317  0.182
1 3 1 83 83  1.339  0.186
1 3 1 84 84  0.452  0.110
1 3 1 85 85  0.450  0.113
1 3 1 86 86  0.428  0.119
1 3 1 87 87  0.405  0.123
1 3 1 88 88  0.346  0.080
1 3 1 89 89  0.342  0.076
1 3 1 90 90  0.337  0.075
1 3 1 91 91  0.296  0.068
1 3 1 92 92  0.314  0.066
1 3 1 93 95  0.313  0.065
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1	3	1	96	96	0.265	0.052			
1	3	1	97	00	0.216	0.040	0.055	3.38	
1	3	1	01	03	0.214	0.039	0.054	3.38	
1	3	1	04	04	0.100	0.024	0.044	5.13	
1	3	1	05	05	0.105	0.025	0.045	5.08	
1	3	1	06	06	0.098	0.024	0.044	5.15	
1	3	1	07	07	0.090	0.023	0.043	5.23	
1	3	1	08	08	0.078	0.021	0.041	5.36	
1	3	1	09	50	0.065	0.019	0.039	5.50	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.863	0.039			
1	4	1	04	06	0.350	0.023			
1	4	1	07	50	0.275	0.016			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	03	0.281	0.027			
1	6	1	04	04	0.122	0.012			
1	6	1	05	05	0.111	0.011			
1	6	1	06	06	0.100	0.010			
1	6	1	07	07	0.089	0.009			
1	6	1	08	08	0.070	0.007			
1	6	1	09	50	0.052	0.005			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

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TOG BERs - Non-I/M Non-OTR Control (Tier 2) Case + Inc. LD Diesels
0117           ZM    DR1    DR2 Flex Pt  File: NTR_NO_D.BER
1 1 1 65 67  7.488  0.186                      LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.491  0.165
1 1 1 75 75  1.068  0.282
1 1 1 76 77  1.071  0.283
1 1 1 78 79  1.074  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 81  0.401  0.223  0.005  14.63
1 1 1 82 82  0.400  0.221  0.005  14.63
1 1 1 83 83  0.232  0.116
1 1 1 84 84  0.257  0.110
1 1 1 85 85  0.278  0.102
1 1 1 86 86  0.334  0.082
1 1 1 87 87  0.338  0.080
1 1 1 88 88  0.223  0.057
1 1 1 89 89  0.222  0.058
1 1 1 90 90  0.219  0.056
1 1 1 91 91  0.216  0.055
1 1 1 92 92  0.214  0.055
1 1 1 93 93  0.213  0.055
1 1 1 94 94  0.190  0.042
1 1 1 95 95  0.167  0.028
1 1 1 96 00  0.156  0.022  0.047   3.13
1 1 1 01 50  0.064  0.010  0.038   3.72
1 2 1 65 67  7.488  0.186                      LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.470  0.176
1 2 1 75 75  1.802  0.270
1 2 1 76 76  1.813  0.272
1 2 1 77 78  1.807  0.271
1 2 1 79 80  0.876  0.282
1 2 1 81 82  1.319  0.183
1 2 1 83 83  1.335  0.185
1 2 1 84 84  0.446  0.109
1 2 1 85 85  0.434  0.109
1 2 1 86 86  0.401  0.111
1 2 1 87 87  0.384  0.117
1 2 1 88 88  0.331  0.077
1 2 1 89 89  0.331  0.073
1 2 1 90 90  0.320  0.071
1 2 1 91 91  0.296  0.068
1 2 1 92 92  0.314  0.066
1 2 1 93 93  0.313  0.065
1 2 1 94 94  0.264  0.052
1 2 1 95 95  0.216  0.040
1 2 1 96 00  0.192  0.033  0.052   3.38
1 2 1 01 03  0.073  0.018  0.040   4.59
1 2 1 04 50  0.065  0.016  0.038   4.65
1 3 1 65 69  9.885  0.186                      LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.887  0.286
1 3 1 81 82  1.317  0.182
1 3 1 83 83  1.339  0.186
1 3 1 84 84  0.452  0.110
1 3 1 85 85  0.450  0.113
1 3 1 86 86  0.428  0.119
1 3 1 87 87  0.405  0.123
1 3 1 88 88  0.346  0.080
1 3 1 89 89  0.342  0.076
1 3 1 90 90  0.337  0.075
1 3 1 91 91  0.296  0.068
1 3 1 92 92  0.314  0.066
1 3 1 93 95  0.313  0.065
```

1	3	1	96	96	0.265	0.052			
1	3	1	97	00	0.216	0.040	0.055	3.38	
1	3	1	01	03	0.214	0.039	0.054	3.38	
1	3	1	04	04	0.100	0.024	0.044	5.13	
1	3	1	05	05	0.105	0.025	0.045	5.08	
1	3	1	06	06	0.098	0.024	0.044	5.15	
1	3	1	07	07	0.090	0.023	0.043	5.23	
1	3	1	08	08	0.078	0.021	0.041	5.36	
1	3	1	09	50	0.065	0.019	0.039	5.50	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.863	0.039			
1	4	1	04	06	0.350	0.023			
1	4	1	07	50	0.275	0.016			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	03	0.281	0.027			
1	6	1	04	04	0.112	0.011			
1	6	1	05	05	0.102	0.010			
1	6	1	06	06	0.083	0.008			
1	6	1	07	07	0.071	0.007			
1	6	1	08	08	0.060	0.006			
1	6	1	09	50	0.052	0.005			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

```
TOG BERs - Non-I/M Non-OTR 0.055 NMHC Case
0118           ZM    DR1    DR2 Flex Pt  File: NTR_NO_5.BER
1 1 1 65 67  7.488  0.186                      LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.491  0.165
1 1 1 75 77  1.071  0.283
1 1 1 78 79  1.074  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 81  0.401  0.223  0.005  14.63
1 1 1 82 82  0.400  0.221  0.005  14.63
1 1 1 83 83  0.232  0.116
1 1 1 84 84  0.257  0.110
1 1 1 85 85  0.278  0.102
1 1 1 86 86  0.334  0.082
1 1 1 87 87  0.338  0.080
1 1 1 88 88  0.223  0.057
1 1 1 89 89  0.222  0.058
1 1 1 90 90  0.219  0.056
1 1 1 91 91  0.216  0.055
1 1 1 92 92  0.214  0.055
1 1 1 93 93  0.213  0.055
1 1 1 94 94  0.190  0.042
1 1 1 95 95  0.167  0.028
1 1 1 96 00  0.156  0.022  0.047   3.13
1 1 1 01 03  0.064  0.010  0.038   3.72
1 1 1 04 50  0.028  0.006  0.034   3.93
1 2 1 65 67  7.488  0.186                      LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.470  0.176
1 2 1 75 75  1.802  0.270
1 2 1 76 76  1.813  0.272
1 2 1 77 78  1.807  0.271
1 2 1 79 80  0.876  0.282
1 2 1 81 82  1.319  0.183
1 2 1 83 83  1.335  0.185
1 2 1 84 84  0.446  0.109
1 2 1 85 85  0.434  0.109
1 2 1 86 86  0.401  0.111
1 2 1 87 87  0.384  0.117
1 2 1 88 88  0.331  0.077
1 2 1 89 89  0.331  0.073
1 2 1 90 90  0.320  0.071
1 2 1 91 91  0.296  0.068
1 2 1 92 92  0.314  0.066
1 2 1 93 93  0.313  0.065
1 2 1 94 94  0.264  0.052
1 2 1 95 95  0.216  0.040
1 2 1 96 00  0.192  0.033  0.052   3.38
1 2 1 01 03  0.073  0.018  0.040   4.59
1 2 1 04 50  0.028  0.012  0.034   4.94
1 3 1 65 69  9.885  0.186                      LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.887  0.286
1 3 1 81 82  1.317  0.182
1 3 1 83 83  1.339  0.186
1 3 1 84 84  0.452  0.110
1 3 1 85 85  0.450  0.113
1 3 1 86 86  0.428  0.119
1 3 1 87 87  0.405  0.123
1 3 1 88 88  0.346  0.080
1 3 1 89 89  0.342  0.076
1 3 1 90 90  0.337  0.075
1 3 1 91 91  0.296  0.068
1 3 1 92 92  0.314  0.066
1 3 1 93 95  0.313  0.065
```

1	3	1	96	96	0.265	0.052			
1	3	1	97	00	0.216	0.040	0.055	3.38	
1	3	1	01	03	0.214	0.039	0.054	3.38	
1	3	1	04	04	0.028	0.014	0.035	5.86	
1	3	1	05	05	0.028	0.014	0.035	5.86	
1	3	1	06	06	0.028	0.014	0.035	5.86	
1	3	1	07	07	0.028	0.014	0.035	5.86	
1	3	1	08	08	0.028	0.014	0.035	5.86	
1	3	1	09	50	0.028	0.014	0.035	5.86	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.863	0.039			
1	4	1	04	06	0.350	0.023			
1	4	1	07	50	0.275	0.016			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	03	0.057	0.006			
1	5	1	04	50	0.027	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	03	0.281	0.027			
1	6	1	04	04	0.027	0.006			
1	6	1	05	05	0.027	0.006			
1	6	1	06	06	0.027	0.006			
1	6	1	07	07	0.027	0.006			
1	6	1	08	08	0.027	0.006			
1	6	1	09	50	0.027	0.006			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

```
TOG BERs - Non-I/M Non-OTR Control (Tier 2) + HDGV Case
0117            ZM    DR1    DR2 Flex Pt  File: NTR_NO_H.BER
1 1 1 65 67  7.488  0.186                       LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.491  0.165
1 1 1 75 75  1.068  0.282
1 1 1 76 77  1.071  0.283
1 1 1 78 79  1.074  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 81  0.401  0.223  0.005  14.63
1 1 1 82 82  0.400  0.221  0.005  14.63
1 1 1 83 83  0.232  0.116
1 1 1 84 84  0.257  0.110
1 1 1 85 85  0.278  0.102
1 1 1 86 86  0.334  0.082
1 1 1 87 87  0.338  0.080
1 1 1 88 88  0.223  0.057
1 1 1 89 89  0.222  0.058
1 1 1 90 90  0.219  0.056
1 1 1 91 91  0.216  0.055
1 1 1 92 92  0.214  0.055
1 1 1 93 93  0.213  0.055
1 1 1 94 94  0.190  0.042
1 1 1 95 95  0.167  0.028
1 1 1 96 00  0.156  0.022  0.047   3.13
1 1 1 01 50  0.064  0.010  0.038   3.72
1 2 1 65 67  7.488  0.186                       LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.470  0.176
1 2 1 75 75  1.802  0.270
1 2 1 76 76  1.813  0.272
1 2 1 77 78  1.807  0.271
1 2 1 79 80  0.876  0.282
1 2 1 81 82  1.319  0.183
1 2 1 83 83  1.335  0.185
1 2 1 84 84  0.446  0.109
1 2 1 85 85  0.434  0.109
1 2 1 86 86  0.401  0.111
1 2 1 87 87  0.384  0.117
1 2 1 88 88  0.331  0.077
1 2 1 89 89  0.331  0.073
1 2 1 90 90  0.320  0.071
1 2 1 91 91  0.296  0.068
1 2 1 92 92  0.314  0.066
1 2 1 93 93  0.313  0.065
1 2 1 94 94  0.264  0.052
1 2 1 95 95  0.216  0.040
1 2 1 96 00  0.192  0.033  0.052   3.38
1 2 1 01 03  0.073  0.018  0.040   4.59
1 2 1 04 50  0.065  0.016  0.038   4.65
1 3 1 65 69  9.885  0.186                       LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.887  0.286
1 3 1 81 82  1.317  0.182
1 3 1 83 83  1.339  0.186
1 3 1 84 84  0.452  0.110
1 3 1 85 85  0.450  0.113
1 3 1 86 86  0.428  0.119
1 3 1 87 87  0.405  0.123
1 3 1 88 88  0.346  0.080
1 3 1 89 89  0.342  0.076
1 3 1 90 90  0.337  0.075
1 3 1 91 91  0.296  0.068
1 3 1 92 92  0.314  0.066
1 3 1 93 95  0.313  0.065
```

1	3	1	96	96	0.265	0.052			
1	3	1	97	00	0.216	0.040	0.055	3.38	
1	3	1	01	03	0.214	0.039	0.054	3.38	
1	3	1	04	04	0.100	0.024	0.044	5.13	
1	3	1	05	05	0.105	0.025	0.045	5.08	
1	3	1	06	06	0.098	0.024	0.044	5.15	
1	3	1	07	07	0.090	0.023	0.043	5.23	
1	3	1	08	08	0.078	0.021	0.041	5.36	
1	3	1	09	50	0.065	0.019	0.039	5.50	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.820	0.037			
1	4	1	04	06	0.304	0.020			
1	4	1	07	50	0.241	0.015			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.189	0.020			
1	5	1	97	97	0.189	0.020			
1	5	1	98	98	0.189	0.020			
1	5	1	99	99	0.189	0.020			
1	5	1	00	00	0.189	0.020			
1	5	1	01	50	0.057	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	03	0.281	0.027			
1	6	1	04	04	0.122	0.012			
1	6	1	05	05	0.111	0.011			
1	6	1	06	06	0.100	0.010			
1	6	1	07	07	0.089	0.009			
1	6	1	08	08	0.070	0.007			
1	6	1	09	50	0.052	0.005			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

TOG BERs - I/M High Altitude Baseline Case

```
0112            ZM    DR1    DR2 Flex Pt  File: HAL_IM_B.BER
2 1 1 65 67  9.660  0.186                       LDGV
2 1 1 68 69  5.765  0.258
2 1 1 70 71  4.741  0.382
2 1 1 72 74  4.783  0.165
2 1 1 75 75  2.029  0.282
2 1 1 76 77  2.035  0.283
2 1 1 78 79  2.042  0.284
2 1 1 80 80  0.704  0.211
2 1 1 81 81  0.567  0.120  0.005  14.63
2 1 1 82 82  0.561  0.119  0.006  14.63
2 1 1 83 83  0.336  0.064
2 1 1 84 84  0.346  0.061
2 1 1 85 85  0.350  0.057
2 1 1 86 86  0.358  0.046
2 1 1 87 87  0.360  0.045
2 1 1 88 88  0.228  0.036
2 1 1 89 89  0.231  0.037
2 1 1 90 90  0.228  0.036
2 1 1 91 91  0.224  0.035
2 1 1 92 92  0.226  0.035
2 1 1 93 93  0.224  0.035
2 1 1 94 94  0.197  0.031
2 1 1 95 95  0.169  0.028
2 1 1 96 00  0.156  0.026  0.024   9.05
2 1 1 01 50  0.064  0.014  0.016  14.64
2 2 1 65 67  9.660  0.186                       LDGT1
2 2 1 68 69  5.765  0.258
2 2 1 70 71  4.741  0.382
2 2 1 72 74  4.720  0.176
2 2 1 75 75  3.423  0.270
2 2 1 76 76  3.445  0.272
2 2 1 77 78  3.434  0.271
2 2 1 79 80  1.665  0.282
2 2 1 81 81  2.671  0.086
2 2 1 82 82  2.671  0.086
2 2 1 83 83  1.850  0.087
2 2 1 84 84  0.743  0.061
2 2 1 85 85  0.606  0.061
2 2 1 86 86  0.570  0.062
2 2 1 87 87  0.558  0.066
2 2 1 88 88  0.417  0.049
2 2 1 89 89  0.416  0.047
2 2 1 90 90  0.399  0.045
2 2 1 91 91  0.366  0.044
2 2 1 92 92  0.392  0.042
2 2 1 93 93  0.390  0.042
2 2 1 94 94  0.310  0.037
2 2 1 95 95  0.231  0.033
2 2 1 96 00  0.192  0.031  0.027  11.84
2 2 1 01 50  0.073  0.015  0.017  17.20
2 3 1 65 69 12.751  0.186                       LDGT2
2 3 1 70 73  8.822  0.258
2 3 1 74 78  8.822  0.176
2 3 1 79 80  1.686  0.286
2 3 1 81 81  2.668  0.086
2 3 1 82 82  2.668  0.086
2 3 1 83 83  1.855  0.088
2 3 1 84 84  0.752  0.061
2 3 1 85 85  0.627  0.063
2 3 1 86 86  0.609  0.067
2 3 1 87 87  0.587  0.069
2 3 1 88 88  0.436  0.051
2 3 1 89 89  0.430  0.048
2 3 1 90 90  0.420  0.048
2 3 1 91 91  0.366  0.044
2 3 1 92 95  0.392  0.042
```

2	3	1	96	96	0.264	0.038			
2	3	1	97	00	0.216	0.034	0.029	13.93	
2	3	1	01	50	0.214	0.034	0.028	13.93	
2	4	1	80	80	7.284	0.203			HDGV
2	4	1	81	83	7.291	0.201			
2	4	1	84	84	7.423	0.205			
2	4	1	85	85	5.352	0.065			
2	4	1	86	86	4.745	0.065			
2	4	1	87	87	2.290	0.126			
2	4	1	88	89	2.029	0.036			
2	4	1	90	90	1.494	0.042			
2	4	1	91	97	1.446	0.039			
2	4	1	98	03	1.466	0.039			
2	4	1	04	06	0.255	0.016			
2	4	1	07	50	0.192	0.011			
2	5	1	65	74	3.233	0.089			LDDV
2	5	1	75	79	1.048	0.078			
2	5	1	80	81	0.715	0.033			
2	5	1	82	83	0.427	0.033			
2	5	1	84	93	0.310	0.033			
2	5	1	94	94	0.261	0.028			
2	5	1	95	95	0.213	0.023			
2	5	1	96	96	0.189	0.020			
2	5	1	97	97	0.189	0.020			
2	5	1	98	98	0.189	0.020			
2	5	1	99	99	0.189	0.020			
2	5	1	00	00	0.189	0.020			
2	5	1	01	50	0.057	0.006			
2	6	1	65	80	2.108	0.089			LDDT
2	6	1	81	83	1.054	0.044			
2	6	1	84	95	0.577	0.044			
2	6	1	96	96	0.465	0.036			
2	6	1	97	97	0.354	0.027			
2	6	1	98	98	0.354	0.027			
2	6	1	99	99	0.354	0.027			
2	6	1	00	00	0.354	0.027			
2	6	1	01	50	0.354	0.027			
2	7	1	88	88	2.022	0.000			HDDV
2	7	1	89	89	2.038	0.000			
2	7	1	90	90	1.716	0.000			
2	7	1	91	91	1.500	0.000			
2	7	1	92	92	1.501	0.000			
2	7	1	93	93	1.452	0.000			
2	7	1	94	94	0.834	0.000			
2	7	1	95	95	0.825	0.000			
2	7	1	96	50	0.821	0.000			

```
TOG BERs - I/M High Altitude Tier 2 Control Case
0124            ZM    DR1    DR2 Flex Pt  File: HAL_IM_C.BER
2 1 1 65 67  9.660  0.186                         LDGV
2 1 1 68 69  5.765  0.258
2 1 1 70 71  4.741  0.382
2 1 1 72 74  4.783  0.165
2 1 1 75 75  2.029  0.282
2 1 1 76 77  2.035  0.283
2 1 1 78 79  2.042  0.284
2 1 1 80 80  0.704  0.211
2 1 1 81 81  0.567  0.120  0.005  14.63
2 1 1 82 82  0.561  0.119  0.006  14.63
2 1 1 83 83  0.336  0.064
2 1 1 84 84  0.346  0.061
2 1 1 85 85  0.350  0.057
2 1 1 86 86  0.358  0.046
2 1 1 87 87  0.360  0.045
2 1 1 88 88  0.228  0.036
2 1 1 89 89  0.231  0.037
2 1 1 90 90  0.228  0.036
2 1 1 91 91  0.224  0.035
2 1 1 92 92  0.226  0.035
2 1 1 93 93  0.224  0.035
2 1 1 94 94  0.197  0.031
2 1 1 95 95  0.169  0.028
2 1 1 96 00  0.156  0.026  0.024   9.05
2 1 1 01 50  0.064  0.014  0.016  14.64
2 2 1 65 67  9.660  0.186                         LDGT1
2 2 1 68 69  5.765  0.258
2 2 1 70 71  4.741  0.382
2 2 1 72 74  4.720  0.176
2 2 1 75 75  3.423  0.270
2 2 1 76 76  3.445  0.272
2 2 1 77 78  3.434  0.271
2 2 1 79 80  1.665  0.282
2 2 1 81 82  2.671  0.086
2 2 1 83 83  1.850  0.087
2 2 1 84 84  0.743  0.061
2 2 1 85 85  0.606  0.061
2 2 1 86 86  0.570  0.062
2 2 1 87 87  0.558  0.066
2 2 1 88 88  0.417  0.049
2 2 1 89 89  0.416  0.047
2 2 1 90 90  0.399  0.045
2 2 1 91 91  0.366  0.044
2 2 1 92 92  0.392  0.042
2 2 1 93 93  0.390  0.042
2 2 1 94 94  0.310  0.037
2 2 1 95 95  0.231  0.033
2 2 1 96 00  0.192  0.031  0.027  11.84
2 2 1 01 03  0.073  0.015  0.017  17.20
2 2 1 04 50  0.065  0.014  0.016  16.61
2 3 1 65 69 12.751  0.186                         LDGT2
2 3 1 70 73  8.822  0.258
2 3 1 74 78  8.822  0.176
2 3 1 79 80  1.686  0.286
2 3 1 81 81  2.668  0.086
2 3 1 82 82  2.668  0.086
2 3 1 83 83  1.855  0.088
2 3 1 84 84  0.752  0.061
2 3 1 85 85  0.627  0.063
2 3 1 86 86  0.609  0.067
2 3 1 87 87  0.587  0.069
2 3 1 88 88  0.436  0.051
2 3 1 89 89  0.430  0.048
2 3 1 90 90  0.420  0.048
2 3 1 91 91  0.366  0.044
2 3 1 92 95  0.392  0.042
```

2	3	1	96	96	0.264	0.038			
2	3	1	97	00	0.216	0.034	0.029	13.93	
2	3	1	01	03	0.214	0.034	0.028	13.93	
2	3	1	04	04	0.100	0.019	0.020	13.05	
2	3	1	05	05	0.105	0.020	0.020	12.59	
2	3	1	06	06	0.098	0.019	0.020	13.59	
2	3	1	07	07	0.090	0.018	0.019	14.45	
2	3	1	08	08	0.078	0.016	0.018	16.33	
2	3	1	09	50	0.065	0.014	0.017	17.99	
2	4	1	80	80	7.284	0.203			HDGV
2	4	1	81	83	7.291	0.201			
2	4	1	84	84	7.423	0.205			
2	4	1	85	85	5.352	0.065			
2	4	1	86	86	4.745	0.065			
2	4	1	87	87	2.290	0.126			
2	4	1	88	89	2.029	0.036			
2	4	1	90	90	1.494	0.042			
2	4	1	91	97	1.446	0.039			
2	4	1	98	03	1.466	0.039			
2	4	1	04	06	0.255	0.016			
2	4	1	07	50	0.192	0.011			
2	5	1	65	74	3.233	0.089			LDDV
2	5	1	75	79	1.048	0.078			
2	5	1	80	81	0.715	0.033			
2	5	1	82	83	0.427	0.033			
2	5	1	84	93	0.310	0.033			
2	5	1	94	94	0.261	0.028			
2	5	1	95	95	0.213	0.023			
2	5	1	96	96	0.189	0.020			
2	5	1	97	97	0.189	0.020			
2	5	1	98	98	0.189	0.020			
2	5	1	99	99	0.189	0.020			
2	5	1	00	00	0.189	0.020			
2	5	1	01	50	0.057	0.006			
2	6	1	65	80	2.108	0.089			LDDT
2	6	1	81	83	1.054	0.044			
2	6	1	84	95	0.577	0.044			
2	6	1	96	96	0.465	0.036			
2	6	1	97	97	0.354	0.027			
2	6	1	98	98	0.354	0.027			
2	6	1	99	99	0.354	0.027			
2	6	1	00	00	0.354	0.027			
2	6	1	01	03	0.354	0.027			
2	6	1	04	04	0.154	0.012			
2	6	1	05	05	0.139	0.011			
2	6	1	06	06	0.126	0.010			
2	6	1	07	07	0.113	0.009			
2	6	1	08	08	0.089	0.007			
2	6	1	09	50	0.065	0.005			
2	7	1	88	88	2.022	0.000			HDDV
2	7	1	89	89	2.038	0.000			
2	7	1	90	90	1.716	0.000			
2	7	1	91	91	1.500	0.000			
2	7	1	92	92	1.501	0.000			
2	7	1	93	93	1.452	0.000			
2	7	1	94	94	0.834	0.000			
2	7	1	95	95	0.825	0.000			
2	7	1	96	50	0.821	0.000			

```
TOG BERs - I/M High Altitude Tier 2 Control Case - Inc. LD Diesel Penetration
0124            ZM    DR1    DR2 Flex Pt  File: HAL_IM_D.BER
2 1 1 65 67  9.660  0.186                       LDGV
2 1 1 68 69  5.765  0.258
2 1 1 70 71  4.741  0.382
2 1 1 72 74  4.783  0.165
2 1 1 75 75  2.029  0.282
2 1 1 76 77  2.035  0.283
2 1 1 78 79  2.042  0.284
2 1 1 80 80  0.704  0.211
2 1 1 81 81  0.567  0.120  0.005  14.63
2 1 1 82 82  0.561  0.119  0.006  14.63
2 1 1 83 83  0.336  0.064
2 1 1 84 84  0.346  0.061
2 1 1 85 85  0.350  0.057
2 1 1 86 86  0.358  0.046
2 1 1 87 87  0.360  0.045
2 1 1 88 88  0.228  0.036
2 1 1 89 89  0.231  0.037
2 1 1 90 90  0.228  0.036
2 1 1 91 91  0.224  0.035
2 1 1 92 92  0.226  0.035
2 1 1 93 93  0.224  0.035
2 1 1 94 94  0.197  0.031
2 1 1 95 95  0.169  0.028
2 1 1 96 00  0.156  0.026  0.024   9.05
2 1 1 01 50  0.064  0.014  0.016  14.64
2 2 1 65 67  9.660  0.186                       LDGT1
2 2 1 68 69  5.765  0.258
2 2 1 70 71  4.741  0.382
2 2 1 72 74  4.720  0.176
2 2 1 75 75  3.423  0.270
2 2 1 76 76  3.445  0.272
2 2 1 77 78  3.434  0.271
2 2 1 79 80  1.665  0.282
2 2 1 81 82  2.671  0.086
2 2 1 83 83  1.850  0.087
2 2 1 84 84  0.743  0.061
2 2 1 85 85  0.606  0.061
2 2 1 86 86  0.570  0.062
2 2 1 87 87  0.558  0.066
2 2 1 88 88  0.417  0.049
2 2 1 89 89  0.416  0.047
2 2 1 90 90  0.399  0.045
2 2 1 91 91  0.366  0.044
2 2 1 92 92  0.392  0.042
2 2 1 93 93  0.390  0.042
2 2 1 94 94  0.310  0.037
2 2 1 95 95  0.231  0.033
2 2 1 96 00  0.192  0.031  0.027  11.84
2 2 1 01 03  0.073  0.015  0.017  17.20
2 2 1 04 50  0.065  0.014  0.016  16.61
2 3 1 65 69 12.751  0.186                       LDGT2
2 3 1 70 73  8.822  0.258
2 3 1 74 78  8.822  0.176
2 3 1 79 80  1.686  0.286
2 3 1 81 81  2.668  0.086
2 3 1 82 82  2.668  0.086
2 3 1 83 83  1.855  0.088
2 3 1 84 84  0.752  0.061
2 3 1 85 85  0.627  0.063
2 3 1 86 86  0.609  0.067
2 3 1 87 87  0.587  0.069
2 3 1 88 88  0.436  0.051
2 3 1 89 89  0.430  0.048
2 3 1 90 90  0.420  0.048
2 3 1 91 91  0.366  0.044
2 3 1 92 95  0.392  0.042
```

2	3	1	96	96	0.264	0.038			
2	3	1	97	00	0.216	0.034	0.029	13.93	
2	3	1	01	03	0.214	0.034	0.028	13.93	
2	3	1	04	04	0.100	0.019	0.020	13.05	
2	3	1	05	05	0.105	0.020	0.020	12.59	
2	3	1	06	06	0.098	0.019	0.020	13.59	
2	3	1	07	07	0.090	0.018	0.019	14.45	
2	3	1	08	08	0.078	0.016	0.018	16.33	
2	3	1	09	50	0.065	0.014	0.017	17.99	
2	4	1	80	80	7.284	0.203			HDGV
2	4	1	81	83	7.291	0.201			
2	4	1	84	84	7.423	0.205			
2	4	1	85	85	5.352	0.065			
2	4	1	86	86	4.745	0.065			
2	4	1	87	87	2.290	0.126			
2	4	1	88	89	2.029	0.036			
2	4	1	90	90	1.494	0.042			
2	4	1	91	97	1.446	0.039			
2	4	1	98	03	1.466	0.039			
2	4	1	04	06	0.255	0.016			
2	4	1	07	50	0.192	0.011			
2	5	1	65	74	3.233	0.089			LDDV
2	5	1	75	79	1.048	0.078			
2	5	1	80	81	0.715	0.033			
2	5	1	82	83	0.427	0.033			
2	5	1	84	93	0.310	0.033			
2	5	1	94	94	0.261	0.028			
2	5	1	95	95	0.213	0.023			
2	5	1	96	96	0.189	0.020			
2	5	1	97	97	0.189	0.020			
2	5	1	98	98	0.189	0.020			
2	5	1	99	99	0.189	0.020			
2	5	1	00	00	0.189	0.020			
2	5	1	01	50	0.057	0.006			
2	6	1	65	80	2.108	0.089			LDDT
2	6	1	81	83	1.054	0.044			
2	6	1	84	95	0.577	0.044			
2	6	1	96	96	0.465	0.036			
2	6	1	97	97	0.354	0.027			
2	6	1	98	98	0.354	0.027			
2	6	1	99	99	0.354	0.027			
2	6	1	00	00	0.354	0.027			
2	6	1	01	03	0.354	0.027			
2	6	1	04	04	0.142	0.011			
2	6	1	05	05	0.129	0.010			
2	6	1	06	06	0.104	0.008			
2	6	1	07	07	0.090	0.007			
2	6	1	08	08	0.076	0.006			
2	6	1	09	50	0.065	0.005			
2	7	1	88	88	2.022	0.000			HDDV
2	7	1	89	89	2.038	0.000			
2	7	1	90	90	1.716	0.000			
2	7	1	91	91	1.500	0.000			
2	7	1	92	92	1.501	0.000			
2	7	1	93	93	1.452	0.000			
2	7	1	94	94	0.834	0.000			
2	7	1	95	95	0.825	0.000			
2	7	1	96	50	0.821	0.000			

TOG BERs - I/M High Altitude 0.055 NMHC Case

0125					ZM	DR1	DR2	Flex Pt	File: HAL_IM_5.BER
2	1	1	65	67	9.660	0.186			LDGV
2	1	1	68	69	5.765	0.258			
2	1	1	70	71	4.741	0.382			
2	1	1	72	74	4.783	0.165			
2	1	1	75	77	2.035	0.283			
2	1	1	78	79	2.042	0.284			
2	1	1	80	80	0.704	0.211			
2	1	1	81	81	0.567	0.120	0.005	14.63	
2	1	1	82	82	0.561	0.119	0.006	14.63	
2	1	1	83	83	0.336	0.064			
2	1	1	84	84	0.346	0.061			
2	1	1	85	85	0.350	0.057			
2	1	1	86	86	0.358	0.046			
2	1	1	87	87	0.360	0.045			
2	1	1	88	88	0.228	0.036			
2	1	1	89	89	0.231	0.037			
2	1	1	90	90	0.228	0.036			
2	1	1	91	91	0.224	0.035			
2	1	1	92	92	0.226	0.035			
2	1	1	93	93	0.224	0.035			
2	1	1	94	94	0.197	0.031			
2	1	1	95	95	0.169	0.028			
2	1	1	96	00	0.156	0.026	0.024	9.05	
2	1	1	01	03	0.064	0.014	0.016	14.64	
2	1	1	04	50	0.028	0.009	0.013	13.20	
2	2	1	65	67	9.660	0.186			LDGT1
2	2	1	68	69	5.765	0.258			
2	2	1	70	71	4.741	0.382			
2	2	1	72	74	4.720	0.176			
2	2	1	75	75	3.423	0.270			
2	2	1	76	76	3.445	0.272			
2	2	1	77	78	3.434	0.271			
2	2	1	79	80	1.665	0.282			
2	2	1	81	82	2.671	0.086			
2	2	1	83	83	1.850	0.087			
2	2	1	84	84	0.743	0.061			
2	2	1	85	85	0.606	0.061			
2	2	1	86	86	0.570	0.062			
2	2	1	87	87	0.558	0.066			
2	2	1	88	88	0.417	0.049			
2	2	1	89	89	0.416	0.047			
2	2	1	90	90	0.399	0.045			
2	2	1	91	91	0.366	0.044			
2	2	1	92	92	0.392	0.042			
2	2	1	93	93	0.390	0.042			
2	2	1	94	94	0.310	0.037			
2	2	1	95	95	0.231	0.033			
2	2	1	96	00	0.192	0.031	0.027	11.84	
2	2	1	01	03	0.073	0.015	0.017	17.20	
2	2	1	04	50	0.028	0.009	0.013	15.20	
2	3	1	65	69	12.751	0.186			LDGT2
2	3	1	70	73	8.822	0.258			
2	3	1	74	78	8.822	0.176			
2	3	1	79	80	1.686	0.286			
2	3	1	81	81	2.668	0.086			
2	3	1	82	82	2.668	0.086			
2	3	1	83	83	1.855	0.088			
2	3	1	84	84	0.752	0.061			
2	3	1	85	85	0.627	0.063			
2	3	1	86	86	0.609	0.067			
2	3	1	87	87	0.587	0.069			
2	3	1	88	88	0.436	0.051			
2	3	1	89	89	0.430	0.048			
2	3	1	90	90	0.420	0.048			
2	3	1	91	91	0.366	0.044			
2	3	1	92	95	0.392	0.042			

2	3	1	96	96	0.264	0.038			
2	3	1	97	00	0.216	0.034	0.029	13.93	
2	3	1	01	03	0.214	0.034	0.028	13.93	
2	3	1	04	04	0.100	0.019	0.020	13.05	
2	3	1	05	05	0.105	0.020	0.020	12.59	
2	3	1	06	06	0.098	0.019	0.020	13.59	
2	3	1	07	07	0.090	0.018	0.019	14.45	
2	3	1	08	08	0.078	0.016	0.018	16.33	
2	3	1	09	50	0.065	0.014	0.017	17.99	
2	4	1	80	80	7.284	0.203			HDGV
2	4	1	81	83	7.291	0.201			
2	4	1	84	84	7.423	0.205			
2	4	1	85	85	5.352	0.065			
2	4	1	86	86	4.745	0.065			
2	4	1	87	87	2.290	0.126			
2	4	1	88	89	2.029	0.036			
2	4	1	90	90	1.494	0.042			
2	4	1	91	97	1.446	0.039			
2	4	1	98	03	1.394	0.037			
2	4	1	04	06	0.211	0.015			
2	4	1	07	50	0.159	0.010			
2	5	1	65	74	3.233	0.089			LDDV
2	5	1	75	79	1.048	0.078			
2	5	1	80	81	0.715	0.033			
2	5	1	82	83	0.427	0.033			
2	5	1	84	93	0.310	0.033			
2	5	1	94	94	0.261	0.028			
2	5	1	95	95	0.213	0.023			
2	5	1	96	96	0.189	0.020			
2	5	1	97	97	0.189	0.020			
2	5	1	98	98	0.189	0.020			
2	5	1	99	99	0.189	0.020			
2	5	1	00	00	0.189	0.020			
2	5	1	01	50	0.057	0.006			
2	6	1	65	80	2.108	0.089			LDDT
2	6	1	81	83	1.054	0.044			
2	6	1	84	95	0.577	0.044			
2	6	1	96	96	0.465	0.036			
2	6	1	97	97	0.354	0.027			
2	6	1	98	98	0.354	0.027			
2	6	1	99	99	0.354	0.027			
2	6	1	00	00	0.354	0.027			
2	6	1	01	03	0.354	0.027			
2	6	1	04	04	0.154	0.012			
2	6	1	05	05	0.139	0.011			
2	6	1	06	06	0.126	0.010			
2	6	1	07	07	0.113	0.009			
2	6	1	08	08	0.089	0.007			
2	6	1	09	50	0.065	0.005			
2	7	1	88	88	2.022	0.000			HDDV
2	7	1	89	89	2.038	0.000			
2	7	1	90	90	1.716	0.000			
2	7	1	91	91	1.500	0.000			
2	7	1	92	92	1.501	0.000			
2	7	1	93	93	1.452	0.000			
2	7	1	94	94	0.834	0.000			
2	7	1	95	95	0.825	0.000			
2	7	1	96	50	0.821	0.000			

TOG BERs - I/M High Altitude Tier 2 Control Case + HDGV

```
0124             ZM    DR1    DR2 Flex Pt  File: HAL_IM_C.BER
2 1 1 65 67  9.660  0.186                        LDGV
2 1 1 68 69  5.765  0.258
2 1 1 70 71  4.741  0.382
2 1 1 72 74  4.783  0.165
2 1 1 75 75  2.029  0.282
2 1 1 76 77  2.035  0.283
2 1 1 78 79  2.042  0.284
2 1 1 80 80  0.704  0.211
2 1 1 81 81  0.567  0.120  0.005  14.63
2 1 1 82 82  0.561  0.119  0.006  14.63
2 1 1 83 83  0.336  0.064
2 1 1 84 84  0.346  0.061
2 1 1 85 85  0.350  0.057
2 1 1 86 86  0.358  0.046
2 1 1 87 87  0.360  0.045
2 1 1 88 88  0.228  0.036
2 1 1 89 89  0.231  0.037
2 1 1 90 90  0.228  0.036
2 1 1 91 91  0.224  0.035
2 1 1 92 92  0.226  0.035
2 1 1 93 93  0.224  0.035
2 1 1 94 94  0.197  0.031
2 1 1 95 95  0.169  0.028
2 1 1 96 00  0.156  0.026  0.024   9.05
2 1 1 01 50  0.064  0.014  0.016  14.64
2 2 1 65 67  9.660  0.186                        LDGT1
2 2 1 68 69  5.765  0.258
2 2 1 70 71  4.741  0.382
2 2 1 72 74  4.720  0.176
2 2 1 75 75  3.423  0.270
2 2 1 76 76  3.445  0.272
2 2 1 77 78  3.434  0.271
2 2 1 79 80  1.665  0.282
2 2 1 81 82  2.671  0.086
2 2 1 83 83  1.850  0.087
2 2 1 84 84  0.743  0.061
2 2 1 85 85  0.606  0.061
2 2 1 86 86  0.570  0.062
2 2 1 87 87  0.558  0.066
2 2 1 88 88  0.417  0.049
2 2 1 89 89  0.416  0.047
2 2 1 90 90  0.399  0.045
2 2 1 91 91  0.366  0.044
2 2 1 92 92  0.392  0.042
2 2 1 93 93  0.390  0.042
2 2 1 94 94  0.310  0.037
2 2 1 95 95  0.231  0.033
2 2 1 96 00  0.192  0.031  0.027  11.84
2 2 1 01 03  0.073  0.015  0.017  17.20
2 2 1 04 50  0.065  0.014  0.016  16.61
2 3 1 65 69 12.751  0.186                        LDGT2
2 3 1 70 73  8.822  0.258
2 3 1 74 78  8.822  0.176
2 3 1 79 80  1.686  0.286
2 3 1 81 81  2.668  0.086
2 3 1 82 82  2.668  0.086
2 3 1 83 83  1.855  0.088
2 3 1 84 84  0.752  0.061
2 3 1 85 85  0.627  0.063
2 3 1 86 86  0.609  0.067
2 3 1 87 87  0.587  0.069
2 3 1 88 88  0.436  0.051
2 3 1 89 89  0.430  0.048
2 3 1 90 90  0.420  0.048
2 3 1 91 91  0.366  0.044
2 3 1 92 95  0.392  0.042
```

2	3	1	96	96	0.264	0.038			
2	3	1	97	00	0.216	0.034	0.029	13.93	
2	3	1	01	03	0.214	0.034	0.028	13.93	
2	3	1	04	04	0.100	0.019	0.020	13.05	
2	3	1	05	05	0.105	0.020	0.020	12.59	
2	3	1	06	06	0.098	0.019	0.020	13.59	
2	3	1	07	07	0.090	0.018	0.019	14.45	
2	3	1	08	08	0.078	0.016	0.018	16.33	
2	3	1	09	50	0.065	0.014	0.017	17.99	
2	4	1	80	80	7.284	0.203			HDGV
2	4	1	81	83	7.291	0.201			
2	4	1	84	84	7.423	0.205			
2	4	1	85	85	5.352	0.065			
2	4	1	86	86	4.745	0.065			
2	4	1	87	87	2.290	0.126			
2	4	1	88	89	2.029	0.036			
2	4	1	90	90	1.494	0.042			
2	4	1	91	97	1.446	0.039			
2	4	1	98	03	1.394	0.037			
2	4	1	04	06	0.211	0.015			
2	4	1	07	50	0.159	0.010			
2	5	1	65	74	3.233	0.089			LDDV
2	5	1	75	79	1.048	0.078			
2	5	1	80	81	0.715	0.033			
2	5	1	82	83	0.427	0.033			
2	5	1	84	93	0.310	0.033			
2	5	1	94	94	0.261	0.028			
2	5	1	95	95	0.213	0.023			
2	5	1	96	96	0.189	0.020			
2	5	1	97	97	0.189	0.020			
2	5	1	98	98	0.189	0.020			
2	5	1	99	99	0.189	0.020			
2	5	1	00	00	0.189	0.020			
2	5	1	01	50	0.057	0.006			
2	6	1	65	80	2.108	0.089			LDDT
2	6	1	81	83	1.054	0.044			
2	6	1	84	95	0.577	0.044			
2	6	1	96	96	0.465	0.036			
2	6	1	97	97	0.354	0.027			
2	6	1	98	98	0.354	0.027			
2	6	1	99	99	0.354	0.027			
2	6	1	00	00	0.354	0.027			
2	6	1	01	03	0.354	0.027			
2	6	1	04	04	0.154	0.012			
2	6	1	05	05	0.139	0.011			
2	6	1	06	06	0.126	0.010			
2	6	1	07	07	0.113	0.009			
2	6	1	08	08	0.089	0.007			
2	6	1	09	50	0.065	0.005			
2	7	1	88	88	2.022	0.000			HDDV
2	7	1	89	89	2.038	0.000			
2	7	1	90	90	1.716	0.000			
2	7	1	91	91	1.500	0.000			
2	7	1	92	92	1.501	0.000			
2	7	1	93	93	1.452	0.000			
2	7	1	94	94	0.834	0.000			
2	7	1	95	95	0.825	0.000			
2	7	1	96	50	0.821	0.000			

TOG BERs - I/M High Altitude Baseline Case

```
0112            ZM    DR1    DR2 Flex Pt  File: HAL_NO_B.BER
2 1 1 65 67  9.660  0.186                         LDGV
2 1 1 68 69  5.765  0.258
2 1 1 70 71  4.741  0.382
2 1 1 72 74  4.783  0.165
2 1 1 75 75  2.029  0.282
2 1 1 76 77  2.035  0.283
2 1 1 78 79  2.042  0.284
2 1 1 80 80  0.704  0.211
2 1 1 81 81  0.490  0.223  0.005  14.63
2 1 1 82 82  0.488  0.221  0.005  14.63
2 1 1 83 83  0.232  0.116
2 1 1 84 84  0.257  0.110
2 1 1 85 85  0.278  0.102
2 1 1 86 86  0.334  0.082
2 1 1 87 87  0.338  0.080
2 1 1 88 88  0.223  0.057
2 1 1 89 89  0.222  0.058
2 1 1 90 90  0.219  0.056
2 1 1 91 91  0.216  0.055
2 1 1 92 92  0.214  0.055
2 1 1 93 93  0.213  0.055
2 1 1 94 94  0.190  0.042
2 1 1 95 95  0.167  0.028
2 1 1 96 00  0.156  0.022  0.047   3.13
2 1 1 01 50  0.064  0.010  0.038   3.72
2 2 1 65 67  9.660  0.186                         LDGT1
2 2 1 68 69  5.765  0.258
2 2 1 70 71  4.741  0.382
2 2 1 72 74  4.720  0.176
2 2 1 75 75  3.423  0.270
2 2 1 76 76  3.445  0.272
2 2 1 77 78  3.434  0.271
2 2 1 79 80  1.665  0.282
2 2 1 81 81  2.506  0.183
2 2 1 82 82  2.506  0.183
2 2 1 83 83  1.736  0.185
2 2 1 84 84  0.670  0.109
2 2 1 85 85  0.543  0.109
2 2 1 86 86  0.501  0.111
2 2 1 87 87  0.480  0.117
2 2 1 88 88  0.414  0.077
2 2 1 89 89  0.414  0.073
2 2 1 90 90  0.400  0.071
2 2 1 91 91  0.371  0.068
2 2 1 92 92  0.393  0.066
2 2 1 93 93  0.392  0.065
2 2 1 94 94  0.311  0.052
2 2 1 95 95  0.231  0.040
2 2 1 96 00  0.192  0.033  0.052   3.38
2 2 1 01 50  0.073  0.018  0.040   4.59
2 3 1 65 69 12.751  0.186                         LDGT2
2 3 1 70 73  8.822  0.258
2 3 1 74 78  8.822  0.176
2 3 1 79 80  1.686  0.286
2 3 1 81 81  2.503  0.182
2 3 1 82 82  2.503  0.182
2 3 1 83 83  1.741  0.186
2 3 1 84 84  0.678  0.110
2 3 1 85 85  0.562  0.113
2 3 1 86 86  0.535  0.119
2 3 1 87 87  0.506  0.123
2 3 1 88 88  0.433  0.080
2 3 1 89 89  0.428  0.076
2 3 1 90 90  0.421  0.075
2 3 1 91 91  0.371  0.068
2 3 1 92 95  0.393  0.066
```

2	3	1	96	96	0.265	0.052			
2	3	1	97	00	0.216	0.040	0.055	3.38	
2	3	1	01	50	0.214	0.039	0.054	3.38	
2	4	1	80	80	7.284	0.203			HDGV
2	4	1	81	83	7.291	0.201			
2	4	1	84	84	7.423	0.205			
2	4	1	85	85	5.352	0.065			
2	4	1	86	86	4.745	0.065			
2	4	1	87	87	2.290	0.126			
2	4	1	88	89	2.029	0.036			
2	4	1	90	90	1.494	0.042			
2	4	1	91	97	1.446	0.039			
2	4	1	98	03	1.467	0.039			
2	4	1	04	06	0.350	0.023			
2	4	1	07	50	0.275	0.016			
2	5	1	65	74	3.233	0.089			LDDV
2	5	1	75	79	1.048	0.078			
2	5	1	80	81	0.715	0.033			
2	5	1	82	83	0.427	0.033			
2	5	1	84	93	0.310	0.033			
2	5	1	94	94	0.261	0.028			
2	5	1	95	95	0.213	0.023			
2	5	1	96	96	0.189	0.020			
2	5	1	97	97	0.189	0.020			
2	5	1	98	98	0.189	0.020			
2	5	1	99	99	0.189	0.020			
2	5	1	00	00	0.189	0.020			
2	5	1	01	50	0.057	0.006			
2	6	1	65	80	2.108	0.089			LDDT
2	6	1	81	83	1.054	0.044			
2	6	1	84	95	0.577	0.044			
2	6	1	96	96	0.465	0.036			
2	6	1	97	97	0.354	0.027			
2	6	1	98	98	0.354	0.027			
2	6	1	99	99	0.354	0.027			
2	6	1	00	00	0.354	0.027			
2	6	1	01	50	0.354	0.027			
2	7	1	88	88	2.022	0.000			HDDV
2	7	1	89	89	2.038	0.000			
2	7	1	90	90	1.716	0.000			
2	7	1	91	91	1.500	0.000			
2	7	1	92	92	1.501	0.000			
2	7	1	93	93	1.452	0.000			
2	7	1	94	94	0.834	0.000			
2	7	1	95	95	0.825	0.000			
2	7	1	96	50	0.821	0.000			

TOG BERs - I/M High Altitude Control (Tier 2) Case

0124					ZM	DR1	DR2	Flex Pt	File: HAL_NO_C.BER
2	1	1	65	67	9.660	0.186			LDGV
2	1	1	68	69	5.765	0.258			
2	1	1	70	71	4.741	0.382			
2	1	1	72	74	4.783	0.165			
2	1	1	75	75	2.029	0.282			
2	1	1	76	77	2.035	0.283			
2	1	1	78	79	2.042	0.284			
2	1	1	80	80	0.704	0.211			
2	1	1	81	81	0.490	0.223	0.005	14.63	
2	1	1	82	82	0.488	0.221	0.005	14.63	
2	1	1	83	83	0.232	0.116			
2	1	1	84	84	0.257	0.110			
2	1	1	85	85	0.278	0.102			
2	1	1	86	86	0.334	0.082			
2	1	1	87	87	0.338	0.080			
2	1	1	88	88	0.223	0.057			
2	1	1	89	89	0.222	0.058			
2	1	1	90	90	0.219	0.056			
2	1	1	91	91	0.216	0.055			
2	1	1	92	92	0.214	0.055			
2	1	1	93	93	0.213	0.055			
2	1	1	94	94	0.190	0.042			
2	1	1	95	95	0.167	0.028			
2	1	1	96	00	0.156	0.022	0.047	3.13	
2	1	1	01	50	0.064	0.010	0.038	3.72	
2	2	1	65	67	9.660	0.186			LDGT1
2	2	1	68	69	5.765	0.258			
2	2	1	70	71	4.741	0.382			
2	2	1	72	74	4.720	0.176			
2	2	1	75	75	3.423	0.270			
2	2	1	76	76	3.445	0.272			
2	2	1	77	78	3.434	0.271			
2	2	1	79	80	1.665	0.282			
2	2	1	81	82	2.506	0.183			
2	2	1	83	83	1.736	0.185			
2	2	1	84	84	0.670	0.109			
2	2	1	85	85	0.543	0.109			
2	2	1	86	86	0.501	0.111			
2	2	1	87	87	0.480	0.117			
2	2	1	88	88	0.414	0.077			
2	2	1	89	89	0.414	0.073			
2	2	1	90	90	0.400	0.071			
2	2	1	91	91	0.371	0.068			
2	2	1	92	92	0.393	0.066			
2	2	1	93	93	0.392	0.065			
2	2	1	94	94	0.311	0.052			
2	2	1	95	95	0.231	0.040			
2	2	1	96	00	0.192	0.033	0.052	3.38	
2	2	1	01	03	0.073	0.018	0.040	4.59	
2	2	1	04	50	0.065	0.016	0.038	4.65	
2	3	1	65	69	12.751	0.186			LDGT2
2	3	1	70	73	8.822	0.258			
2	3	1	74	78	8.822	0.176			
2	3	1	79	80	1.686	0.286			
2	3	1	81	81	2.503	0.182			
2	3	1	82	82	2.503	0.182			
2	3	1	83	83	1.741	0.186			
2	3	1	84	84	0.678	0.110			
2	3	1	85	85	0.562	0.113			
2	3	1	86	86	0.535	0.119			
2	3	1	87	87	0.506	0.123			
2	3	1	88	88	0.433	0.080			
2	3	1	89	89	0.428	0.076			
2	3	1	90	90	0.421	0.075			
2	3	1	91	91	0.371	0.068			
2	3	1	92	95	0.393	0.066			

2	3	1	96	96	0.265	0.052			
2	3	1	97	00	0.216	0.040	0.055	3.38	
2	3	1	01	03	0.214	0.039	0.054	3.38	
2	3	1	04	04	0.100	0.024	0.044	5.13	
2	3	1	05	05	0.105	0.025	0.045	5.08	
2	3	1	06	06	0.098	0.024	0.044	5.15	
2	3	1	07	07	0.090	0.023	0.043	5.23	
2	3	1	08	08	0.078	0.021	0.041	5.36	
2	3	1	09	50	0.065	0.019	0.039	5.50	
2	4	1	80	80	7.284	0.203			HDGV
2	4	1	81	83	7.291	0.201			
2	4	1	84	84	7.423	0.205			
2	4	1	85	85	5.352	0.065			
2	4	1	86	86	4.745	0.065			
2	4	1	87	87	2.290	0.126			
2	4	1	88	89	2.029	0.036			
2	4	1	90	90	1.494	0.042			
2	4	1	91	97	1.446	0.039			
2	4	1	98	03	1.467	0.039			
2	4	1	04	06	0.350	0.023			
2	4	1	07	50	0.275	0.016			
2	5	1	65	74	3.233	0.089			LDDV
2	5	1	75	79	1.048	0.078			
2	5	1	80	81	0.715	0.033			
2	5	1	82	83	0.427	0.033			
2	5	1	84	93	0.310	0.033			
2	5	1	94	94	0.261	0.028			
2	5	1	95	95	0.213	0.023			
2	5	1	96	96	0.189	0.020			
2	5	1	97	97	0.189	0.020			
2	5	1	98	98	0.189	0.020			
2	5	1	99	99	0.189	0.020			
2	5	1	00	00	0.189	0.020			
2	5	1	01	50	0.057	0.006			
2	6	1	65	80	2.108	0.089			LDDT
2	6	1	81	83	1.054	0.044			
2	6	1	84	95	0.577	0.044			
2	6	1	96	96	0.465	0.036			
2	6	1	97	97	0.354	0.027			
2	6	1	98	98	0.354	0.027			
2	6	1	99	99	0.354	0.027			
2	6	1	00	00	0.354	0.027			
2	6	1	01	03	0.354	0.027			
2	6	1	04	04	0.154	0.012			
2	6	1	05	05	0.139	0.011			
2	6	1	06	06	0.126	0.010			
2	6	1	07	07	0.113	0.009			
2	6	1	08	08	0.089	0.007			
2	6	1	09	50	0.065	0.005			
2	7	1	88	88	2.022	0.000			HDDV
2	7	1	89	89	2.038	0.000			
2	7	1	90	90	1.716	0.000			
2	7	1	91	91	1.500	0.000			
2	7	1	92	92	1.501	0.000			
2	7	1	93	93	1.452	0.000			
2	7	1	94	94	0.834	0.000			
2	7	1	95	95	0.825	0.000			
2	7	1	96	50	0.821	0.000			

TOG BERs - I/M High Altitude Control (Tier 2) Case + Inc. LD Diesel Penetration

```
0124            ZM    DR1    DR2 Flex Pt  File: HAL_NO_D.BER
2 1 1 65 67  9.660  0.186                       LDGV
2 1 1 68 69  5.765  0.258
2 1 1 70 71  4.741  0.382
2 1 1 72 74  4.783  0.165
2 1 1 75 75  2.029  0.282
2 1 1 76 77  2.035  0.283
2 1 1 78 79  2.042  0.284
2 1 1 80 80  0.704  0.211
2 1 1 81 81  0.490  0.223  0.005  14.63
2 1 1 82 82  0.488  0.221  0.005  14.63
2 1 1 83 83  0.232  0.116
2 1 1 84 84  0.257  0.110
2 1 1 85 85  0.278  0.102
2 1 1 86 86  0.334  0.082
2 1 1 87 87  0.338  0.080
2 1 1 88 88  0.223  0.057
2 1 1 89 89  0.222  0.058
2 1 1 90 90  0.219  0.056
2 1 1 91 91  0.216  0.055
2 1 1 92 92  0.214  0.055
2 1 1 93 93  0.213  0.055
2 1 1 94 94  0.190  0.042
2 1 1 95 95  0.167  0.028
2 1 1 96 00  0.156  0.022  0.047   3.13
2 1 1 01 50  0.064  0.010  0.038   3.72
2 2 1 65 67  9.660  0.186                       LDGT1
2 2 1 68 69  5.765  0.258
2 2 1 70 71  4.741  0.382
2 2 1 72 74  4.720  0.176
2 2 1 75 75  3.423  0.270
2 2 1 76 76  3.445  0.272
2 2 1 77 78  3.434  0.271
2 2 1 79 80  1.665  0.282
2 2 1 81 82  2.506  0.183
2 2 1 83 83  1.736  0.185
2 2 1 84 84  0.670  0.109
2 2 1 85 85  0.543  0.109
2 2 1 86 86  0.501  0.111
2 2 1 87 87  0.480  0.117
2 2 1 88 88  0.414  0.077
2 2 1 89 89  0.414  0.073
2 2 1 90 90  0.400  0.071
2 2 1 91 91  0.371  0.068
2 2 1 92 92  0.393  0.066
2 2 1 93 93  0.392  0.065
2 2 1 94 94  0.311  0.052
2 2 1 95 95  0.231  0.040
2 2 1 96 00  0.192  0.033  0.052   3.38
2 2 1 01 03  0.073  0.018  0.040   4.59
2 2 1 04 50  0.065  0.016  0.038   4.65
2 3 1 65 69 12.751  0.186                       LDGT2
2 3 1 70 73  8.822  0.258
2 3 1 74 78  8.822  0.176
2 3 1 79 80  1.686  0.286
2 3 1 81 81  2.503  0.182
2 3 1 82 82  2.503  0.182
2 3 1 83 83  1.741  0.186
2 3 1 84 84  0.678  0.110
2 3 1 85 85  0.562  0.113
2 3 1 86 86  0.535  0.119
2 3 1 87 87  0.506  0.123
2 3 1 88 88  0.433  0.080
2 3 1 89 89  0.428  0.076
2 3 1 90 90  0.421  0.075
2 3 1 91 91  0.371  0.068
2 3 1 92 95  0.393  0.066
```

2	3	1	96	96	0.265	0.052			
2	3	1	97	00	0.216	0.040	0.055	3.38	
2	3	1	01	03	0.214	0.039	0.054	3.38	
2	3	1	04	04	0.100	0.024	0.044	5.13	
2	3	1	05	05	0.105	0.025	0.045	5.08	
2	3	1	06	06	0.098	0.024	0.044	5.15	
2	3	1	07	07	0.090	0.023	0.043	5.23	
2	3	1	08	08	0.078	0.021	0.041	5.36	
2	3	1	09	50	0.065	0.019	0.039	5.50	
2	4	1	80	80	7.284	0.203			HDGV
2	4	1	81	83	7.291	0.201			
2	4	1	84	84	7.423	0.205			
2	4	1	85	85	5.352	0.065			
2	4	1	86	86	4.745	0.065			
2	4	1	87	87	2.290	0.126			
2	4	1	88	89	2.029	0.036			
2	4	1	90	90	1.494	0.042			
2	4	1	91	97	1.446	0.039			
2	4	1	98	03	1.467	0.039			
2	4	1	04	06	0.350	0.023			
2	4	1	07	50	0.275	0.016			
2	5	1	65	74	3.233	0.089			LDDV
2	5	1	75	79	1.048	0.078			
2	5	1	80	81	0.715	0.033			
2	5	1	82	83	0.427	0.033			
2	5	1	84	93	0.310	0.033			
2	5	1	94	94	0.261	0.028			
2	5	1	95	95	0.213	0.023			
2	5	1	96	96	0.189	0.020			
2	5	1	97	97	0.189	0.020			
2	5	1	98	98	0.189	0.020			
2	5	1	99	99	0.189	0.020			
2	5	1	00	00	0.189	0.020			
2	5	1	01	50	0.057	0.006			
2	6	1	65	80	2.108	0.089			LDDT
2	6	1	81	83	1.054	0.044			
2	6	1	84	95	0.577	0.044			
2	6	1	96	96	0.465	0.036			
2	6	1	97	97	0.354	0.027			
2	6	1	98	98	0.354	0.027			
2	6	1	99	99	0.354	0.027			
2	6	1	00	00	0.354	0.027			
2	6	1	01	03	0.354	0.027			
2	6	1	04	04	0.142	0.011			
2	6	1	05	05	0.129	0.010			
2	6	1	06	06	0.104	0.008			
2	6	1	07	07	0.090	0.007			
2	6	1	08	08	0.076	0.006			
2	6	1	09	50	0.065	0.005			
2	7	1	88	88	2.022	0.000			HDDV
2	7	1	89	89	2.038	0.000			
2	7	1	90	90	1.716	0.000			
2	7	1	91	91	1.500	0.000			
2	7	1	92	92	1.501	0.000			
2	7	1	93	93	1.452	0.000			
2	7	1	94	94	0.834	0.000			
2	7	1	95	95	0.825	0.000			
2	7	1	96	50	0.821	0.000			

TOG BERs - I/M High Altitude 0.055 NMHC Case

0125					ZM	DR1	DR2	Flex Pt	File: HAL_NO_5.BER
2	1	1	65	67	9.660	0.186			LDGV
2	1	1	68	69	5.765	0.258			
2	1	1	70	71	4.741	0.382			
2	1	1	72	74	4.783	0.165			
2	1	1	75	77	2.035	0.283			
2	1	1	78	79	2.042	0.284			
2	1	1	80	80	0.704	0.211			
2	1	1	81	81	0.490	0.223	0.005	14.63	
2	1	1	82	82	0.488	0.221	0.005	14.63	
2	1	1	83	83	0.232	0.116			
2	1	1	84	84	0.257	0.110			
2	1	1	85	85	0.278	0.102			
2	1	1	86	86	0.334	0.082			
2	1	1	87	87	0.338	0.080			
2	1	1	88	88	0.223	0.057			
2	1	1	89	89	0.222	0.058			
2	1	1	90	90	0.219	0.056			
2	1	1	91	91	0.216	0.055			
2	1	1	92	92	0.214	0.055			
2	1	1	93	93	0.213	0.055			
2	1	1	94	94	0.190	0.042			
2	1	1	95	95	0.167	0.028			
2	1	1	96	00	0.156	0.022	0.047	3.13	
2	1	1	01	03	0.064	0.010	0.038	3.72	
2	1	1	04	50	0.028	0.006	0.034	3.93	
2	2	1	65	67	9.660	0.186			LDGT1
2	2	1	68	69	5.765	0.258			
2	2	1	70	71	4.741	0.382			
2	2	1	72	74	4.720	0.176			
2	2	1	75	75	3.423	0.270			
2	2	1	76	76	3.445	0.272			
2	2	1	77	78	3.434	0.271			
2	2	1	79	80	1.665	0.282			
2	2	1	81	82	2.506	0.183			
2	2	1	83	83	1.736	0.185			
2	2	1	84	84	0.670	0.109			
2	2	1	85	85	0.543	0.109			
2	2	1	86	86	0.501	0.111			
2	2	1	87	87	0.480	0.117			
2	2	1	88	88	0.414	0.077			
2	2	1	89	89	0.414	0.073			
2	2	1	90	90	0.400	0.071			
2	2	1	91	91	0.371	0.068			
2	2	1	92	92	0.393	0.066			
2	2	1	93	93	0.392	0.065			
2	2	1	94	94	0.311	0.052			
2	2	1	95	95	0.231	0.040			
2	2	1	96	00	0.192	0.033	0.052	3.38	
2	2	1	01	03	0.073	0.018	0.040	4.59	
2	2	1	04	50	0.028	0.012	0.034	4.94	
2	3	1	65	69	12.751	0.186			LDGT2
2	3	1	70	73	8.822	0.258			
2	3	1	74	78	8.822	0.176			
2	3	1	79	80	1.686	0.286			
2	3	1	81	81	2.503	0.182			
2	3	1	82	82	2.503	0.182			
2	3	1	83	83	1.741	0.186			
2	3	1	84	84	0.678	0.110			
2	3	1	85	85	0.562	0.113			
2	3	1	86	86	0.535	0.119			
2	3	1	87	87	0.506	0.123			
2	3	1	88	88	0.433	0.080			
2	3	1	89	89	0.428	0.076			
2	3	1	90	90	0.421	0.075			
2	3	1	91	91	0.371	0.068			
2	3	1	92	95	0.393	0.066			

2	3	1	96	96	0.265	0.052			
2	3	1	97	00	0.216	0.040	0.055	3.38	
2	3	1	01	03	0.214	0.039	0.054	3.38	
2	3	1	04	04	0.028	0.014	0.035	5.86	
2	3	1	05	05	0.028	0.014	0.035	5.86	
2	3	1	06	06	0.028	0.014	0.035	5.86	
2	3	1	07	07	0.028	0.014	0.035	5.86	
2	3	1	08	08	0.028	0.014	0.035	5.86	
2	3	1	09	50	0.028	0.014	0.035	5.86	
2	4	1	80	80	7.284	0.203			HDGV
2	4	1	81	83	7.291	0.201			
2	4	1	84	84	7.423	0.205			
2	4	1	85	85	5.352	0.065			
2	4	1	86	86	4.745	0.065			
2	4	1	87	87	2.290	0.126			
2	4	1	88	89	2.029	0.036			
2	4	1	90	90	1.494	0.042			
2	4	1	91	97	1.446	0.039			
2	4	1	98	03	1.467	0.039			
2	4	1	04	06	0.350	0.023			
2	4	1	07	50	0.275	0.016			
2	5	1	65	74	3.233	0.089			LDDV
2	5	1	75	79	1.048	0.078			
2	5	1	80	81	0.715	0.033			
2	5	1	82	83	0.427	0.033			
2	5	1	84	93	0.310	0.033			
2	5	1	94	94	0.261	0.028			
2	5	1	95	95	0.213	0.023			
2	5	1	96	96	0.189	0.020			
2	5	1	97	97	0.189	0.020			
2	5	1	98	98	0.189	0.020			
2	5	1	99	99	0.189	0.020			
2	5	1	00	00	0.189	0.020			
2	5	1	01	03	0.057	0.006			
2	5	1	04	50	0.027	0.006			
2	6	1	65	80	2.108	0.089			LDDT
2	6	1	81	83	1.054	0.044			
2	6	1	84	95	0.577	0.044			
2	6	1	96	96	0.465	0.036			
2	6	1	97	97	0.354	0.027			
2	6	1	98	98	0.354	0.027			
2	6	1	99	99	0.354	0.027			
2	6	1	00	00	0.354	0.027			
2	6	1	01	03	0.354	0.027			
2	6	1	04	04	0.027	0.006			
2	6	1	05	05	0.027	0.006			
2	6	1	06	06	0.027	0.006			
2	6	1	07	07	0.027	0.006			
2	6	1	08	08	0.027	0.006			
2	6	1	09	50	0.027	0.006			
2	7	1	88	88	2.022	0.000			HDDV
2	7	1	89	89	2.038	0.000			
2	7	1	90	90	1.716	0.000			
2	7	1	91	91	1.500	0.000			
2	7	1	92	92	1.501	0.000			
2	7	1	93	93	1.452	0.000			
2	7	1	94	94	0.834	0.000			
2	7	1	95	95	0.825	0.000			
2	7	1	96	50	0.821	0.000			

TOG BERs - I/M High Altitude Control (Tier 2) + HDGV Case

```
0124            ZM    DR1    DR2 Flex Pt  File: HAL_NO_H.BER
2 1 1 65 67  9.660  0.186                         LDGV
2 1 1 68 69  5.765  0.258
2 1 1 70 71  4.741  0.382
2 1 1 72 74  4.783  0.165
2 1 1 75 75  2.029  0.282
2 1 1 76 77  2.035  0.283
2 1 1 78 79  2.042  0.284
2 1 1 80 80  0.704  0.211
2 1 1 81 81  0.490  0.223  0.005  14.63
2 1 1 82 82  0.488  0.221  0.005  14.63
2 1 1 83 83  0.232  0.116
2 1 1 84 84  0.257  0.110
2 1 1 85 85  0.278  0.102
2 1 1 86 86  0.334  0.082
2 1 1 87 87  0.338  0.080
2 1 1 88 88  0.223  0.057
2 1 1 89 89  0.222  0.058
2 1 1 90 90  0.219  0.056
2 1 1 91 91  0.216  0.055
2 1 1 92 92  0.214  0.055
2 1 1 93 93  0.213  0.055
2 1 1 94 94  0.190  0.042
2 1 1 95 95  0.167  0.028
2 1 1 96 00  0.156  0.022  0.047   3.13
2 1 1 01 50  0.064  0.010  0.038   3.72
2 2 1 65 67  9.660  0.186                         LDGT1
2 2 1 68 69  5.765  0.258
2 2 1 70 71  4.741  0.382
2 2 1 72 74  4.720  0.176
2 2 1 75 75  3.423  0.270
2 2 1 76 76  3.445  0.272
2 2 1 77 78  3.434  0.271
2 2 1 79 80  1.665  0.282
2 2 1 81 82  2.506  0.183
2 2 1 83 83  1.736  0.185
2 2 1 84 84  0.670  0.109
2 2 1 85 85  0.543  0.109
2 2 1 86 86  0.501  0.111
2 2 1 87 87  0.480  0.117
2 2 1 88 88  0.414  0.077
2 2 1 89 89  0.414  0.073
2 2 1 90 90  0.400  0.071
2 2 1 91 91  0.371  0.068
2 2 1 92 92  0.393  0.066
2 2 1 93 93  0.392  0.065
2 2 1 94 94  0.311  0.052
2 2 1 95 95  0.231  0.040
2 2 1 96 00  0.192  0.033  0.052   3.38
2 2 1 01 03  0.073  0.018  0.040   4.59
2 2 1 04 50  0.065  0.016  0.038   4.65
2 3 1 65 69 12.751  0.186                         LDGT2
2 3 1 70 73  8.822  0.258
2 3 1 74 78  8.822  0.176
2 3 1 79 80  1.686  0.286
2 3 1 81 81  2.503  0.182
2 3 1 82 82  2.503  0.182
2 3 1 83 83  1.741  0.186
2 3 1 84 84  0.678  0.110
2 3 1 85 85  0.562  0.113
2 3 1 86 86  0.535  0.119
2 3 1 87 87  0.506  0.123
2 3 1 88 88  0.433  0.080
2 3 1 89 89  0.428  0.076
2 3 1 90 90  0.421  0.075
2 3 1 91 91  0.371  0.068
2 3 1 92 95  0.393  0.066
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2	3	1	96	96	0.265	0.052			
2	3	1	97	00	0.216	0.040	0.055	3.38	
2	3	1	01	03	0.214	0.039	0.054	3.38	
2	3	1	04	04	0.100	0.024	0.044	5.13	
2	3	1	05	05	0.105	0.025	0.045	5.08	
2	3	1	06	06	0.098	0.024	0.044	5.15	
2	3	1	07	07	0.090	0.023	0.043	5.23	
2	3	1	08	08	0.078	0.021	0.041	5.36	
2	3	1	09	50	0.065	0.019	0.039	5.50	
2	4	1	80	80	7.284	0.203			HDGV
2	4	1	81	83	7.291	0.201			
2	4	1	84	84	7.423	0.205			
2	4	1	85	85	5.352	0.065			
2	4	1	86	86	4.745	0.065			
2	4	1	87	87	2.290	0.126			
2	4	1	88	89	2.029	0.036			
2	4	1	90	90	1.494	0.042			
2	4	1	91	97	1.446	0.039			
2	4	1	98	03	1.394	0.037			
2	4	1	04	06	0.304	0.020			
2	4	1	07	50	0.241	0.015			
2	5	1	65	74	3.233	0.089			LDDV
2	5	1	75	79	1.048	0.078			
2	5	1	80	81	0.715	0.033			
2	5	1	82	83	0.427	0.033			
2	5	1	84	93	0.310	0.033			
2	5	1	94	94	0.261	0.028			
2	5	1	95	95	0.213	0.023			
2	5	1	96	96	0.189	0.020			
2	5	1	97	97	0.189	0.020			
2	5	1	98	98	0.189	0.020			
2	5	1	99	99	0.189	0.020			
2	5	1	00	00	0.189	0.020			
2	5	1	01	50	0.057	0.006			
2	6	1	65	80	2.108	0.089			LDDT
2	6	1	81	83	1.054	0.044			
2	6	1	84	95	0.577	0.044			
2	6	1	96	96	0.465	0.036			
2	6	1	97	97	0.354	0.027			
2	6	1	98	98	0.354	0.027			
2	6	1	99	99	0.354	0.027			
2	6	1	00	00	0.354	0.027			
2	6	1	01	03	0.354	0.027			
2	6	1	04	04	0.154	0.012			
2	6	1	05	05	0.139	0.011			
2	6	1	06	06	0.126	0.010			
2	6	1	07	07	0.113	0.009			
2	6	1	08	08	0.089	0.007			
2	6	1	09	50	0.065	0.005			
2	7	1	88	88	2.022	0.000			HDDV
2	7	1	89	89	2.038	0.000			
2	7	1	90	90	1.716	0.000			
2	7	1	91	91	1.500	0.000			
2	7	1	92	92	1.501	0.000			
2	7	1	93	93	1.452	0.000			
2	7	1	94	94	0.834	0.000			
2	7	1	95	95	0.825	0.000			
2	7	1	96	50	0.821	0.000			

TOG BERs - California I/M Baseline Case

0119					ZM	DR1	DR2	Flex Pt	File: CA_IM_B.BER
1	1	1	65	67	7.488	0.186			LDGV
1	1	1	68	69	4.576	0.258			
1	1	1	70	71	3.099	0.382			
1	1	1	72	74	3.286	0.165			
1	1	1	75	77	0.641	0.282			
1	1	1	78	79	0.294	0.284			
1	1	1	80	80	0.371	0.211			
1	1	1	81	82	0.464	0.120	0.005	14.63	
1	1	1	83	83	0.336	0.064			
1	1	1	84	84	0.346	0.061			
1	1	1	85	85	0.350	0.057			
1	1	1	86	87	0.358	0.046			
1	1	1	88	90	0.228	0.036			
1	1	1	91	92	0.225	0.035			
1	1	1	93	93	0.189	0.035			
1	1	1	94	94	0.142	0.031			
1	1	1	95	95	0.139	0.028			
1	1	1	96	96	0.140	0.026	0.024	9.05	
1	1	1	97	97	0.126	0.026	0.024	9.05	
1	1	1	98	98	0.098	0.026	0.024	9.05	
1	1	1	99	99	0.070	0.026	0.024	9.05	
1	1	1	00	00	0.045	0.026	0.024	9.05	
1	1	1	01	01	0.060	0.014	0.016	14.64	
1	1	1	02	02	0.058	0.014	0.016	14.64	
1	1	1	03	50	0.053	0.014	0.016	14.64	
1	2	1	65	67	7.488	0.186			LDGT1
1	2	1	68	69	4.576	0.258			
1	2	1	70	71	3.099	0.382			
1	2	1	72	74	3.266	0.176			
1	2	1	75	75	0.811	0.270			
1	2	1	76	76	0.816	0.272			
1	2	1	77	78	0.452	0.271			
1	2	1	79	80	0.258	0.282			
1	2	1	81	82	0.566	0.086			
1	2	1	83	83	0.409	0.087			
1	2	1	84	85	0.425	0.061			
1	2	1	86	87	0.436	0.062			
1	2	1	88	90	0.278	0.049			
1	2	1	91	92	0.274	0.044			
1	2	1	93	93	0.234	0.042			
1	2	1	94	94	0.182	0.037			
1	2	1	95	95	0.177	0.033			
1	2	1	96	96	0.172	0.031	0.027	11.84	
1	2	1	97	97	0.156	0.031	0.027	11.84	
1	2	1	98	98	0.123	0.031	0.027	11.84	
1	2	1	99	99	0.090	0.031	0.027	11.84	
1	2	1	00	00	0.081	0.031	0.027	11.84	
1	2	1	01	01	0.072	0.015	0.017	17.20	
1	2	1	02	02	0.070	0.015	0.017	17.20	
1	2	1	03	50	0.068	0.015	0.017	17.20	
1	3	1	65	69	9.885	0.186			LDGT2
1	3	1	70	73	6.486	0.258			
1	3	1	74	78	6.486	0.176			
1	3	1	79	80	0.470	0.286			
1	3	1	81	81	0.566	0.086			
1	3	1	82	82	0.560	0.086			
1	3	1	83	83	0.409	0.088			
1	3	1	84	84	0.422	0.061			
1	3	1	85	85	0.427	0.063			
1	3	1	86	86	0.436	0.067			
1	3	1	87	87	0.439	0.069			
1	3	1	88	88	0.278	0.051			
1	3	1	89	89	0.282	0.048			
1	3	1	90	90	0.278	0.048			
1	3	1	91	91	0.273	0.044			
1	3	1	92	92	0.275	0.042			

1	3	1	93	95	0.234	0.042			
1	3	1	96	96	0.209	0.038			
1	3	1	97	97	0.184	0.034	0.029	13.93	
1	3	1	98	98	0.170	0.034	0.029	13.93	
1	3	1	99	99	0.145	0.034	0.029	13.93	
1	3	1	00	00	0.120	0.034	0.029	13.93	
1	3	1	01	01	0.097	0.034	0.028	13.93	
1	3	1	02	02	0.095	0.034	0.028	13.93	
1	3	1	03	50	0.093	0.034	0.028	13.93	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.862	0.039			
1	4	1	04	06	0.255	0.016			
1	4	1	07	50	0.192	0.011			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.170	0.020			
1	5	1	97	97	0.152	0.020			
1	5	1	98	98	0.119	0.020			
1	5	1	99	99	0.085	0.020			
1	5	1	00	00	0.055	0.020			
1	5	1	01	01	0.053	0.006			
1	5	1	02	02	0.051	0.006			
1	5	1	03	50	0.047	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	97	0.281	0.027			
1	6	1	98	98	0.242	0.027			
1	6	1	99	99	0.207	0.027			
1	6	1	00	00	0.171	0.027			
1	6	1	01	01	0.138	0.027			
1	6	1	02	02	0.135	0.027			
1	6	1	03	50	0.132	0.027			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

```
TOG BERs - California I/M LEV II Case
0123           ZM    DR1    DR2 Flex Pt  File: CA_IM_C.BER
1 1 1 65 67  7.488  0.186                      LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.286  0.165
1 1 1 75 77  0.641  0.282
1 1 1 78 79  0.294  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 82  0.464  0.120  0.005  14.63
1 1 1 83 83  0.336  0.064
1 1 1 84 84  0.346  0.061
1 1 1 85 85  0.350  0.057
1 1 1 86 87  0.358  0.046
1 1 1 88 90  0.228  0.036
1 1 1 91 92  0.225  0.035
1 1 1 93 93  0.189  0.035
1 1 1 94 94  0.142  0.031
1 1 1 95 95  0.139  0.028
1 1 1 96 96  0.140  0.026  0.024   9.05
1 1 1 97 97  0.126  0.026  0.024   9.05
1 1 1 98 98  0.098  0.026  0.024   9.05
1 1 1 99 99  0.070  0.026  0.024   9.05
1 1 1 00 00  0.045  0.026  0.024   9.05
1 1 1 01 03  0.057  0.014  0.016  14.64
1 1 1 04 08  0.039  0.014  0.016  14.64
1 1 1 09 50  0.031  0.014  0.016  14.64
1 2 1 65 67  7.488  0.186                      LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.266  0.176
1 2 1 75 75  0.811  0.270
1 2 1 76 76  0.816  0.272
1 2 1 77 78  0.452  0.271
1 2 1 79 80  0.258  0.282
1 2 1 81 82  0.566  0.086
1 2 1 83 83  0.409  0.087
1 2 1 84 85  0.425  0.061
1 2 1 86 87  0.436  0.062
1 2 1 88 90  0.278  0.049
1 2 1 91 92  0.274  0.044
1 2 1 93 93  0.234  0.042
1 2 1 94 94  0.182  0.037
1 2 1 95 95  0.177  0.033
1 2 1 96 96  0.172  0.031  0.027  11.84
1 2 1 97 97  0.156  0.031  0.027  11.84
1 2 1 98 98  0.123  0.031  0.027  11.84
1 2 1 99 99  0.090  0.031  0.027  11.84
1 2 1 00 00  0.080  0.031  0.027  11.84
1 2 1 01 03  0.070  0.015  0.017  17.20
1 2 1 04 08  0.046  0.014  0.017  17.20
1 2 1 09 50  0.034  0.014  0.017  17.20
1 3 1 65 69  9.885  0.186                      LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.470  0.286
1 3 1 81 81  0.566  0.086
1 3 1 82 82  0.560  0.086
1 3 1 83 83  0.409  0.088
1 3 1 84 84  0.422  0.061
1 3 1 85 85  0.427  0.063
1 3 1 86 86  0.436  0.067
1 3 1 87 87  0.439  0.069
1 3 1 88 88  0.278  0.051
1 3 1 89 89  0.282  0.048
1 3 1 90 90  0.278  0.048
1 3 1 91 91  0.273  0.044
1 3 1 92 92  0.275  0.042
```

1	3	1	93	95	0.234	0.042			
1	3	1	96	96	0.209	0.038			
1	3	1	97	97	0.184	0.034	0.029	13.93	
1	3	1	98	98	0.170	0.034	0.029	13.93	
1	3	1	99	99	0.145	0.034	0.029	13.93	
1	3	1	00	00	0.120	0.034	0.029	13.93	
1	3	1	01	03	0.095	0.034	0.028	13.93	
1	3	1	04	08	0.046	0.014	0.017	17.20	
1	3	1	09	50	0.034	0.014	0.017	17.20	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.862	0.039			
1	4	1	04	06	0.255	0.016			
1	4	1	07	50	0.192	0.011			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.170	0.020			
1	5	1	97	97	0.152	0.020			
1	5	1	98	98	0.119	0.020			
1	5	1	99	99	0.085	0.020			
1	5	1	00	00	0.055	0.020			
1	5	1	01	01	0.053	0.006			
1	5	1	02	02	0.051	0.006			
1	5	1	03	03	0.047	0.006			
1	5	1	04	08	0.039	0.014	0.016	14.64	
1	5	1	09	50	0.031	0.014	0.016	14.64	
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	97	0.281	0.027			
1	6	1	98	98	0.242	0.027			
1	6	1	99	99	0.207	0.027			
1	6	1	00	00	0.171	0.027			
1	6	1	01	01	0.138	0.027			
1	6	1	02	02	0.135	0.027			
1	6	1	03	03	0.132	0.027			
1	6	1	04	08	0.046	0.014	0.017	17.20	
1	6	1	09	50	0.034	0.014	0.017	17.20	
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

```
TOG BERs - California I/M LEV II Case + Diesel Penetration
0123             ZM    DR1    DR2 Flex Pt  File: CA_IM_D.BER
1 1 1 65 67  7.488  0.186                        LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.286  0.165
1 1 1 75 77  0.641  0.282
1 1 1 78 79  0.294  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 82  0.464  0.120  0.005  14.63
1 1 1 83 83  0.336  0.064
1 1 1 84 84  0.346  0.061
1 1 1 85 85  0.350  0.057
1 1 1 86 87  0.358  0.046
1 1 1 88 90  0.228  0.036
1 1 1 91 92  0.225  0.035
1 1 1 93 93  0.189  0.035
1 1 1 94 94  0.142  0.031
1 1 1 95 95  0.139  0.028
1 1 1 96 96  0.140  0.026  0.024   9.05
1 1 1 97 97  0.126  0.026  0.024   9.05
1 1 1 98 98  0.098  0.026  0.024   9.05
1 1 1 99 99  0.070  0.026  0.024   9.05
1 1 1 00 00  0.045  0.026  0.024   9.05
1 1 1 01 03  0.057  0.014  0.016  14.64
1 1 1 04 08  0.039  0.014  0.016  14.64
1 1 1 09 50  0.031  0.014  0.016  14.64
1 2 1 65 67  7.488  0.186                        LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.266  0.176
1 2 1 75 75  0.811  0.270
1 2 1 76 76  0.816  0.272
1 2 1 77 78  0.452  0.271
1 2 1 79 80  0.258  0.282
1 2 1 81 82  0.566  0.086
1 2 1 83 83  0.409  0.087
1 2 1 84 85  0.425  0.061
1 2 1 86 87  0.436  0.062
1 2 1 88 90  0.278  0.049
1 2 1 91 92  0.274  0.044
1 2 1 93 93  0.234  0.042
1 2 1 94 94  0.182  0.037
1 2 1 95 95  0.177  0.033
1 2 1 96 96  0.172  0.031  0.027  11.84
1 2 1 97 97  0.156  0.031  0.027  11.84
1 2 1 98 98  0.123  0.031  0.027  11.84
1 2 1 99 99  0.090  0.031  0.027  11.84
1 2 1 00 00  0.080  0.031  0.027  11.84
1 2 1 01 03  0.070  0.015  0.017  17.20
1 2 1 04 08  0.046  0.014  0.017  17.20
1 2 1 09 50  0.034  0.014  0.017  17.20
1 3 1 65 69  9.885  0.186                        LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.470  0.286
1 3 1 81 81  0.566  0.086
1 3 1 82 82  0.560  0.086
1 3 1 83 83  0.409  0.088
1 3 1 84 84  0.422  0.061
1 3 1 85 85  0.427  0.063
1 3 1 86 86  0.436  0.067
1 3 1 87 87  0.439  0.069
1 3 1 88 88  0.278  0.051
1 3 1 89 89  0.282  0.048
1 3 1 90 90  0.278  0.048
1 3 1 91 91  0.273  0.044
1 3 1 92 92  0.275  0.042
```

1	3	1	93	95	0.234	0.042			
1	3	1	96	96	0.209	0.038			
1	3	1	97	97	0.184	0.034	0.029	13.93	
1	3	1	98	98	0.170	0.034	0.029	13.93	
1	3	1	99	99	0.145	0.034	0.029	13.93	
1	3	1	00	00	0.120	0.034	0.029	13.93	
1	3	1	01	03	0.095	0.034	0.028	13.93	
1	3	1	04	08	0.046	0.014	0.017	17.20	
1	3	1	09	50	0.034	0.014	0.017	17.20	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.862	0.039			
1	4	1	04	06	0.255	0.016			
1	4	1	07	50	0.192	0.011			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.170	0.020			
1	5	1	97	97	0.152	0.020			
1	5	1	98	98	0.119	0.020			
1	5	1	99	99	0.085	0.020			
1	5	1	00	00	0.055	0.020			
1	5	1	01	01	0.053	0.006			
1	5	1	02	02	0.051	0.006			
1	5	1	03	03	0.047	0.006			
1	5	1	04	08	0.039	0.014	0.016	14.64	
1	5	1	09	50	0.031	0.014	0.016	14.64	
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	97	0.281	0.027			
1	6	1	98	98	0.242	0.027			
1	6	1	99	99	0.207	0.027			
1	6	1	00	00	0.171	0.027			
1	6	1	01	01	0.138	0.027			
1	6	1	02	02	0.135	0.027			
1	6	1	03	03	0.132	0.027			
1	6	1	04	08	0.046	0.014	0.017	17.20	
1	6	1	09	50	0.034	0.014	0.017	17.20	
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

```
TOG BERs - California I/M 0.055 NMHC Case
0118            ZM    DR1    DR2 Flex Pt  File: CA_IM_5.BER
1 1 1 65 67  7.488  0.186                             LDGV
1 1 1 68 69  4.576  0.258
1 1 1 70 71  3.099  0.382
1 1 1 72 74  3.286  0.165
1 1 1 75 77  0.641  0.282
1 1 1 78 79  0.294  0.284
1 1 1 80 80  0.371  0.211
1 1 1 81 82  0.464  0.120  0.005  14.63
1 1 1 83 83  0.336  0.064
1 1 1 84 84  0.346  0.061
1 1 1 85 85  0.350  0.057
1 1 1 86 87  0.358  0.046
1 1 1 88 90  0.228  0.036
1 1 1 91 92  0.225  0.035
1 1 1 93 93  0.189  0.035
1 1 1 94 94  0.142  0.031
1 1 1 95 95  0.139  0.028
1 1 1 96 96  0.140  0.026  0.024   9.05
1 1 1 97 97  0.126  0.026  0.024   9.05
1 1 1 98 98  0.098  0.026  0.024   9.05
1 1 1 99 99  0.070  0.026  0.024   9.05
1 1 1 00 00  0.045  0.026  0.024   9.05
1 1 1 01 03  0.057  0.014  0.016  14.64
1 1 1 04 50  0.028  0.009  0.013  13.20
1 2 1 65 67  7.488  0.186                             LDGT1
1 2 1 68 69  4.576  0.258
1 2 1 70 71  3.099  0.382
1 2 1 72 74  3.266  0.176
1 2 1 75 75  0.811  0.270
1 2 1 76 76  0.816  0.272
1 2 1 77 78  0.452  0.271
1 2 1 79 80  0.258  0.282
1 2 1 81 82  0.566  0.086
1 2 1 83 83  0.409  0.087
1 2 1 84 85  0.425  0.061
1 2 1 86 87  0.436  0.062
1 2 1 88 90  0.278  0.049
1 2 1 91 92  0.274  0.044
1 2 1 93 93  0.234  0.042
1 2 1 94 94  0.182  0.037
1 2 1 95 95  0.177  0.033
1 2 1 96 96  0.172  0.031  0.027  11.84
1 2 1 97 97  0.156  0.031  0.027  11.84
1 2 1 98 98  0.123  0.031  0.027  11.84
1 2 1 99 99  0.090  0.031  0.027  11.84
1 2 1 00 00  0.080  0.031  0.027  11.84
1 2 1 01 03  0.070  0.015  0.017  17.20
1 2 1 04 50  0.028  0.009  0.013  16.61
1 3 1 65 69  9.885  0.186                             LDGT2
1 3 1 70 73  6.486  0.258
1 3 1 74 78  6.486  0.176
1 3 1 79 80  0.470  0.286
1 3 1 81 81  0.566  0.086
1 3 1 82 82  0.560  0.086
1 3 1 83 83  0.409  0.088
1 3 1 84 84  0.422  0.061
1 3 1 85 85  0.427  0.063
1 3 1 86 86  0.436  0.067
1 3 1 87 87  0.439  0.069
1 3 1 88 88  0.278  0.051
1 3 1 89 89  0.282  0.048
1 3 1 90 90  0.278  0.048
1 3 1 91 91  0.273  0.044
1 3 1 92 92  0.275  0.042
1 3 1 93 95  0.234  0.042
1 3 1 96 96  0.209  0.038
```

1	3	1	97	97	0.184	0.034	0.029	13.93	
1	3	1	98	98	0.170	0.034	0.029	13.93	
1	3	1	99	99	0.145	0.034	0.029	13.93	
1	3	1	00	00	0.120	0.034	0.029	13.93	
1	3	1	01	03	0.095	0.034	0.028	13.93	
1	3	1	04	50	0.028	0.009	0.014	16.78	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.862	0.039			
1	4	1	04	06	0.255	0.016			
1	4	1	07	50	0.192	0.011			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.170	0.020			
1	5	1	97	97	0.152	0.020			
1	5	1	98	98	0.119	0.020			
1	5	1	99	99	0.085	0.020			
1	5	1	00	00	0.055	0.020			
1	5	1	01	01	0.053	0.006			
1	5	1	02	02	0.051	0.006			
1	5	1	03	03	0.047	0.006			
1	5	1	04	50	0.027	0.006			
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	97	0.281	0.027			
1	6	1	98	98	0.242	0.027			
1	6	1	99	99	0.207	0.027			
1	6	1	00	00	0.171	0.027			
1	6	1	01	01	0.138	0.027			
1	6	1	02	02	0.135	0.027			
1	6	1	03	03	0.132	0.027			
1	6	1	04	50	0.027	0.006			
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

TOG BERs - California I/M LEV II Case + HDGV

0123					ZM	DR1	DR2	Flex Pt	File: CA_IM_H.BER
1	1	1	65	67	7.488	0.186			LDGV
1	1	1	68	69	4.576	0.258			
1	1	1	70	71	3.099	0.382			
1	1	1	72	74	3.286	0.165			
1	1	1	75	77	0.641	0.282			
1	1	1	78	79	0.294	0.284			
1	1	1	80	80	0.371	0.211			
1	1	1	81	82	0.464	0.120	0.005	14.63	
1	1	1	83	83	0.336	0.064			
1	1	1	84	84	0.346	0.061			
1	1	1	85	85	0.350	0.057			
1	1	1	86	87	0.358	0.046			
1	1	1	88	90	0.228	0.036			
1	1	1	91	92	0.225	0.035			
1	1	1	93	93	0.189	0.035			
1	1	1	94	94	0.142	0.031			
1	1	1	95	95	0.139	0.028			
1	1	1	96	96	0.140	0.026	0.024	9.05	
1	1	1	97	97	0.126	0.026	0.024	9.05	
1	1	1	98	98	0.098	0.026	0.024	9.05	
1	1	1	99	99	0.070	0.026	0.024	9.05	
1	1	1	00	00	0.045	0.026	0.024	9.05	
1	1	1	01	03	0.057	0.014	0.016	14.64	
1	1	1	04	08	0.039	0.014	0.016	14.64	
1	1	1	09	50	0.031	0.014	0.016	14.64	
1	2	1	65	67	7.488	0.186			LDGT1
1	2	1	68	69	4.576	0.258			
1	2	1	70	71	3.099	0.382			
1	2	1	72	74	3.266	0.176			
1	2	1	75	75	0.811	0.270			
1	2	1	76	76	0.816	0.272			
1	2	1	77	78	0.452	0.271			
1	2	1	79	80	0.258	0.282			
1	2	1	81	82	0.566	0.086			
1	2	1	83	83	0.409	0.087			
1	2	1	84	85	0.425	0.061			
1	2	1	86	87	0.436	0.062			
1	2	1	88	90	0.278	0.049			
1	2	1	91	92	0.274	0.044			
1	2	1	93	93	0.234	0.042			
1	2	1	94	94	0.182	0.037			
1	2	1	95	95	0.177	0.033			
1	2	1	96	96	0.172	0.031	0.027	11.84	
1	2	1	97	97	0.156	0.031	0.027	11.84	
1	2	1	98	98	0.123	0.031	0.027	11.84	
1	2	1	99	99	0.090	0.031	0.027	11.84	
1	2	1	00	00	0.080	0.031	0.027	11.84	
1	2	1	01	03	0.070	0.015	0.017	17.20	
1	2	1	04	08	0.046	0.014	0.017	17.20	
1	2	1	09	50	0.034	0.014	0.017	17.20	
1	3	1	65	69	9.885	0.186			LDGT2
1	3	1	70	73	6.486	0.258			
1	3	1	74	78	6.486	0.176			
1	3	1	79	80	0.470	0.286			
1	3	1	81	81	0.566	0.086			
1	3	1	82	82	0.560	0.086			
1	3	1	83	83	0.409	0.088			
1	3	1	84	84	0.422	0.061			
1	3	1	85	85	0.427	0.063			
1	3	1	86	86	0.436	0.067			
1	3	1	87	87	0.439	0.069			
1	3	1	88	88	0.278	0.051			
1	3	1	89	89	0.282	0.048			
1	3	1	90	90	0.278	0.048			
1	3	1	91	91	0.273	0.044			
1	3	1	92	92	0.275	0.042			

1	3	1	93	95	0.234	0.042			
1	3	1	96	96	0.209	0.038			
1	3	1	97	97	0.184	0.034	0.029	13.93	
1	3	1	98	98	0.170	0.034	0.029	13.93	
1	3	1	99	99	0.145	0.034	0.029	13.93	
1	3	1	00	00	0.120	0.034	0.029	13.93	
1	3	1	01	03	0.095	0.034	0.028	13.93	
1	3	1	04	08	0.046	0.014	0.017	17.20	
1	3	1	09	50	0.034	0.014	0.017	17.20	
1	4	1	80	80	4.285	0.203			HDGV
1	4	1	81	83	4.289	0.201			
1	4	1	84	84	4.366	0.205			
1	4	1	85	85	3.148	0.065			
1	4	1	86	86	2.791	0.065			
1	4	1	87	87	1.347	0.126			
1	4	1	88	89	1.194	0.036			
1	4	1	90	90	0.879	0.042			
1	4	1	91	97	0.851	0.039			
1	4	1	98	03	0.820	0.037			
1	4	1	04	06	0.211	0.015			
1	4	1	07	50	0.159	0.010			
1	5	1	65	74	1.406	0.089			LDDV
1	5	1	75	79	0.454	0.078			
1	5	1	80	93	0.310	0.033			
1	5	1	94	94	0.261	0.028			
1	5	1	95	95	0.213	0.023			
1	5	1	96	96	0.170	0.020			
1	5	1	97	97	0.152	0.020			
1	5	1	98	98	0.119	0.020			
1	5	1	99	99	0.085	0.020			
1	5	1	00	00	0.055	0.020			
1	5	1	01	01	0.053	0.006			
1	5	1	02	02	0.051	0.006			
1	5	1	03	03	0.047	0.006			
1	5	1	04	08	0.039	0.014	0.016	14.64	
1	5	1	09	50	0.031	0.014	0.016	14.64	
1	6	1	65	80	0.916	0.089			LDDT
1	6	1	81	95	0.458	0.044			
1	6	1	96	96	0.369	0.036			
1	6	1	97	97	0.281	0.027			
1	6	1	98	98	0.242	0.027			
1	6	1	99	99	0.207	0.027			
1	6	1	00	00	0.171	0.027			
1	6	1	01	01	0.138	0.027			
1	6	1	02	02	0.135	0.027			
1	6	1	03	03	0.132	0.027			
1	6	1	04	08	0.046	0.014	0.017	17.20	
1	6	1	09	50	0.034	0.014	0.017	17.20	
1	7	1	88	88	0.879	0.000			HDDV
1	7	1	89	89	0.886	0.000			
1	7	1	90	90	0.746	0.000			
1	7	1	91	91	0.652	0.000			
1	7	1	92	92	0.653	0.000			
1	7	1	93	93	0.632	0.000			
1	7	1	94	94	0.362	0.000			
1	7	1	95	95	0.359	0.000			
1	7	1	96	50	0.357	0.000			

Off-Cycle Corrections - 1990 Baseline - Non-OTR - With UC/FTP Toxics Mass Fraction Ratios

IV	MYA	MYB	A	+B*Odo	+C*Odo^2	BNZ	ACET	FORM	13BD	MTBE
1	1965	1965	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1966	1966	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1967	1967	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1968	1968	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1969	1969	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1970	1970	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1971	1971	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1972	1972	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1973	1973	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1974	1974	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1975	1975	5.21E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1976	1976	5.23E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1977	1977	5.23E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1978	1978	5.24E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1979	1979	5.24E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1980	1980	5.33E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1981	1981	1.17E-01	-1.46E-02	1.17E-04	1.131	0.922	0.901	0.716	0.962
1	1982	1982	1.15E-01	-1.42E-02	9.80E-05	1.133	0.923	0.904	0.721	0.960
1	1983	1983	1.16E-01	-2.49E-03	-3.04E-05	1.163	0.939	0.947	0.773	0.937
1	1984	1984	1.14E-01	-2.75E-03	-2.56E-05	1.171	0.943	0.958	0.786	0.932
1	1985	1985	1.10E-01	-2.94E-03	-2.05E-05	1.180	0.948	0.971	0.802	0.925
1	1986	1986	9.76E-02	-2.91E-03	-3.34E-07	1.198	0.957	0.996	0.832	0.912
1	1987	1987	9.68E-02	-3.10E-03	-7.30E-07	1.212	0.965	1.016	0.857	0.902
1	1988	1988	6.27E-02	1.60E-03	-6.96E-05	1.289	1.006	1.125	0.991	0.845
1	1989	1989	6.56E-02	1.68E-03	-6.21E-05	1.315	1.020	1.163	1.037	0.825
1	1990	1990	6.53E-02	2.18E-03	-6.52E-05	1.315	1.020	1.163	1.037	0.825
1	1991	1991	6.38E-02	2.18E-03	-6.63E-05	1.315	1.020	1.163	1.037	0.825
1	1992	1992	6.59E-02	2.33E-03	-6.15E-05	1.315	1.020	1.163	1.037	0.825
1	1993	1993	6.51E-02	2.30E-03	-6.18E-05	1.315	1.020	1.163	1.037	0.825
1	1994	1994	6.69E-02	1.83E-03	-4.03E-05	1.315	1.020	1.163	1.037	0.825
1	1995	1995	6.86E-02	1.35E-03	-1.87E-05	1.315	1.020	1.163	1.037	0.825
1	1996	1996	6.95E-02	1.11E-03	-7.92E-06	1.315	1.020	1.163	1.037	0.825
1	1997	1997	6.95E-03	1.11E-03	-7.92E-06	1.315	1.020	1.163	1.037	0.825
1	1998	1998	6.95E-04	1.11E-03	-7.92E-06	1.315	1.020	1.163	1.037	0.825
1	1999	1999	6.95E-04	1.11E-03	-7.92E-06	1.315	1.020	1.163	1.037	0.825
1	2000	2000	6.95E-04	1.11E-03	-7.92E-06	1.315	1.020	1.163	1.037	0.825
1	2001	2001	6.52E-02	7.73E-04	1.37E-06	1.315	1.020	1.163	1.037	0.825
1	2002	2002	4.43E-02	6.07E-04	3.23E-06	1.315	1.020	1.163	1.037	0.825
1	2003	2003	1.48E-02	3.73E-04	5.88E-06	1.315	1.020	1.163	1.037	0.825
1	2004	2050	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
2	1965	1965	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1966	1966	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1967	1967	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1968	1968	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1969	1969	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1970	1970	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1971	1971	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1972	1972	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1973	1973	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000

2	1974	1974	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1975	1975	1.68E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1976	1976	1.69E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1977	1977	1.68E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1978	1978	1.68E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1979	1979	1.69E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1980	1980	1.69E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1981	1981	1.82E-01	-1.67E-02	-4.11E-04	1.126	0.919	0.894	0.708	0.965
2	1982	1982	1.82E-01	-1.67E-02	-4.11E-04	1.126	0.919	0.894	0.708	0.965
2	1983	1983	1.84E-01	-1.69E-02	-4.16E-04	1.126	0.919	0.894	0.708	0.965
2	1984	1984	1.38E-01	1.44E-03	-2.69E-04	1.159	0.937	0.942	0.766	0.940
2	1985	1985	1.35E-01	1.37E-03	-2.79E-04	1.167	0.941	0.952	0.779	0.935
2	1986	1986	1.25E-01	1.21E-03	-3.08E-04	1.178	0.947	0.967	0.798	0.927
2	1987	1987	1.21E-01	1.09E-03	-3.45E-04	1.193	0.955	0.990	0.825	0.915
2	1988	1988	8.24E-02	2.52E-03	-2.02E-04	1.234	0.977	1.047	0.896	0.885
2	1989	1989	7.97E-02	2.85E-03	-1.89E-04	1.260	0.991	1.085	0.942	0.865
2	1990	1990	7.60E-02	2.84E-03	-1.83E-04	1.261	0.991	1.086	0.943	0.865
2	1991	1991	7.01E-02	2.53E-03	-1.80E-04	1.315	1.020	1.163	1.037	0.825
2	1992	1992	7.27E-02	3.06E-03	-1.69E-04	1.315	1.020	1.163	1.037	0.825
2	1993	1993	7.19E-02	3.12E-03	-1.65E-04	1.315	1.020	1.163	1.037	0.825
2	1994	1994	7.19E-02	2.41E-03	-1.03E-04	1.315	1.020	1.163	1.037	0.825
2	1995	1995	7.21E-02	1.72E-03	-4.23E-05	1.315	1.020	1.163	1.037	0.825
2	1996	1996	7.24E-02	1.37E-03	-1.17E-05	1.315	1.020	1.163	1.037	0.825
2	1997	1997	7.24E-02	1.37E-03	-1.17E-05	1.315	1.020	1.163	1.037	0.825
2	1998	1998	7.24E-02	1.37E-03	-1.17E-05	1.315	1.020	1.163	1.037	0.825
2	1999	1999	7.24E-02	1.37E-03	-1.17E-05	1.315	1.020	1.163	1.037	0.825
2	2000	2000	7.24E-02	1.37E-03	-1.17E-05	1.315	1.020	1.163	1.037	0.825
2	2001	2001	6.10E-02	8.85E-04	6.50E-07	1.315	1.020	1.163	1.037	0.825
2	2002	2002	4.11E-02	7.04E-04	1.63E-06	1.315	1.020	1.163	1.037	0.825
2	2003	2003	1.34E-02	4.49E-04	3.12E-06	1.315	1.020	1.163	1.037	0.825
2	2004	2050	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
3	1965	1965	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1966	1966	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1967	1967	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1968	1968	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1969	1969	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1970	1970	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1971	1971	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1972	1972	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1973	1973	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1974	1974	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1975	1975	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1976	1976	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1977	1977	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1978	1978	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1979	1979	1.71E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1980	1980	1.71E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1981	1981	1.82E-01	-1.66E-02	-4.10E-04	1.126	0.919	0.894	0.708	0.965
3	1982	1982	1.82E-01	-1.66E-02	-4.10E-04	1.126	0.919	0.894	0.708	0.965
3	1983	1983	1.85E-01	-1.69E-02	-4.18E-04	1.126	0.919	0.894	0.708	0.965
3	1984	1984	1.40E-01	1.46E-03	-2.72E-04	1.159	0.937	0.942	0.766	0.940

3	1985	1985	1.39E-01	1.42E-03	-2.89E-04	1.167	0.941	0.952	0.779	0.935
3	1986	1986	1.33E-01	1.29E-03	-3.28E-04	1.178	0.947	0.967	0.798	0.927
3	1987	1987	1.27E-01	1.15E-03	-3.63E-04	1.193	0.955	0.990	0.825	0.915
3	1988	1988	8.62E-02	2.63E-03	-2.11E-04	1.234	0.977	1.047	0.896	0.885
3	1989	1989	8.25E-02	2.95E-03	-1.95E-04	1.260	0.991	1.085	0.942	0.865
3	1990	1990	8.00E-02	2.99E-03	-1.93E-04	1.261	0.991	1.086	0.943	0.865
3	1991	1991	7.01E-02	2.53E-03	-1.80E-04	1.315	1.020	1.163	1.037	0.825
3	1992	1992	7.27E-02	3.06E-03	-1.69E-04	1.315	1.020	1.163	1.037	0.825
3	1993	1993	7.19E-02	3.12E-03	-1.65E-04	1.315	1.020	1.163	1.037	0.825
3	1994	1994	7.17E-02	3.11E-03	-1.64E-04	1.315	1.020	1.163	1.037	0.825
3	1995	1995	7.17E-02	3.11E-03	-1.64E-04	1.315	1.020	1.163	1.037	0.825
3	1996	1996	7.26E-02	2.32E-03	-8.87E-05	1.315	1.020	1.163	1.037	0.825
3	1997	1997	7.33E-02	1.52E-03	-1.25E-05	1.315	1.020	1.163	1.037	0.825
3	1998	1998	7.33E-02	1.52E-03	-1.25E-05	1.315	1.020	1.163	1.037	0.825
3	1999	1999	7.33E-02	1.52E-03	-1.25E-05	1.315	1.020	1.163	1.037	0.825
3	2000	2000	7.33E-02	1.52E-03	-1.25E-05	1.315	1.020	1.163	1.037	0.825
3	2001	2001	7.25E-02	1.50E-03	-1.24E-05	1.315	1.020	1.163	1.037	0.825
3	2002	2002	4.71E-02	1.04E-03	-4.83E-06	1.315	1.020	1.163	1.037	0.825
3	2003	2003	2.19E-02	5.85E-04	2.81E-06	1.315	1.020	1.163	1.037	0.825
3	2004	2050	9.16E-03	3.56E-04	6.65E-06	1.315	1.020	1.163	1.037	0.825
4	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
5	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
6	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
7	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
8	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000

Off-Cycle Corrections - 1996 Baseline - Non-OTR - With UC/FTP Toxics Mass Fraction Ratios

IV	MYA	MYB	A	+B*Odo	+C*Odo^2	BNZ	ACET	FORM	13BD	MTBE
1	1965	1965	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1966	1966	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1967	1967	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1968	1968	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1969	1969	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1970	1970	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1971	1971	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1972	1972	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1973	1973	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1974	1974	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1975	1975	5.21E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1976	1976	5.23E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1977	1977	5.23E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1978	1978	5.24E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1979	1979	5.24E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1980	1980	5.33E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1981	1981	1.17E-01	-1.46E-02	1.17E-04	1.128	0.920	0.896	0.711	0.964
1	1982	1982	1.15E-01	-1.42E-02	9.80E-05	1.128	0.920	0.896	0.711	0.964
1	1983	1983	1.16E-01	-2.49E-03	-3.04E-05	1.144	0.928	0.919	0.739	0.952
1	1984	1984	1.14E-01	-2.75E-03	-2.56E-05	1.147	0.930	0.924	0.745	0.949
1	1985	1985	1.10E-01	-2.94E-03	-2.05E-05	1.151	0.932	0.929	0.751	0.947
1	1986	1986	9.76E-02	-2.91E-03	-3.34E-07	1.160	0.937	0.943	0.768	0.940
1	1987	1987	9.68E-02	-3.10E-03	-7.30E-07	1.163	0.939	0.947	0.773	0.937
1	1988	1988	6.27E-02	1.60E-03	-6.96E-05	1.191	0.954	0.987	0.821	0.917
1	1989	1989	6.56E-02	1.68E-03	-6.21E-05	1.196	0.956	0.994	0.830	0.913
1	1990	1990	6.53E-02	2.18E-03	-6.52E-05	1.208	0.963	1.010	0.850	0.905
1	1991	1991	6.38E-02	2.18E-03	-6.63E-05	1.220	0.969	1.028	0.872	0.895
1	1992	1992	6.59E-02	2.33E-03	-6.15E-05	1.234	0.977	1.048	0.897	0.885
1	1993	1993	6.51E-02	2.30E-03	-6.18E-05	1.256	0.988	1.079	0.934	0.869
1	1994	1994	6.69E-02	1.83E-03	-4.03E-05	1.287	1.005	1.123	0.988	0.846
1	1995	1995	6.86E-02	1.35E-03	-1.87E-05	1.315	1.020	1.163	1.037	0.825
1	1996	1996	6.95E-02	1.11E-03	-7.92E-06	1.315	1.020	1.163	1.037	0.825
1	1997	1997	6.95E-03	1.11E-03	-7.92E-06	1.315	1.020	1.163	1.037	0.825
1	1998	1998	6.95E-04	1.11E-03	-7.92E-06	1.315	1.020	1.163	1.037	0.825
1	1999	1999	6.95E-04	1.11E-03	-7.92E-06	1.315	1.020	1.163	1.037	0.825
1	2000	2000	6.95E-04	1.11E-03	-7.92E-06	1.315	1.020	1.163	1.037	0.825
1	2001	2001	6.52E-02	7.73E-04	1.37E-06	1.315	1.020	1.163	1.037	0.825
1	2002	2002	4.43E-02	6.07E-04	3.23E-06	1.315	1.020	1.163	1.037	0.825
1	2003	2003	1.48E-02	3.73E-04	5.88E-06	1.315	1.020	1.163	1.037	0.825
1	2004	2050	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
2	1965	1965	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1966	1966	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1967	1967	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1968	1968	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1969	1969	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1970	1970	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1971	1971	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1972	1972	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1973	1973	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000

2	1974	1974	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1975	1975	1.68E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1976	1976	1.69E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1977	1977	1.68E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1978	1978	1.68E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1979	1979	1.69E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1980	1980	1.69E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1981	1981	1.82E-01	-1.67E-02	-4.11E-04	1.126	0.919	0.894	0.708	0.965
2	1982	1982	1.82E-01	-1.67E-02	-4.11E-04	1.126	0.919	0.894	0.708	0.965
2	1983	1983	1.84E-01	-1.69E-02	-4.16E-04	1.126	0.919	0.894	0.708	0.965
2	1984	1984	1.38E-01	1.44E-03	-2.69E-04	1.140	0.926	0.913	0.732	0.955
2	1985	1985	1.35E-01	1.37E-03	-2.79E-04	1.141	0.927	0.916	0.735	0.954
2	1986	1986	1.25E-01	1.21E-03	-3.08E-04	1.143	0.928	0.919	0.738	0.952
2	1987	1987	1.21E-01	1.09E-03	-3.45E-04	1.146	0.930	0.923	0.743	0.950
2	1988	1988	8.24E-02	2.52E-03	-2.02E-04	1.166	0.940	0.951	0.778	0.935
2	1989	1989	7.97E-02	2.85E-03	-1.89E-04	1.174	0.945	0.963	0.792	0.929
2	1990	1990	7.60E-02	2.84E-03	-1.83E-04	1.182	0.949	0.974	0.806	0.923
2	1991	1991	7.01E-02	2.53E-03	-1.80E-04	1.190	0.953	0.985	0.820	0.917
2	1992	1992	7.27E-02	3.06E-03	-1.69E-04	1.205	0.961	1.006	0.845	0.907
2	1993	1993	7.19E-02	3.12E-03	-1.65E-04	1.221	0.970	1.029	0.873	0.895
2	1994	1994	7.19E-02	2.41E-03	-1.03E-04	1.242	0.981	1.059	0.909	0.879
2	1995	1995	7.21E-02	1.72E-03	-4.23E-05	1.315	1.020	1.163	1.037	0.825
2	1996	1996	7.24E-02	1.37E-03	-1.17E-05	1.315	1.020	1.163	1.037	0.825
2	1997	1997	7.24E-02	1.37E-03	-1.17E-05	1.315	1.020	1.163	1.037	0.825
2	1998	1998	7.24E-02	1.37E-03	-1.17E-05	1.315	1.020	1.163	1.037	0.825
2	1999	1999	7.24E-02	1.37E-03	-1.17E-05	1.315	1.020	1.163	1.037	0.825
2	2000	2000	7.24E-02	1.37E-03	-1.17E-05	1.315	1.020	1.163	1.037	0.825
2	2001	2001	6.10E-02	8.85E-04	6.50E-07	1.315	1.020	1.163	1.037	0.825
2	2002	2002	4.11E-02	7.04E-04	1.63E-06	1.315	1.020	1.163	1.037	0.825
2	2003	2003	1.34E-02	4.49E-04	3.12E-06	1.315	1.020	1.163	1.037	0.825
2	2004	2050	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
3	1965	1965	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1966	1966	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1967	1967	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1968	1968	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1969	1969	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1970	1970	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1971	1971	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1972	1972	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1973	1973	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1974	1974	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1975	1975	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1976	1976	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1977	1977	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1978	1978	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1979	1979	1.71E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1980	1980	1.71E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1981	1981	1.82E-01	-1.66E-02	-4.10E-04	1.126	0.919	0.894	0.708	0.965
3	1982	1982	1.82E-01	-1.66E-02	-4.10E-04	1.126	0.919	0.894	0.708	0.965
3	1983	1983	1.85E-01	-1.69E-02	-4.18E-04	1.126	0.919	0.894	0.708	0.965
3	1984	1984	1.40E-01	1.46E-03	-2.72E-04	1.140	0.926	0.913	0.732	0.955

3	1985	1985	1.39E-01	1.42E-03	-2.89E-04	1.141	0.927	0.916	0.735	0.954
3	1986	1986	1.33E-01	1.29E-03	-3.28E-04	1.143	0.928	0.919	0.738	0.952
3	1987	1987	1.27E-01	1.15E-03	-3.63E-04	1.146	0.930	0.923	0.743	0.950
3	1988	1988	8.62E-02	2.63E-03	-2.11E-04	1.166	0.940	0.951	0.778	0.935
3	1989	1989	8.25E-02	2.95E-03	-1.95E-04	1.174	0.945	0.963	0.792	0.929
3	1990	1990	8.00E-02	2.99E-03	-1.93E-04	1.182	0.949	0.974	0.806	0.923
3	1991	1991	7.01E-02	2.53E-03	-1.80E-04	1.190	0.953	0.985	0.820	0.917
3	1992	1992	7.27E-02	3.06E-03	-1.69E-04	1.205	0.961	1.006	0.845	0.907
3	1993	1993	7.19E-02	3.12E-03	-1.65E-04	1.221	0.970	1.029	0.873	0.895
3	1994	1994	7.17E-02	3.11E-03	-1.64E-04	1.242	0.981	1.059	0.909	0.879
3	1995	1995	7.17E-02	3.11E-03	-1.64E-04	1.265	0.993	1.092	0.950	0.862
3	1996	1996	7.26E-02	2.32E-03	-8.87E-05	1.268	0.995	1.096	0.956	0.860
3	1997	1997	7.33E-02	1.52E-03	-1.25E-05	1.315	1.020	1.163	1.037	0.825
3	1998	1998	7.33E-02	1.52E-03	-1.25E-05	1.315	1.020	1.163	1.037	0.825
3	1999	1999	7.33E-02	1.52E-03	-1.25E-05	1.315	1.020	1.163	1.037	0.825
3	2000	2000	7.33E-02	1.52E-03	-1.25E-05	1.315	1.020	1.163	1.037	0.825
3	2001	2001	7.25E-02	1.50E-03	-1.24E-05	1.315	1.020	1.163	1.037	0.825
3	2002	2002	4.71E-02	1.04E-03	-4.83E-06	1.315	1.020	1.163	1.037	0.825
3	2003	2003	2.19E-02	5.85E-04	2.81E-06	1.315	1.020	1.163	1.037	0.825
3	2004	2050	9.16E-03	3.56E-04	6.65E-06	1.315	1.020	1.163	1.037	0.825
4	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
5	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
6	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
7	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
8	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000

Off-Cycle Corrections - 2007 Baseline - Non-OTR - With UC/FTP Toxics Mass Fraction Ratios

IV	MYA	MYB	A	+B*Odo	+C*Odo^2	BNZ	ACET	FORM	13BD	MTBE
1	1965	1965	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1966	1966	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1967	1967	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1968	1968	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1969	1969	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1970	1970	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1971	1971	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1972	1972	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1973	1973	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1974	1974	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1975	1975	5.21E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1976	1976	5.23E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1977	1977	5.23E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1978	1978	5.24E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1979	1979	5.24E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1980	1980	5.33E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1981	1981	1.17E-01	-1.46E-02	1.17E-04	1.127	0.919	0.895	0.709	0.964
1	1982	1982	1.15E-01	-1.42E-02	9.80E-05	1.127	0.919	0.895	0.709	0.964
1	1983	1983	1.16E-01	-2.49E-03	-3.04E-05	1.133	0.923	0.904	0.720	0.960
1	1984	1984	1.14E-01	-2.75E-03	-2.56E-05	1.134	0.924	0.906	0.723	0.959
1	1985	1985	1.10E-01	-2.94E-03	-2.05E-05	1.136	0.924	0.908	0.725	0.958
1	1986	1986	9.76E-02	-2.91E-03	-3.34E-07	1.143	0.928	0.918	0.738	0.952
1	1987	1987	9.68E-02	-3.10E-03	-7.30E-07	1.144	0.929	0.920	0.739	0.952
1	1988	1988	6.27E-02	1.60E-03	-6.96E-05	1.158	0.936	0.939	0.763	0.941
1	1989	1989	6.56E-02	1.68E-03	-6.21E-05	1.158	0.936	0.940	0.764	0.941
1	1990	1990	6.53E-02	2.18E-03	-6.52E-05	1.161	0.938	0.944	0.770	0.939
1	1991	1991	6.38E-02	2.18E-03	-6.63E-05	1.164	0.939	0.948	0.774	0.937
1	1992	1992	6.59E-02	2.33E-03	-6.15E-05	1.165	0.940	0.950	0.776	0.936
1	1993	1993	6.51E-02	2.30E-03	-6.18E-05	1.168	0.941	0.953	0.780	0.934
1	1994	1994	6.69E-02	1.83E-03	-4.03E-05	1.177	0.946	0.967	0.797	0.927
1	1995	1995	6.86E-02	1.35E-03	-1.87E-05	1.187	0.951	0.981	0.814	0.920
1	1996	1996	6.95E-02	1.11E-03	-7.92E-06	1.192	0.954	0.987	0.822	0.916
1	1997	1997	6.95E-03	1.11E-03	-7.92E-06	1.196	0.956	0.994	0.830	0.913
1	1998	1998	6.95E-04	1.11E-03	-7.92E-06	1.201	0.959	1.001	0.839	0.909
1	1999	1999	6.95E-04	1.11E-03	-7.92E-06	1.259	0.990	1.083	0.940	0.866
1	2000	2000	6.95E-04	1.11E-03	-7.92E-06	1.315	1.020	1.163	1.037	0.825
1	2001	2001	6.52E-02	7.73E-04	1.37E-06	1.315	1.020	1.163	1.037	0.825
1	2002	2002	4.43E-02	6.07E-04	3.23E-06	1.315	1.020	1.163	1.037	0.825
1	2003	2003	1.48E-02	3.73E-04	5.88E-06	1.315	1.020	1.163	1.037	0.825
1	2004	2004	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2005	2005	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2006	2006	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2007	2007	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2008	2008	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2009	2009	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2010	2010	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2011	2011	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2012	2012	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2013	2013	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825

1	2014	2014	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2015	2015	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2016	2050	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
2	1965	1965	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1966	1966	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1967	1967	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1968	1968	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1969	1969	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1970	1970	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1971	1971	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1972	1972	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1973	1973	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1974	1974	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1975	1975	1.68E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1976	1976	1.69E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1977	1977	1.68E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1978	1978	1.68E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1979	1979	1.69E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1980	1980	1.69E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1981	1981	1.82E-01	-1.67E-02	-4.11E-04	1.126	0.919	0.894	0.708	0.965
2	1982	1982	1.82E-01	-1.67E-02	-4.11E-04	1.126	0.919	0.894	0.708	0.965
2	1983	1983	1.84E-01	-1.69E-02	-4.16E-04	1.126	0.919	0.894	0.708	0.965
2	1984	1984	1.38E-01	1.44E-03	-2.69E-04	1.129	0.921	0.898	0.713	0.963
2	1985	1985	1.35E-01	1.37E-03	-2.79E-04	1.129	0.921	0.899	0.714	0.963
2	1986	1986	1.25E-01	1.21E-03	-3.08E-04	1.129	0.921	0.899	0.714	0.962
2	1987	1987	1.21E-01	1.09E-03	-3.45E-04	1.130	0.921	0.899	0.714	0.962
2	1988	1988	8.24E-02	2.52E-03	-2.02E-04	1.142	0.927	0.917	0.736	0.953
2	1989	1989	7.97E-02	2.85E-03	-1.89E-04	1.145	0.929	0.921	0.742	0.951
2	1990	1990	7.60E-02	2.84E-03	-1.83E-04	1.147	0.930	0.924	0.745	0.949
2	1991	1991	7.01E-02	2.53E-03	-1.80E-04	1.148	0.931	0.925	0.746	0.949
2	1992	1992	7.27E-02	3.06E-03	-1.69E-04	1.153	0.933	0.932	0.754	0.945
2	1993	1993	7.19E-02	3.12E-03	-1.65E-04	1.155	0.934	0.935	0.758	0.944
2	1994	1994	7.19E-02	2.41E-03	-1.03E-04	1.170	0.942	0.956	0.784	0.933
2	1995	1995	7.21E-02	1.72E-03	-4.23E-05	1.184	0.950	0.977	0.809	0.922
2	1996	1996	7.24E-02	1.37E-03	-1.17E-05	1.192	0.954	0.987	0.822	0.916
2	1997	1997	7.24E-02	1.37E-03	-1.17E-05	1.196	0.956	0.994	0.830	0.913
2	1998	1998	7.24E-02	1.37E-03	-1.17E-05	1.201	0.959	1.001	0.839	0.909
2	1999	1999	7.24E-02	1.37E-03	-1.17E-05	1.259	0.990	1.083	0.940	0.866
2	2000	2000	7.24E-02	1.37E-03	-1.17E-05	1.315	1.020	1.163	1.037	0.825
2	2001	2001	6.10E-02	8.85E-04	6.50E-07	1.315	1.020	1.163	1.037	0.825
2	2002	2002	4.11E-02	7.04E-04	1.63E-06	1.315	1.020	1.163	1.037	0.825
2	2003	2003	1.34E-02	4.49E-04	3.12E-06	1.315	1.020	1.163	1.037	0.825
2	2004	2004	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
2	2005	2005	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
2	2006	2006	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
2	2007	2007	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
2	2008	2008	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
2	2009	2009	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
2	2010	2010	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
2	2011	2011	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
2	2012	2012	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825

2	2013	2013	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
2	2014	2014	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
2	2015	2015	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
2	2016	2050	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
3	1965	1965	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1966	1966	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1967	1967	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1968	1968	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1969	1969	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1970	1970	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1971	1971	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1972	1972	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1973	1973	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1974	1974	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1975	1975	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1976	1976	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1977	1977	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1978	1978	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1979	1979	1.71E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1980	1980	1.71E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1981	1981	1.82E-01	-1.66E-02	-4.10E-04	1.126	0.919	0.894	0.708	0.965
3	1982	1982	1.82E-01	-1.66E-02	-4.10E-04	1.126	0.919	0.894	0.708	0.965
3	1983	1983	1.85E-01	-1.69E-02	-4.18E-04	1.126	0.919	0.894	0.708	0.965
3	1984	1984	1.40E-01	1.46E-03	-2.72E-04	1.129	0.921	0.898	0.713	0.963
3	1985	1985	1.39E-01	1.42E-03	-2.89E-04	1.129	0.921	0.899	0.714	0.963
3	1986	1986	1.33E-01	1.29E-03	-3.28E-04	1.129	0.921	0.899	0.714	0.962
3	1987	1987	1.27E-01	1.15E-03	-3.63E-04	1.130	0.921	0.899	0.714	0.962
3	1988	1988	8.62E-02	2.63E-03	-2.11E-04	1.142	0.927	0.917	0.736	0.953
3	1989	1989	8.25E-02	2.95E-03	-1.95E-04	1.145	0.929	0.921	0.742	0.951
3	1990	1990	8.00E-02	2.99E-03	-1.93E-04	1.147	0.930	0.924	0.745	0.949
3	1991	1991	7.01E-02	2.53E-03	-1.80E-04	1.148	0.931	0.925	0.746	0.949
3	1992	1992	7.27E-02	3.06E-03	-1.69E-04	1.153	0.933	0.932	0.754	0.945
3	1993	1993	7.19E-02	3.12E-03	-1.65E-04	1.155	0.934	0.935	0.758	0.944
3	1994	1994	7.17E-02	3.11E-03	-1.64E-04	1.157	0.936	0.938	0.762	0.942
3	1995	1995	7.17E-02	3.11E-03	-1.64E-04	1.159	0.937	0.941	0.766	0.940
3	1996	1996	7.26E-02	2.32E-03	-8.87E-05	1.172	0.944	0.960	0.789	0.931
3	1997	1997	7.33E-02	1.52E-03	-1.25E-05	1.186	0.951	0.979	0.812	0.921
3	1998	1998	7.33E-02	1.52E-03	-1.25E-05	1.191	0.954	0.986	0.821	0.917
3	1999	1999	7.33E-02	1.52E-03	-1.25E-05	1.197	0.957	0.995	0.831	0.913
3	2000	2000	7.33E-02	1.52E-03	-1.25E-05	1.204	0.961	1.005	0.844	0.907
3	2001	2001	7.25E-02	1.50E-03	-1.24E-05	1.213	0.966	1.018	0.860	0.900
3	2002	2002	4.71E-02	1.04E-03	-4.83E-06	1.225	0.972	1.035	0.880	0.892
3	2003	2003	2.19E-02	5.85E-04	2.81E-06	1.239	0.980	1.055	0.905	0.881
3	2004	2004	9.16E-03	3.56E-04	6.65E-06	1.259	0.990	1.083	0.940	0.866
3	2005	2005	9.16E-03	3.56E-04	6.65E-06	1.286	1.005	1.122	0.987	0.846
3	2006	2006	9.16E-03	3.56E-04	6.65E-06	1.315	1.020	1.163	1.037	0.825
3	2007	2007	9.16E-03	3.56E-04	6.65E-06	1.315	1.020	1.163	1.037	0.825
3	2008	2008	9.16E-03	3.56E-04	6.65E-06	1.315	1.020	1.163	1.037	0.825
3	2009	2009	9.16E-03	3.56E-04	6.65E-06	1.315	1.020	1.163	1.037	0.825
3	2010	2010	9.16E-03	3.56E-04	6.65E-06	1.315	1.020	1.163	1.037	0.825
3	2011	2011	9.16E-03	3.56E-04	6.65E-06	1.315	1.020	1.163	1.037	0.825

3	2012	2012	9.16E-03	3.56E-04	6.65E-06	1.315	1.020	1.163	1.037	0.825
3	2013	2013	9.16E-03	3.56E-04	6.65E-06	1.315	1.020	1.163	1.037	0.825
3	2014	2014	9.16E-03	3.56E-04	6.65E-06	1.315	1.020	1.163	1.037	0.825
3	2015	2015	9.16E-03	3.56E-04	6.65E-06	1.315	1.020	1.163	1.037	0.825
3	2016	2050	9.16E-03	3.56E-04	6.65E-06	1.315	1.020	1.163	1.037	0.825
4	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
5	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
6	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
7	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
8	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000

Off-Cycle Corrections - 2020 Baseline - Non-OTR - With   UC/FTP Toxics Mass Fraction Ratios

IV	MYA	MYB	A	+B*Odo	+C*Odo^2	BNZ	ACET	FORM	13BD	MTBE
1	1965	1965	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1966	1966	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1967	1967	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1968	1968	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1969	1969	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1970	1970	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1971	1971	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1972	1972	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1973	1973	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1974	1974	4.94E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1975	1975	5.21E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1976	1976	5.23E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1977	1977	5.23E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1978	1978	5.24E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1979	1979	5.24E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1980	1980	5.33E-02	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
1	1981	1981	1.17E-01	-1.46E-02	1.17E-04	1.127	0.919	0.895	0.709	0.964
1	1982	1982	1.15E-01	-1.42E-02	9.80E-05	1.127	0.919	0.895	0.709	0.964
1	1983	1983	1.16E-01	-2.49E-03	-3.04E-05	1.127	0.919	0.895	0.709	0.964
1	1984	1984	1.14E-01	-2.75E-03	-2.56E-05	1.127	0.919	0.895	0.709	0.964
1	1985	1985	1.10E-01	-2.94E-03	-2.05E-05	1.127	0.919	0.895	0.709	0.964
1	1986	1986	9.76E-02	-2.91E-03	-3.34E-07	1.127	0.919	0.895	0.709	0.964
1	1987	1987	9.68E-02	-3.10E-03	-7.30E-07	1.127	0.919	0.895	0.709	0.964
1	1988	1988	6.27E-02	1.60E-03	-6.96E-05	1.127	0.919	0.895	0.709	0.964
1	1989	1989	6.56E-02	1.68E-03	-6.21E-05	1.127	0.919	0.895	0.709	0.964
1	1990	1990	6.53E-02	2.18E-03	-6.52E-05	1.127	0.919	0.895	0.709	0.964
1	1991	1991	6.38E-02	2.18E-03	-6.63E-05	1.127	0.919	0.895	0.709	0.964
1	1992	1992	6.59E-02	2.33E-03	-6.15E-05	1.127	0.919	0.895	0.709	0.964
1	1993	1993	6.51E-02	2.30E-03	-6.18E-05	1.127	0.919	0.895	0.709	0.964
1	1994	1994	6.69E-02	1.83E-03	-4.03E-05	1.146	0.930	0.922	0.742	0.950
1	1995	1995	6.86E-02	1.35E-03	-1.87E-05	1.165	0.940	0.949	0.775	0.936
1	1996	1996	6.95E-02	1.11E-03	-7.92E-06	1.174	0.945	0.962	0.792	0.929
1	1997	1997	6.95E-03	1.11E-03	-7.92E-06	1.175	0.945	0.964	0.794	0.928
1	1998	1998	6.95E-04	1.11E-03	-7.92E-06	1.177	0.946	0.966	0.796	0.927
1	1999	1999	6.95E-04	1.11E-03	-7.92E-06	1.206	0.962	1.008	0.847	0.906
1	2000	2000	6.95E-04	1.11E-03	-7.92E-06	1.235	0.977	1.049	0.897	0.885
1	2001	2001	6.52E-02	7.73E-04	1.37E-06	1.253	0.987	1.075	0.930	0.871
1	2002	2002	4.43E-02	6.07E-04	3.23E-06	1.258	0.990	1.082	0.938	0.867
1	2003	2003	1.48E-02	3.73E-04	5.88E-06	1.263	0.992	1.090	0.947	0.863
1	2004	2004	2.26E-03	2.73E-04	7.04E-06	1.269	0.996	1.098	0.958	0.859
1	2005	2005	2.26E-03	2.73E-04	7.04E-06	1.276	0.999	1.108	0.970	0.854
1	2006	2006	2.26E-03	2.73E-04	7.04E-06	1.284	1.003	1.119	0.983	0.848
1	2007	2007	2.26E-03	2.73E-04	7.04E-06	1.293	1.008	1.132	0.999	0.841
1	2008	2008	2.26E-03	2.73E-04	7.04E-06	1.303	1.014	1.146	1.017	0.834
1	2009	2009	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2010	2010	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2011	2011	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2012	2012	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2013	2013	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825

1	2014	2014	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2015	2015	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
1	2016	2050	2.26E-03	2.73E-04	7.04E-06	1.315	1.020	1.163	1.037	0.825
2	1965	1965	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1966	1966	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1967	1967	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1968	1968	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1969	1969	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1970	1970	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1971	1971	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1972	1972	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1973	1973	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1974	1974	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1975	1975	1.68E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1976	1976	1.69E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1977	1977	1.68E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1978	1978	1.68E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1979	1979	1.69E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1980	1980	1.69E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
2	1981	1981	1.82E-01	-1.67E-02	-4.11E-04	1.126	0.919	0.894	0.708	0.965
2	1982	1982	1.82E-01	-1.67E-02	-4.11E-04	1.126	0.919	0.894	0.708	0.965
2	1983	1983	1.84E-01	-1.69E-02	-4.16E-04	1.126	0.919	0.894	0.708	0.965
2	1984	1984	1.38E-01	1.44E-03	-2.69E-04	1.126	0.919	0.894	0.708	0.965
2	1985	1985	1.35E-01	1.37E-03	-2.79E-04	1.126	0.919	0.894	0.708	0.965
2	1986	1986	1.25E-01	1.21E-03	-3.08E-04	1.126	0.919	0.894	0.708	0.965
2	1987	1987	1.21E-01	1.09E-03	-3.45E-04	1.126	0.919	0.894	0.708	0.965
2	1988	1988	8.24E-02	2.52E-03	-2.02E-04	1.126	0.919	0.894	0.708	0.965
2	1989	1989	7.97E-02	2.85E-03	-1.89E-04	1.126	0.919	0.894	0.708	0.965
2	1990	1990	7.60E-02	2.84E-03	-1.83E-04	1.126	0.919	0.894	0.708	0.965
2	1991	1991	7.01E-02	2.53E-03	-1.80E-04	1.126	0.919	0.894	0.708	0.965
2	1992	1992	7.27E-02	3.06E-03	-1.69E-04	1.126	0.919	0.894	0.708	0.965
2	1993	1993	7.19E-02	3.12E-03	-1.65E-04	1.126	0.919	0.894	0.708	0.965
2	1994	1994	7.19E-02	2.41E-03	-1.03E-04	1.141	0.927	0.915	0.734	0.954
2	1995	1995	7.21E-02	1.72E-03	-4.23E-05	1.156	0.935	0.937	0.761	0.943
2	1996	1996	7.24E-02	1.37E-03	-1.17E-05	1.164	0.939	0.948	0.774	0.937
2	1997	1997	7.24E-02	1.37E-03	-1.17E-05	1.165	0.940	0.949	0.776	0.936
2	1998	1998	7.24E-02	1.37E-03	-1.17E-05	1.166	0.940	0.951	0.778	0.935
2	1999	1999	7.24E-02	1.37E-03	-1.17E-05	1.194	0.956	0.991	0.827	0.914
2	2000	2000	7.24E-02	1.37E-03	-1.17E-05	1.223	0.971	1.032	0.877	0.893
2	2001	2001	6.10E-02	8.85E-04	6.50E-07	1.241	0.980	1.057	0.908	0.880
2	2002	2002	4.11E-02	7.04E-04	1.63E-06	1.245	0.983	1.064	0.915	0.877
2	2003	2003	1.34E-02	4.49E-04	3.12E-06	1.250	0.985	1.071	0.924	0.873
2	2004	2004	1.49E-03	3.40E-04	3.79E-06	1.256	0.988	1.078	0.934	0.869
2	2005	2005	1.49E-03	3.40E-04	3.79E-06	1.262	0.992	1.087	0.944	0.864
2	2006	2006	1.49E-03	3.40E-04	3.79E-06	1.269	0.995	1.097	0.957	0.859
2	2007	2007	1.49E-03	3.40E-04	3.79E-06	1.277	0.999	1.108	0.970	0.854
2	2008	2008	1.49E-03	3.40E-04	3.79E-06	1.285	1.004	1.120	0.985	0.847
2	2009	2009	1.49E-03	3.40E-04	3.79E-06	1.295	1.009	1.134	1.002	0.840
2	2010	2010	1.49E-03	3.40E-04	3.79E-06	1.306	1.015	1.150	1.021	0.832
2	2011	2011	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
2	2012	2012	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825

2	2013	2013	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
2	2014	2014	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
2	2015	2015	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
2	2016	2050	1.49E-03	3.40E-04	3.79E-06	1.315	1.020	1.163	1.037	0.825
3	1965	1965	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1966	1966	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1967	1967	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1968	1968	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1969	1969	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1970	1970	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1971	1971	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1972	1972	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1973	1973	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1974	1974	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1975	1975	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1976	1976	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1977	1977	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1978	1978	1.60E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1979	1979	1.71E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1980	1980	1.71E-01	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
3	1981	1981	1.82E-01	-1.66E-02	-4.10E-04	1.126	0.919	0.894	0.708	0.965
3	1982	1982	1.82E-01	-1.66E-02	-4.10E-04	1.126	0.919	0.894	0.708	0.965
3	1983	1983	1.85E-01	-1.69E-02	-4.18E-04	1.126	0.919	0.894	0.708	0.965
3	1984	1984	1.40E-01	1.46E-03	-2.72E-04	1.126	0.919	0.894	0.708	0.965
3	1985	1985	1.39E-01	1.42E-03	-2.89E-04	1.126	0.919	0.894	0.708	0.965
3	1986	1986	1.33E-01	1.29E-03	-3.28E-04	1.126	0.919	0.894	0.708	0.965
3	1987	1987	1.27E-01	1.15E-03	-3.63E-04	1.126	0.919	0.894	0.708	0.965
3	1988	1988	8.62E-02	2.63E-03	-2.11E-04	1.126	0.919	0.894	0.708	0.965
3	1989	1989	8.25E-02	2.95E-03	-1.95E-04	1.126	0.919	0.894	0.708	0.965
3	1990	1990	8.00E-02	2.99E-03	-1.93E-04	1.126	0.919	0.894	0.708	0.965
3	1991	1991	7.01E-02	2.53E-03	-1.80E-04	1.126	0.919	0.894	0.708	0.965
3	1992	1992	7.27E-02	3.06E-03	-1.69E-04	1.126	0.919	0.894	0.708	0.965
3	1993	1993	7.19E-02	3.12E-03	-1.65E-04	1.126	0.919	0.894	0.708	0.965
3	1994	1994	7.17E-02	3.11E-03	-1.64E-04	1.126	0.919	0.894	0.708	0.965
3	1995	1995	7.17E-02	3.11E-03	-1.64E-04	1.126	0.919	0.894	0.708	0.965
3	1996	1996	7.26E-02	2.32E-03	-8.87E-05	1.142	0.928	0.917	0.737	0.953
3	1997	1997	7.33E-02	1.52E-03	-1.25E-05	1.159	0.937	0.941	0.765	0.941
3	1998	1998	7.33E-02	1.52E-03	-1.25E-05	1.160	0.937	0.942	0.767	0.940
3	1999	1999	7.33E-02	1.52E-03	-1.25E-05	1.161	0.938	0.944	0.769	0.939
3	2000	2000	7.33E-02	1.52E-03	-1.25E-05	1.162	0.938	0.946	0.771	0.938
3	2001	2001	7.25E-02	1.50E-03	-1.24E-05	1.164	0.939	0.947	0.773	0.937
3	2002	2002	4.71E-02	1.04E-03	-4.83E-06	1.165	0.940	0.950	0.776	0.936
3	2003	2003	2.19E-02	5.85E-04	2.81E-06	1.167	0.941	0.952	0.779	0.935
3	2004	2004	9.16E-03	3.56E-04	6.65E-06	1.169	0.942	0.955	0.782	0.933
3	2005	2005	9.16E-03	3.56E-04	6.65E-06	1.171	0.943	0.958	0.786	0.932
3	2006	2006	9.16E-03	3.56E-04	6.65E-06	1.173	0.944	0.961	0.790	0.930
3	2007	2007	9.16E-03	3.56E-04	6.65E-06	1.175	0.945	0.964	0.794	0.928
3	2008	2008	9.16E-03	3.56E-04	6.65E-06	1.178	0.947	0.968	0.799	0.926
3	2009	2009	9.16E-03	3.56E-04	6.65E-06	1.182	0.949	0.973	0.805	0.924
3	2010	2010	9.16E-03	3.56E-04	6.65E-06	1.186	0.951	0.979	0.812	0.921
3	2011	2011	9.16E-03	3.56E-04	6.65E-06	1.191	0.954	0.986	0.821	0.917

3	2012	2012	9.16E-03	3.56E-04	6.65E-06	1.197	0.957	0.995	0.831	0.913
3	2013	2013	9.16E-03	3.56E-04	6.65E-06	1.204	0.961	1.005	0.844	0.907
3	2014	2014	9.16E-03	3.56E-04	6.65E-06	1.213	0.966	1.018	0.860	0.900
3	2015	2015	9.16E-03	3.56E-04	6.65E-06	1.225	0.972	1.035	0.880	0.892
3	2016	2050	9.16E-03	3.56E-04	6.65E-06	1.315	1.020	1.163	1.037	0.825
4	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
5	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
6	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
7	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000
8	1965	2050	0.00E+00	0.00E+00	0.00E+00	1.000	1.000	1.000	1.000	1.000

Appendix B

Revised CO Inputs for MOBILE5b Emissions Modeling

The following inputs and data are included in this appendix:

1. Alternative CO base emission rate equations for the following:

    a. Low-altitude
    b. High-altitude (Denver)

2. Off-Cycle CO correction factors (I/M and non-I/M combined)

3. Air conditioning data for CO estimates (fraction equipped, malfunction rates)

4. Oxygenated fuels CO effects

CO BERs - Non-I/M

0044					ZM	DR1	DR2	Flex Pt	File: BER_CO.PRN
1	1	2	65	67	78.270	2.250			LDGV
1	1	2	68	69	56.340	2.550			
1	1	2	70	71	42.170	3.130			
1	1	2	72	74	40.940	2.350			
1	1	2	75	79	17.720	2.460			
1	1	2	80	80	6.090	1.958			
1	1	2	81	81	4.301	2.441	3.037	1.50	
1	1	2	82	82	4.301	2.441	3.037	1.50	
1	1	2	83	83	2.813	0.191	1.650	2.16	
1	1	2	84	84	2.813	0.191	1.650	2.16	
1	1	2	85	85	2.813	0.191	1.650	2.16	
1	1	2	86	86	2.795	0.696			
1	1	2	87	87	2.795	0.696			
1	1	2	88	88	2.795	0.696			
1	1	2	89	89	2.795	0.696			
1	1	2	90	90	2.188	0.076	0.556	1.85	
1	1	2	91	91	2.188	0.076	0.556	1.85	
1	2	2	65	67	78.270	2.250			LDGT1
1	2	2	68	69	56.340	2.550			
1	2	2	70	71	42.170	3.130			
1	2	2	72	74	40.780	2.440			
1	2	2	75	78	24.550	2.590			
1	2	2	79	80	12.280	2.430			
1	2	2	81	83	14.503	1.929			
1	2	2	84	84	6.045	0.496	1.094	5.34	
1	2	2	85	85	6.045	0.496	1.094	5.34	
1	2	2	86	86	6.045	0.496	1.094	5.34	
1	2	2	87	87	6.045	0.496	1.094	5.34	
1	2	2	88	88	6.045	0.496	1.094	5.34	
1	2	2	89	89	6.045	0.496	1.094	5.34	
1	2	2	90	90	5.382	0.245	0.717	5.37	
1	2	2	91	91	5.382	0.245	0.717	5.37	
1	3	2	65	69	93.980	2.250			LDGT2
1	3	2	70	78	60.080	2.550			
1	3	2	79	80	12.280	2.430			
1	3	2	81	83	14.503	1.929			
1	3	2	84	84	6.045	0.496	1.094	5.34	
1	3	2	85	85	6.045	0.496	1.094	5.34	
1	3	2	86	86	6.045	0.496	1.094	5.34	
1	3	2	87	87	6.045	0.496	1.094	5.34	
1	3	2	88	88	6.045	0.496	1.094	5.34	
1	3	2	89	89	6.045	0.496	1.094	5.34	
1	3	2	90	90	5.382	0.245	0.717	5.37	
1	3	2	91	91	5.382	0.245	0.717	5.37	

Hi Alt CO BERs - Non-I/M

0033					ZM	DR1	DR2	Flex Pt	File: DNV_CO.PRN
1	1	2	81	81	16.815	2.441	3.037	1.50	LDGV
1	1	2	82	82	11.455	2.441	3.037	1.50	
1	1	2	83	83	2.839	0.191	1.650	2.16	
1	1	2	84	84	2.813	0.191	1.650	2.16	
1	1	2	85	85	2.813	0.191	1.650	2.16	
1	1	2	86	86	2.795	0.696			
1	1	2	87	87	2.795	0.696			
1	1	2	88	88	2.795	0.696			
1	1	2	89	89	2.795	0.696			
1	1	2	90	90	2.188	0.076	0.556	1.85	
1	1	2	91	91	2.188	0.076	0.556	1.85	
1	2	2	81	81	51.014	1.929			LDGT1
1	2	2	82	82	34.770	1.929			
1	2	2	83	83	34.770	1.929			
1	2	2	84	84	14.968	0.496	1.094	5.34	
1	2	2	85	85	8.462	0.496	1.094	5.34	
1	2	2	86	86	8.462	0.496	1.094	5.34	
1	2	2	87	87	8.463	0.496	1.094	5.34	
1	2	2	88	88	8.462	0.496	1.094	5.34	
1	2	2	89	89	8.461	0.496	1.094	5.34	
1	2	2	90	90	7.533	0.245	0.717	5.37	
1	2	2	91	91	7.532	0.245	0.717	5.37	
1	3	2	81	81	51.014	1.929			LDGT2
1	3	2	82	82	34.770	1.929			
1	3	2	83	83	34.770	1.929			
1	3	2	84	84	14.968	0.496	1.094	5.34	
1	3	2	85	85	8.462	0.496	1.094	5.34	
1	3	2	86	86	8.462	0.496	1.094	5.34	
1	3	2	87	87	8.463	0.496	1.094	5.34	
1	3	2	88	88	8.462	0.496	1.094	5.34	
1	3	2	89	89	8.461	0.496	1.094	5.34	
1	3	2	90	90	7.533	0.245	0.717	5.37	
1	3	2	91	91	7.532	0.245	0.717	5.37	

I/M	IV	MY	Agg Drv	A/C	
1	1	1965	1.328	1.217	Non-I/M Factors
1	1	1966	1.328	1.217	
1	1	1967	1.324	1.215	
1	1	1968	1.370	1.237	
1	1	1969	1.365	1.235	
1	1	1970	1.375	1.240	
1	1	1971	1.371	1.238	
1	1	1972	1.432	1.265	
1	1	1973	1.426	1.263	
1	1	1974	1.419	1.260	
1	1	1975	1.574	1.321	
1	1	1976	1.568	1.319	
1	1	1977	1.560	1.316	
1	1	1978	1.552	1.313	
1	1	1979	1.543	1.310	
1	1	1980	1.861	1.407	
1	1	1981	1.611	1.326	
1	1	1982	1.611	1.326	
1	1	1983	1.611	1.326	
1	1	1984	1.611	1.326	
1	1	1985	1.611	1.326	
1	1	1986	1.611	1.326	
1	1	1987	1.611	1.326	
1	1	1988	1.611	1.326	
1	1	1989	1.611	1.326	
1	1	1990	1.611	1.326	
1	1	1991	1.611	1.326	
1	2	1965	1.328	1.217	
1	2	1966	1.328	1.217	
1	2	1967	1.324	1.215	
1	2	1968	1.370	1.237	
1	2	1969	1.365	1.235	
1	2	1970	1.375	1.240	
1	2	1971	1.371	1.238	
1	2	1972	1.432	1.265	
1	2	1973	1.426	1.263	
1	2	1974	1.419	1.260	
1	2	1975	1.574	1.321	
1	2	1976	1.568	1.319	
1	2	1977	1.560	1.316	
1	2	1978	1.552	1.313	
1	2	1979	1.543	1.310	
1	2	1980	1.292	1.158	
1	2	1981	1.318	1.169	
1	2	1982	1.316	1.168	
1	2	1983	1.314	1.167	
1	2	1984	1.617	1.267	
1	2	1985	1.617	1.267	
1	2	1986	1.617	1.267	
1	2	1987	1.617	1.267	
1	2	1988	1.617	1.267	
1	2	1989	1.617	1.267	
1	2	1990	1.617	1.267	
1	2	1991	1.617	1.267	
1	3	1965	1.125	1.069	
1	3	1966	1.125	1.069	
1	3	1967	1.124	1.068	
1	3	1968	1.123	1.068	
1	3	1969	1.121	1.067	
1	3	1970	1.152	1.082	
1	3	1971	1.151	1.081	
1	3	1972	1.149	1.081	
1	3	1973	1.147	1.080	
1	3	1974	1.148	1.080	
1	3	1975	1.146	1.079	
1	3	1976	1.144	1.078	
1	3	1977	1.141	1.077	

1	3	1978	1.138	1.075	
1	3	1979	1.292	1.140	
1	3	1980	1.292	1.140	
1	3	1981	1.320	1.150	
1	3	1982	1.317	1.150	
1	3	1983	1.314	1.148	
1	3	1984	1.617	1.238	
1	3	1985	1.617	1.238	
1	3	1986	1.617	1.238	
1	3	1987	1.617	1.238	
1	3	1988	1.617	1.238	
1	3	1989	1.617	1.238	
1	3	1990	1.617	1.238	
1	3	1991	1.617	1.238	
2	1	1965	1.328	1.217	I/M Factors
2	1	1966	1.328	1.217	
2	1	1967	1.324	1.215	
2	1	1968	1.370	1.237	
2	1	1969	1.365	1.235	
2	1	1970	1.375	1.240	
2	1	1971	1.371	1.238	
2	1	1972	1.432	1.265	
2	1	1973	1.426	1.263	
2	1	1974	1.419	1.260	
2	1	1975	1.574	1.321	
2	1	1976	1.568	1.319	
2	1	1977	1.560	1.316	
2	1	1978	1.552	1.313	
2	1	1979	1.543	1.310	
2	1	1980	1.861	1.407	
2	1	1981	1.630	1.340	
2	1	1982	1.630	1.340	
2	1	1983	1.630	1.340	
2	1	1984	1.630	1.340	
2	1	1985	1.630	1.340	
2	1	1986	1.630	1.340	
2	1	1987	1.630	1.340	
2	1	1988	1.630	1.340	
2	1	1989	1.630	1.340	
2	1	1990	1.630	1.340	
2	1	1991	1.630	1.340	
2	2	1965	1.328	1.217	
2	2	1966	1.328	1.217	
2	2	1967	1.324	1.215	
2	2	1968	1.370	1.237	
2	2	1969	1.365	1.235	
2	2	1970	1.375	1.240	
2	2	1971	1.371	1.238	
2	2	1972	1.432	1.265	
2	2	1973	1.426	1.263	
2	2	1974	1.419	1.260	
2	2	1975	1.574	1.321	
2	2	1976	1.568	1.319	
2	2	1977	1.560	1.316	
2	2	1978	1.552	1.313	
2	2	1979	1.543	1.310	
2	2	1980	1.292	1.158	
2	2	1981	1.318	1.169	
2	2	1982	1.316	1.168	
2	2	1983	1.314	1.167	
2	2	1984	1.630	1.270	
2	2	1985	1.630	1.270	
2	2	1986	1.630	1.270	
2	2	1987	1.630	1.270	
2	2	1988	1.630	1.270	
2	2	1989	1.630	1.270	
2	2	1990	1.630	1.270	
2	2	1991	1.630	1.270	

2	3	1965	1.125	1.069
2	3	1966	1.125	1.069
2	3	1967	1.124	1.068
2	3	1968	1.123	1.068
2	3	1969	1.121	1.067
2	3	1970	1.152	1.082
2	3	1971	1.151	1.081
2	3	1972	1.149	1.081
2	3	1973	1.147	1.080
2	3	1974	1.148	1.080
2	3	1975	1.146	1.079
2	3	1976	1.144	1.078
2	3	1977	1.141	1.077
2	3	1978	1.138	1.075
2	3	1979	1.292	1.140
2	3	1980	1.292	1.140
2	3	1981	1.320	1.150
2	3	1982	1.317	1.150
2	3	1983	1.314	1.148
2	3	1984	1.630	1.240
2	3	1985	1.630	1.240
2	3	1986	1.630	1.240
2	3	1987	1.630	1.240
2	3	1988	1.630	1.240
2	3	1989	1.630	1.240
2	3	1990	1.630	1.240
2	3	1991	1.630	1.240

MY	LDGV	LDGT	Malf Rate	Functioning Systems LDGV	LDGT
1965	0.60	0.29	0.050	0.570	0.276
1966	0.60	0.29	0.050	0.570	0.276
1967	0.60	0.29	0.050	0.570	0.276
1968	0.60	0.29	0.050	0.570	0.276
1969	0.60	0.29	0.050	0.570	0.276
1970	0.60	0.29	0.050	0.570	0.276
1971	0.60	0.29	0.050	0.570	0.276
1972	0.60	0.29	0.050	0.570	0.276
1973	0.65	0.29	0.038	0.626	0.279
1974	0.65	0.29	0.038	0.626	0.279
1975	0.65	0.29	0.038	0.626	0.279
1976	0.65	0.29	0.038	0.626	0.279
1977	0.65	0.35	0.038	0.626	0.337
1978	0.65	0.35	0.025	0.634	0.341
1979	0.65	0.35	0.025	0.634	0.341
1980	0.65	0.35	0.025	0.634	0.341
1981	0.67	0.39	0.025	0.655	0.382
1982	0.69	0.43	0.025	0.677	0.423
1983	0.72	0.48	0.010	0.709	0.471
1984	0.74	0.52	0.009	0.732	0.513
1985	0.76	0.56	0.008	0.754	0.556
1986	0.78	0.60	0.006	0.777	0.598
1987	0.80	0.64	0.005	0.800	0.641
1988	0.83	0.69	0.000	0.826	0.686
1989	0.85	0.73	0.000	0.848	0.728
1990	0.87	0.77	0.000	0.870	0.770
1991	0.87	0.77	0.000	0.870	0.770

		Normals		Highs	
IV	MY	% Red	g/mi	% Red	g/mi
1	1981	0.0552	4.9	0.0645	20.5
1	1982	0.0576	4.9	0.0663	20.5
1	1983	0.0532	4.9	0.0630	20.5
1	1984	0.0431	4.9	0.0554	20.5
1	1985	0.0441	4.9	0.0561	20.5
1	1986	0.0535	3.2	0.0540	20.5
1	1987	0.0532	3.2	0.0537	20.5
1	1988	0.0375	3.0	0.0530	20.5
1	1989	0.0375	3.0	0.0530	20.5
1	1990	0.0336	2.8	0.0530	20.5
1	1991	0.0336	2.8	0.0530	20.5
1	1992	0.0310	2.8	0.0530	20.5
1	1993	0.0310	2.8	0.0530	20.5
1	1994	0.0186	2.2	0.0530	20.5
1	1995	0.0062	1.7	0.0530	20.5
1	1996	0.0000	1.4	0.0530	20.5
1	1997	0.0000	1.4	0.0530	20.5
1	1998	0.0000	1.4	0.0530	20.5
1	1999	0.0000	1.4	0.0530	20.5
1	2000	0.0000	1.4	0.0530	20.5
1	2001	0.0000	0.9	0.0530	20.5
1	2002	0.0000	0.9	0.0530	20.5
1	2003	0.0000	0.9	0.0530	20.5
1	2004	0.0000	0.9	0.0530	20.5
1	2005	0.0000	0.9	0.0530	20.5
1	2006	0.0000	0.9	0.0530	20.5
1	2007	0.0000	0.9	0.0530	20.5
1	2008	0.0000	0.9	0.0530	20.5
1	2009	0.0000	0.9	0.0530	20.5
1	2010	0.0000	0.9	0.0530	20.5
2	1981	0.0913	4.9	0.0920	20.5
2	1982	0.0918	4.9	0.0924	20.5
2	1983	0.0854	4.9	0.0874	20.5
2	1984	0.0793	4.9	0.0828	20.5
2	1985	0.0667	4.9	0.0733	20.5
2	1986	0.0668	3.2	0.0638	20.5
2	1987	0.0589	3.2	0.0551	20.5
2	1988	0.0575	3.2	0.0536	20.5
2	1989	0.0574	3.2	0.0535	20.5
2	1990	0.0570	3.2	0.0530	20.5
2	1991	0.0570	3.2	0.0530	20.5
2	1992	0.0310	2.8	0.0530	20.5
2	1993	0.0310	2.8	0.0530	20.5
2	1994	0.0186	2.2	0.0530	20.5
2	1995	0.0062	1.7	0.0530	20.5
2	1996	0.0000	1.4	0.0530	20.5
2	1997	0.0000	1.4	0.0530	20.5
2	1998	0.0000	1.4	0.0530	20.5
2	1999	0.0000	1.4	0.0530	20.5
2	2000	0.0000	1.4	0.0530	20.5
2	2001	0.0000	0.9	0.0530	20.5
2	2002	0.0000	0.9	0.0530	20.5
2	2003	0.0000	0.9	0.0530	20.5
2	2004	0.0000	0.9	0.0530	20.5
2	2005	0.0000	0.9	0.0530	20.5
2	2006	0.0000	0.9	0.0530	20.5
2	2007	0.0000	0.9	0.0530	20.5
2	2008	0.0000	0.9	0.0530	20.5
2	2009	0.0000	0.9	0.0530	20.5
2	2010	0.0000	0.9	0.0530	20.5
3	1981	0.0913	4.9	0.0920	20.5
3	1982	0.0918	4.9	0.0924	20.5
3	1983	0.0854	4.9	0.0874	20.5
3	1984	0.0793	4.9	0.0828	20.5
3	1985	0.0667	4.9	0.0733	20.5
3	1986	0.0668	3.2	0.0638	20.5

3	1987	0.0589	3.2	0.0551	20.5
3	1988	0.0575	3.2	0.0536	20.5
3	1989	0.0574	3.2	0.0535	20.5
3	1990	0.0570	3.2	0.0530	20.5
3	1991	0.0570	3.2	0.0530	20.5
3	1992	0.0310	2.8	0.0530	20.5
3	1993	0.0310	2.8	0.0530	20.5
3	1994	0.0310	2.8	0.0530	20.5
3	1995	0.0310	2.8	0.0530	20.5
3	1996	0.0186	2.2	0.0530	20.5
3	1997	0.0062	1.7	0.0530	20.5
3	1998	0.0000	1.4	0.0530	20.5
3	1999	0.0000	1.4	0.0530	20.5
3	2000	0.0000	1.4	0.0530	20.5
3	2001	0.0000	1.4	0.0530	20.5
3	2002	0.0000	1.4	0.0530	20.5
3	2003	0.0000	1.4	0.0530	20.5
3	2004	0.0000	1.4	0.0530	20.5
3	2005	0.0000	1.4	0.0530	20.5
3	2006	0.0000	1.4	0.0530	20.5
3	2007	0.0000	1.4	0.0530	20.5
3	2008	0.0000	1.4	0.0530	20.5
3	2009	0.0000	1.4	0.0530	20.5
3	2010	0.0000	1.4	0.0530	20.5

Appendix C

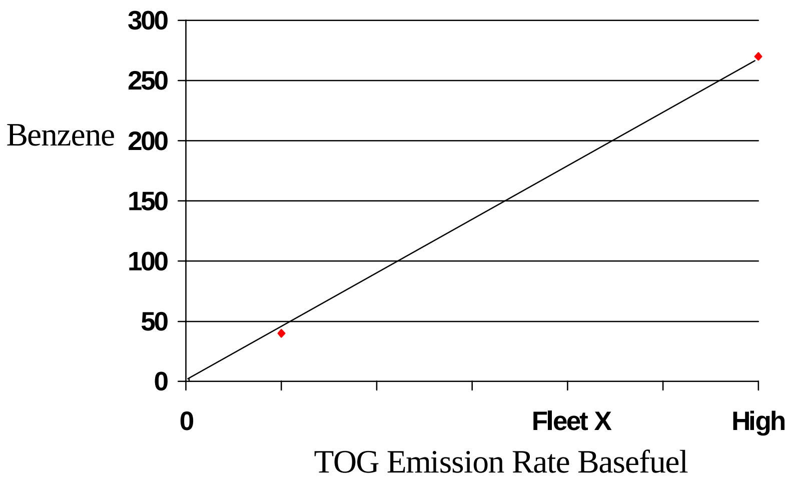
Methodology to Account for Normal/High Emitter Distributions in MOBTOX5b (Development of Toxic-TOG Curves)

Modeling Toxics to Account for Normal/High Emitter Distributions in T2ATTOX

1) Complex Model gives benzene emission rate at normal and high emission levels

2) Figure below relates benzene gram per mile to TOG gram per mile

3) Case: MY cohort fleet with FTP $TOG_{Basefuel}$ = X (X is calculated within MOBILE)



4) Assume: This fleet is a mix of

$$N_H = \frac{X - FTP\ TOG_{NormalBasefuel}}{FTP\ TOG_{HighBasefuel} - FTP\ TOG_{NormalBasefuel}} X\ 100\ \%$$

$$N_N = \frac{FTP\ TOG_{HighBasefuel} - X}{FTP\ TOG_{HighBasefuel} - FTP\ TOG_{NormalBasefuel}}\ X\ 100\ \%$$

5) Question: What is the fleet's benzene on fuel F1?

Answer:

$$\frac{N_H\ X\ Bz_{HighFuelF1} + N_N\ X\ Bz_{Normal\ FuelF1}}{N_H + N_N = 1}$$

$$= \left(\frac{X - FTP\ TOG_N}{FTP\ TOG_H - FTP\ TOG_N}\right)\ X\ (Bz_{H\ F1}) + \left(\frac{FTP\ TOG_H - X}{FTP\ TOG_H - FTP\ TOG_N}\right)\ X\ (Bz_{N\ F1})$$

$$= \left(\frac{FTP\ TOG_H\ X\ Bz_{N\ F1} - FTP\ TOG_N\ X\ Bz_{H\ F1}}{FTP\ TOG_H - FTP\ TOG_N} + \left(\frac{Bz_H - Bz_N}{FTP\ TOG_H - FTP\ TOG_N}\right) * X\right.$$

$$= A_{F1\ Tech1} + B_{F1\ Tech1} * X$$

(Mass emission rate of benzene on Fuel F1, including the effect of fuel F1 on TOG)

$$Bz\ \% = \frac{A + B * X}{X}$$

6) Inside MOBILE5b:

- No fleet ought to be cleaner than TOG FTP_N or dirtier than TOG FTP_H
- If base fuel is not indolene, need to be sure commercial fuel adjustment is applied before X is used with A and B
- I/M adjustment happens before toxic number calculated
- Other adjustments (non-FTP -- speed, temp, etc.) have to come after A and B are applied

7) For non-complex model technology types:

$$A = 0$$

$$B = (k_X) * \left(\frac{VOC_{Fuel\ X}}{VOC_{Fuel\ Baseline}}\right)$$

Appendix D

Equations Used to Generate Toxics Fractions for Non-Complex Model Vehicles

Non-Catalyst and Oxidation Catalyst LDGVs, LDGT1s, and LDGT2s

All Heavy-Duty Gasoline Vehicles and Motorcycles

All Diesel Vehicles

Exhaust Toxic Fraction Equations for LDGV with Oxidation Catalysts, Non-Catalyst LDGV, HDGV, LDDV and HDDV

Table 1 presents equations for estimating exhaust toxic fractions for light-duty gasoline vehicles with oxidation catalysts, light duty non-catalyst gasoline vehicles, heavy duty gasoline vehicles, and heavy duty diesel vehicles. Exhaust benzene, 1,3-butadiene, formaldehyde, and acetaldehyde fractions for light duty gasoline vehicles with three-way catalysts and three-way plus oxidation catalysts, as well as evaporative benzene fractions for all catalyst technologies and vehicle classes, will be estimated using the Complex Model.

<u>Benzene</u>

For LDGVs with no catalyst or an oxidation catalyst, and for HDGVs with no catalyst, the equation used was:

$$Bz\%THC = (0.8551*(\text{volume \% benzene}) + 0.12198*(\text{volume \% aromatics}) - 1.1626)$$

For HDGVs with three-way catalysts, the equation used was:

$$Bz\%THC = 1.077 + 0.7732*(\text{volume \% benzene}) + 0.0987*(\text{volume \% aromatics - volume \% benzene})$$

These equations were used in the "Motor Vehicle-Related Air Toxics Study" (EPA, 1993) and were originally developed for the draft Regulatory Impact Analysis for RVP regulations (EPA, 1987). The benzene/TOG fractions for LDDVs, LDDTs, and HDDVs in Table 1 were based on analysis of available speciation data (Springer, 1977; Springer, 1979; Bass and Newkirk, 1995; CE-CERT, 1998).

<u>Formaldehyde</u>

Formaldehyde/TOG fractions for vehicles running on baseline gasoline and diesels were based on analysis of available speciation data (see attachment). The TOG fraction for LDGVs/LDGTs with oxidation catalysts, running on baseline fuel, was based on data from fifty vehicles tested in eleven studies (Urban, 1980a; Springer, 1979; Sigsby et al., 1987; Smith, 1981; Stump et al., 1989, 1990, 1994, 1996; Auto/Oil, 1990; Boekhaus et al., 1991; Warner-Selph and Smith, 1991; Colorado Department of Health, 1987). The TOG fraction for LDGVs/LDGTs without catalysts, running on baseline fuel, was based on data from sixteen vehicles tested in five studies (Urban, 1981, Urban 1980a, Sigsby et al., 1987, Warner-Selph and Smith, 1991, Stump et. al, unpublished). The LDDV fraction was based on data from seven vehicles tested in two studies (Springer, 1977; Springer, 1979). The HDDV fraction were based on data from four engines in three studies (Springer, 1979; Bass and Newkirk, 1995; CE-CERT, 1998). The fraction for HDGVs without catalysts was based on data from two engines in two studies (Springer, 1979; Bass and Newkirk, 1995). The three-way fraction for HDGVs was based on data from one engine in one study (Bass and Newkirk, 1995).

To calculate TOG fractions for vehicles running on MTBE blends and gasohol, adjustment factors were applied to the baseline emission fractions for each vehicle class/catalyst combination based on average percent change. The adjustment factors were obtained by comparing data from vehicles running on baseline gasoline to data from the same vehicles running on oxygenated gasoline. For MTBE, change was defined by solving the equation:

TOG frac @ 0% MTBE * (1 + (change/2.7) * Ox) = TOG frac @ 15% MTBE

For ethanol, change was defined by solving the equation:

TOG frac @ 0% EtOH * (1 + (change/3.5) * Ox) = TOG frac @ 10% EtOH

The data used to develop the change estimates are provided in the attachment.

Data from five vehicles in three studies were used to develop the MTBE change estimate for LDGVs/LDGTs with oxidation catalysts (Auto/Oil, 1990; Boekhaus et al., 1991; Stump et al., 1994). Data from two vehicles in two studies were used to develop the MTBE change estimate for LDGVs/LDGTs without catalysts (Warner-Selph and Smith, 1991; Stump, 1997). Data from one vehicle was used to develop the MTBE change estimate for non-catalyst HDGVs (Bass and Newkirk, 1995). For catalyst-equipped HDGVs, the MTBE change estimate for LDGVs with three-way catalysts from the EPA document, "Motor Vehicle-Related Air Toxics Study" was used as a surrogate (EPA, 1993).

For ethanol, data from ten vehicles in three studies were used to develop the change estimate for LDGVs/LDGTs with oxidation catalysts (Warner-Selph and Smith, 1991; Colorado Department of Health, 1987; Stump et al., 1996). Data from five vehicles in two studies were used to develop the ethanol change estimate for LDGVs/LDGTs/HDGVs without catalysts (Warner-Selph and Smith, 1991; Colorado Department of Health, 1987). For catalyst-equipped HDGVs, the ethanol change estimate for LDGVs with three-way catalysts from the EPA document, "Motor Vehicle-Related Air Toxics Study" was used as a surrogate (EPA, 1993).

Acetaldehyde

Acetaldehyde/TOG fractions for vehicles running on baseline gasoline and diesels were based on analysis of the same speciation data used for formaldehyde (see attachment). The adjustment factors for MTBE blends and gasohol were also obtained using the same equations and data that were used for formaldehyde.

1,3-Butadiene

1,3-butadiene/TOG fractions for vehicles running on baseline gasoline and diesels were based on analysis of available speciation data (see attachment). The TOG fraction for LDGVs/LDGTs with oxidation catalysts, running on baseline fuel, was based on data from fifty vehicles tested in ten studies (Urban, 1980a; Springer, 1979; Sigsby et al., 1987; Smith, 1981; Stump et al., 1989, 1990, 1994, 1996; Auto/Oil, 1990; Boekhaus et al., 1991; Warner-Selph and Smith, 1991; CARB, 1991). The TOG fraction for LDGVs/LDGTs without catalysts, running on baseline fuel, was based on data from eighteen vehicles tested in three studies (CARB, 1991; Stump, 1997; Warner-Selph and Smith, 1991). The LDDV fraction was based on data from two vehicles tested in one study (CARB, 1991). The HDDV fraction was based on data from three engines in three studies (CARB, 1991; Bass and Newkirk, 1995; CE-CERT, 1998). The fraction for HDGVs without catalysts and HDGVs with catalysts were both based on data from one engine in one study (Bass and Newkirk, 1995).

The adjustment factors were also obtained using the same equations and data that were used for formaldehyde and acetaldehyde, with one exception. The adjustment factor for formaldehyde and acetaldehyde with an MTBE blend uses a change estimate from LDGVs with three-way catalysts as a surrogate. However, for 1,3-butadiene, the estimate is based on data from one vehicle in one study (Bass and Newkirk, 1995).

MTBE

MTBE/TOG fractions were based on available speciation data. These data were from vehicles running on fuels with varying levels of MTBE. To obtain an average 15% MTBE fraction across studies for a given vehicle class/technology group, an assumption was made that the relationship between MTBE in the fuel and exhaust was linear. MTBE/TOG fractions from vehicles running on a blend with X percent MTBE were adjusted to represent the emission fractions for a 15% by volume blend as follows:

$$\text{TOG frac @ 15\% MTBE} = \text{TOG frac @ X\% MTBE} * (2.7 / \text{wt. \% oxygen})$$

The resultant MTBE emission fractions for a 15% blend were used to develop the equations in Table 1.

Data from five vehicles in three studies were used to develop the 15% MTBE emission fraction for LDGVs/LDGTs with oxidation catalysts (Auto/Oil, 1990; Boekhaus et al., 1991; Stump et al., 1994). Data from one vehicle was used to develop the fraction for LDGVs/LDGTs without catalysts (Warner-Selph and Smith, 1991), the fraction for non-catalyst HDGVs (Bass and Newkirk, 1995), and the fraction for HDGVs with catalysts (Bass and Newkirk, 1995).

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Vehicle Class/ Catalyst	**Baseline Gasoline**	**MTBE Gasoline**	**EtOH Gasoline**
Benzene			
LDGV/oxcat	Bz % TOG = 0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626[1]	Bz % TOG = 0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626	Bz % TOG = 0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626
LDGV/noncat	Bz % TOG = 0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626[2]	Bz % TOG = 0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626	Bz % TOG = 0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626
HDGV/noncat	Bz % TOG = 0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626[3]	Bz % TOG = 0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626	Bz % TOG = 0.8551* (vol. % Bz) + 0.12198 * (vol. % Arom.) - 1.1626
HDGV/cat	Bz%TOG = 1.077 + 0.7732*(volume % benzene) + 0.0987 * (volume % aromatics - volume % benzene)[4]	Bz%TOG = 1.077 + 0.7732*(volume % benzene) + 0.0987 * (volume % aromatics - volume % benzene)	Bz%TOG = 1.077 + 0.7732*(volume % benzene) + 0.0987 * (volume % aromatics - volume % benzene)
LDDV	Bz % TOG = 0.0200		

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[1]From 1993 EPA Report, "Motor Vehicle-Related Air Toxics Study," EPA 420-R-93-005.

[2]From 1993 EPA Report, "Motor Vehicle-Related Air Toxics Study," EPA 420-R-93-005.

[3]From 1993 EPA Report, "Motor Vehicle-Related Air Toxics Study," EPA 420-R-93-005.

[4]From 1993 EPA Report, "Motor Vehicle-Related Air Toxics Study," EPA 420-R-93-005.

Vehicle Class/ Catalyst	**Baseline Gasoline**	**MTBE Gasoline**	**EtOH Gasoline**
LDDT	Bz % TOG = 0.0200		
HDDV	Bz % TOG = 0.0105		
Formaldehyde			
LDGV/oxcat	Form % TOG = 0.0151	Form % TOG = 0.0151 + ((0.0151 * 1.2082)*(wt % MTBE/2.7))	Form % TOG = 0.0151 + ((0.0151 * 0.3350)*(wt % EtOH/3.5))
LDGV/noncat	Form % TOG = 0.0224	Form % TOG = 0.0224 + ((0.0224 * 0.4336)*(wt % MTBE/2.7))	Form % TOG = 0.0224 + ((0.0224 * 0.1034)*(wt % EtOH/3.5))
HDGV/noncat	Form % TOG = 0.0347	Form % TOG = 0.0347 + ((0.0347 * 0.1259)*(wt % MTBE/2.7))	Form % TOG = 0.0347 + ((0.0347 * 0.1034)*(wt % EtOH/3.5))
HDGV/cat	Form % TOG = 0.0054	Form % TOG = 0.0054 + ((0.0054 * 0.6746)*(wt % MTBE/2.7))[5]	Form % TOG = 0.0054 + ((0.0054 * 0.4758)*(wt % EtOH/3.5))[6]
LDDV	Form % TOG = 0.0386		
LDDT	Form % TOG = 0.0386		
HDDV	Form % TOG = 0.0782		

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[5]Change with oxygenate estimate, 0.6746, from 3-way catalyst LDGV estimate in Appendix B4 of 1993 EPA Report, "Motor Vehicle-Related Air Toxics Study," EPA 420-R-93-005.

[6]Change with oxygenate estimate, 0.4758, from 3-way catalyst LDGV estimate in Appendix B4 of 1993 EPA Report, "Motor Vehicle-Related Air Toxics Study," EPA 420-R-93-005.

Vehicle Class/ Catalyst	Baseline Gasoline	MTBE Gasoline	EtOH Gasoline
<u>Acetaldehyde</u>			
LDGV/oxcat	Acet % TOG = 0.0047	Acet % TOG = 0.0047 + ((0.0047 * 0.2556)*(wt % MTBE/2.7))	Acet % TOG = 0.0047 + ((0.0047 * 2.1074)*(wt % EtOH/3.5))
LDGV/noncat	Acet % TOG = 0.0060	Acet % TOG = 0.0060 + ((0.0060 * 0.2303)*(wt % MTBE/2.7))	Acet % TOG = 0.0060 + ((0.0060 * 1.1445)*(wt % EtOH/3.5))
HDGV/noncat	Acet % TOG = 0.0067	Acet % TOG = 0.0067	Acet % TOG = 0.0067 + ((0.0067 * 1.1445)*(wt % EtOH/3.5))
HDGV/cat	Acet % TOG = 0.0005	Acet % TOG = 0.0005 + ((0.0005 * 0.0826)*(wt % MTBE/2.7))[7]	Acet % TOG = 0.0005 + ((0.0005 * 1.1369)*(wt % EtOH/3.5))[8]
LDDV	Acet % TOG = 0.0123		
LDDT	Acet % TOG = 0.0123		
HDDV	Acet % TOG = 0.0288		

[7]Change with oxygenate estimate, 0.0826, from 3-way catalyst LDGV estimate in Appendix B4 of 1993 EPA Report, "Motor Vehicle-Related Air Toxics Study," EPA 420-R-93-005.

[8]Change with oxygenate estimate, 1.1369, from 3-way catalyst LDGV estimate in Appendix B4 of 1993 EPA Report, "Motor Vehicle-Related Air Toxics Study," EPA 420-R-93-005.

Vehicle Class/ Catalyst	Baseline Gasoline	MTBE Gasoline	EtOH Gasoline
<u>1,3-Butadiene</u>			
LDGV/oxcat	Buta % TOG = 0.0044	Buta % TOG = 0.0044 + ((0.0044 * -0.2227)*(wt % MTBE/2.7))	Buta % TOG = 0.0044 + ((0.0044* -0.2804)*(wt % EtOH/3.5))
LDGV/noncat	Buta % TOG = 0.0092	Buta % TOG = 0.0092 + ((0.0092 * 0.1517)*(wt % MTBE/2.7))	Buta % TOG = 0.0092 + ((0.0092 * 0.1233)*(wt % EtOH/3.5))
HDGV/noncat	Buta % TOG = 0.0074	Buta % TOG = 0.0074 + ((0.0074 * -0.2172)*(wt % MTBE/2.7))	Buta % TOG = 0.0074 + ((0.0074 * 0.1233)*(wt % MTBE/2.7))
HDGV/cat	Buta % TOG = 0.0029	Buta % TOG = 0.0029 + ((0.0029 * -0.3233)*(wt % MTBE/2.7))	Buta % TOG = 0.0029 + ((0.0029 * -0.1188)*(wt % EtOH/3.5))[9]
LDDV	Buta % TOG = 0.0090		
LDDT	Buta % TOG = 0.0090		
HDDV	Buta % TOG = 0.0061		

[9]Change with oxygenate estimate, -0.1188, from 3-way catalyst LDGV estimate in Appendix B4 of 1993 EPA Report, "Motor Vehicle-Related Air Toxics Study," EPA 420-R-93-005.

Vehicle Class/ Catalyst	Baseline Gasoline	MTBE Gasoline	EtOH Gasoline
MTBE			
LDGV/oxcat		MTBE % TOG = 0.0464*(wt % MTBE/2.7)	
LDGV/noncat		MTBE % TOG = 0.0333*(wt % MTBE/2.7)	
HDGV/noncat		MTBE % TOG = 0.0209*(wt % MTBE/2.7)	
HDGV/cat		MTBE % TOG = 0.0155*(wt % MTBE/2.7)	

Appendix E

EPA's Suggested Methodology to Determine Toxics Fuel Effects from the Complex Model

(fuelsum5.wpd)

Toxics Fuel Effects Summary

I. Pre-1981 vehicles

A. Technology description: These vehicles include open-loop noncatalyst vehicles (through 1974) and open-loop vehicles equipped with oxidation catalysts (1975-1980 cars and trucks).

B. Fuel effect quantification

Baseline VOC emissions are derived from T2AT. The effects of fuel changes on exhaust VOC emissions from these vehicles are taken from Greg Janssen's July 31, 1991 memo and are summarized below.

VOC Emission Effects

Fuel parameter	Non-catalyst vehicles	Oxidation catalyst vehicles
Oxygen, per 1 wt%	- 1.6%	- 4.46
RVP, per 1 psi	+ 1.8%	+ 1.7%

To convert VOC FTP emissions to toxics emissions, Rich Cook has developed mass fraction equations that describe toxics as a function of at most one or two fuel properties.

Off-cycle VOC emissions are modeled in T2AT as an additive factor to FTP emissions. These emissions may have different toxics fractions than on-cycle emissions do. To model these emissions, the CARB database should be used to develop off-cycle toxics fractions using one of two approaches: If available, data from open-loop non-catalyst or oxidation catalyst cars should be used to develop off-cycle toxics fractions. Otherwise, assume the same proportional change in toxics fractions as was observed for more modern vehicles in the CARB database.

The CARB Predictive Model is not a viable option for these vehicles because CARB has repudiated its earlier analysis of fuel effects on emissions from pre-1981 cars.

II. 1981-1983 Vehicles

A. Technology description: These vehicles fall into 3 classes: open-loop vehicles equipped with oxidation catalysts, open-loop vehicles equipped with three-way plus oxidation catalysts, and closed-loop vehicles. The latter class includes vehicles with a range of fuel distribution systems and both three-way and three-way plus oxidation catalysts. A small fraction of trucks have no controls.

B. Fuel effect quantification

1. Non-catalyst and open-loop oxidation catalyst vehicles: The equations developed by Rich Cook can be used.

2. Open-loop vehicles with three-way + oxidation catalysts: These vehicles will be modeled as open-loop vehicles with oxidation catalysts. The three-way catalyst is primarily used to control NOx. Furthermore, in the absence of closed-loop controls, the efficacy of the three-way catalyst on older vehicles (all such vehicles will be at least 5 years old in 1990 and 11 years old in 1996) is questionable.

3. Closed-loop vehicles: The appropriate complex model technology types can be used. The relationship between vehicle technologies and Complex Model technology types is summarized below.

Technology	Complex Model Tech Types
Carbureted (3-way and 3-way+oxcat)	9
3-way PFI	Simple average of 1, 2, 5
3-way TBI	Simple average of 3 & 6
3-way+oxcat PFI	4
3-way+oxcat TBI	7
Higher emitters (all technologies)	Higher emitter

Off-cycle VOC emissions are modeled in T2AT as an additive factor to FTP emissions. These emissions may have different toxics fractions than on-cycle emissions do. To model these emissions, the CARB database should be used to develop off-cycle toxics fractions using one of two approaches: If available, data from cars with the corresponding vehicle technology should be used to develop off-cycle toxics fractions. Otherwise, assume the same proportional change in toxics fractions as was observed for more modern vehicles in the CARB database.

The CARB Predictive Model is not a viable option for these vehicles because the CARB model does not distinguish between normal and higher emitters. It also is not designed to account for tech group to tech group variations, which can be large (two-fold or even more).

C. Caveats

These vehicles are not equipped with adaptive learning, whereas the vehicles tested for the Complex Model all had adaptive learning. Using Complex Model fuel effects to represent the effect of fuel changes on emissions will tend to underestimate the benefits of oxygenates in particular; it may also underestimate the impact of RVP on exhaust emissions.

D. Additional work: Adjust tech group-specific emissions to account for tech group to tech group variations in baseline VOC and toxics emissions, as described in Appendix A.

III. 1984-1985 cars, 1984-1987 trucks

A. Technology description: These vehicles are dominated by closed-loop technologies without adaptive learning. They include a small percentage of open-loop cars equipped with three-way plus oxidation catalysts and a few open-loop trucks with oxidation catalysts, but they are dominated by closed-loop vehicles. The latter class includes vehicles with a range of fuel distribution systems and both three-way and three-way plus oxidation catalysts.

B. Fuel effect quantification

1. Open-loop vehicles: The same approach described for earlier open-loop vehicles should be followed.

2. Closed-loop vehicles: The appropriate complex model technology types can be used. The relationship between vehicle technologies and Complex Model technology types is summarized below.

Technology	**Complex Model Tech Types**
Carbureted (3-way and 3-way+oxcat)	9
3-way PFI	Simple average of 1, 2, 5
3-way TBI	Simple average of 3 & 6
3-way+oxcat PFI	4
3-way+oxcat TBI	7
Higher emitters (all technologies)	Higher emitter

The CARB Predictive Model is not a viable option for these vehicles because the CARB model does not distinguish between normal and higher emitters. It also is not designed to account for tech group to tech group variations, which can be large (two-fold or even more).

3. Off-cycle adjustments: T2AT uses a multiplicative adjustment factor to account for off-cycle adjustments for these and later vehicles. Toxics fractions will have to be modified to account for the different toxics fractions observed in off-cycle emissions.

C. Additional work: Adjust tech group-specific emissions to account for tech group to tech group variations in baseline VOC and toxics emissions as discussed in Appendix A.

IV. 1986-1994 Tier 0 cars, 1988-1994 Tier 0 trucks

A. Technology description: These vehicles are dominated by closed-loop technologies with adaptive learning. The mix of fuel distribution systems shifts away from carbureted and TBI systems to PFI systems. Both three-way and three-way plus oxidation catalyst designs are used.

B. Fuel effect quantification

The appropriate complex model technology types can be used. The relationship between vehicle technologies and Complex Model technology types is summarized below.

Technology	Complex Model Tech Types
Carbureted (3-way and 3-way+oxcat)	9
3-way PFI	Simple average of 1, 2, 5
3-way TBI	Simple average of 3 & 6
3-way+oxcat PFI	4
3-way+oxcat TBI	7
Higher emitters (all technologies)	Higher emitter

Off-cycle adjustments: T2AT uses a multiplicative adjustment factor to account for off-cycle adjustments for these and later vehicles. Toxics fractions will have to be modified to account for the different toxics fractions observed in off-cycle emissions.

C. Additional work: Adjust tech group-specific emissions to account for tech group to tech group variations in baseline VOC and toxics emissions, as described in Appendix A.

V. Tier 1 Vehicles

A. Technology description: These vehicles are dominated by closed-loop technologies, PFI fuel metering systems, and adaptive learning. Both three-way and three-way plus oxidation catalyst designs are used.

B. Fuel effect quantification: The appropriate complex model technology types can be used. The relationship between vehicle technologies and Complex Model technology types is summarized below.

Technology	**Complex Model Tech Types**
3-way PFI	Simple average of 1, 2, 5
3-way TBI	Simple average of 3 & 6
3-way+oxcat PFI	4
3-way+oxcat TBI	7
Higher emitters (all technologies)	Higher emitter

Off-cycle adjustments: T2AT uses a multiplicative adjustment factor to account for off-cycle adjustments for these and later vehicles. Toxics fractions will have to be modified to account for the different toxics fractions observed in off-cycle emissions.

C. Additional work: Adjust tech group-specific emissions to account for tech group to tech group variations in baseline VOC and toxics emissions, as per Appendix A.

VI. LEVs

A. Technology description: These vehicles are dominated by closed-loop technologies, PFI fuel metering systems, adaptive learning, and advanced catalysts. Three-way or three-way plus oxidation catalyst designs may be used.

B. Fuel effect quantification

1. Advanced catalyst designs show greater sulfur sensitivity than the Complex Model suggests. The CRC sulfur study should be used to develop the sulfur effect. The appropriate complex model technology types can be used for the other fuel parameters to calculate percentage changes in baseline toxics levels, which in turn can be calculated based on the CRC sulfur study results.

2. A less desirable alternative would be to use Complex Model baseline toxics emissions, adjusted to reflect lower VOC emissions from LEVs so that average normal emitter emissions for LEVs do not fall below the Complex Model normal level. The relationship between vehicle technologies and Complex Model technology types that could be used is summarized below.

Technology	**Complex Model Tech Types**
3-way PFI	Simple average of 1, 2, 5
3-way+oxcat PFI	4
Higher emitters (all technologies)	Higher emitter

It may be possible to further restrict the technology types used to evaluate the impact of fuel changes on LEVs if information becomes available that suggests EGR or supplementary air injection will become dominant.

3. Off-cycle adjustments: T2AT uses a multiplicative adjustment factor to account for off-cycle adjustments for these vehicles. Toxics fractions will have to be modified to account for the different toxics fractions observed in off-cycle emissions.

C. Additional work

1. Option 1: Calculate baseline toxics using CRC data.

2. Option 2: Adjust Complex Model baseline emissions to account for tech group to tech group variations in VOC and toxics emissions.

Appendix A: Adjusting Tech Group-Specific Emissions to Account for Tech Group to Tech Group Variations in VOC and Toxics

1. The complex model normal emitter baseline numbers for VOC (482 mg/mi in summer and 712 mg/mi in winter) and toxics are incorrectly assumed to be the same for all tech groups. They need to be corrected by multiplying normal emitter baseline VOC and toxics numbers by the following factors to reflect tech group to tech group variations in VOC emissions:

Tech	Correction	New Summer baseline fuel emissions (mg/mi)				
Group	Factor	VOC	BZ	Form	Acet	Buta
1	1.0223	493	27.298	5.913	2.424	2.671
2	0.8384	404	22.388	4.849	1.988	2.190
3	0.8458	408	22.585	4.892	2.006	2.210
4	1.5996	771	42.715	9.252	3.793	4.179
5	0.6582	317	17.577	3/807	1.561	1.720
6	0.7355	354	19.639	4.254	1.744	1.921
7	1.4305	689	38.198	8.274	3.392	3.737
9	0.9487	457	25.334	5.488	2.250	2.479

Winter VOC and toxics emissions would be 47.7% higher.

These emission factors should not be used to calculate in-use VOC or toxics emissions. Rather, these factors should be used to determine the percent change in VOC and toxics emissions due to fuel changes, which in turn should be applied to the VOC inputs to T2ATTOX and to the toxics outputs from T2ATTOX.

2. The complex model database suggests that toxics fractions are not the same across tech groups. However, no further correction will be made because the mix of test fuels differs across tech groups, thereby limiting the usefulness of the complex model database in correcting for tech group differences on baseline fuels. Furthermore, these differences are smaller than they first appear due to averaging.

3. The complex model's percent change values for fuel changes are correct.

Appendix F

Model-Year-Specific Technology Fractions

			Open-Loop		Closed-Loop			3W+OX	3W+OX	
IV	MYA	MYB	NCAT	CAT	Carb	3W PFI	3W TBI	PFI	TBI	
1	65	74	100.00	0.00	0.00	0.00	0.00	0.00	0.00	100
1	75	75	20.00	80.00	0.00	0.00	0.00	0.00	0.00	100
1	76	77	15.00	85.00	0.00	0.00	0.00	0.00	0.00	100
1	78	79	10.00	90.00	0.00	0.00	0.00	0.00	0.00	100
1	80	80	5.00	95.00	0.00	0.00	0.00	0.00	0.00	100
1	81	81	0.00	28.10	62.90	6.00	0.00	0.10	2.90	100
1	82	82	0.00	32.50	50.60	6.20	6.70	0.00	4.00	100
1	83	83	0.00	24.40	48.60	8.50	11.50	0.20	6.80	100
1	84	84	0.00	5.80	55.00	10.50	15.90	0.50	12.30	100
1	85	85	0.00	7.60	40.80	29.20	5.80	1.60	15.00	100
1	86	86	0.00	2.40	31.90	32.90	13.30	6.40	13.10	100
1	87	87	0.00	1.70	24.90	34.70	21.70	2.40	14.60	100
1	88	88	0.00	0.00	10.10	44.40	32.70	4.80	8.00	100
1	89	89	0.00	0.30	12.50	54.60	23.90	5.10	3.60	100
1	90	90	0.00	0.10	1.80	71.80	19.40	4.30	2.60	100
1	91	91	0.00	0.00	0.30	77.50	18.90	2.10	1.20	100
1	92	92	0.00	0.29	0.00	86.47	9.56	3.68	0.00	100
1	93	93	0.00	0.00	0.00	89.06	10.94	0.00	0.00	100
1	94	94	0.00	0.00	0.00	96.12	3.88	0.00	0.00	100
1	95	95	0.00	0.00	0.00	98.80	1.20	0.00	0.00	100
1	96	99	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100
1	00	00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100
1	01	03	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100
1	04	50	0.00	0.00	0.00	100.00	0.00	0.00	0.00	100
2	65	74	100.00	0.00	0.00	0.00	0.00	0.00	0.00	100
2	75	75	30.00	70.00	0.00	0.00	0.00	0.00	0.00	100
2	76	76	20.00	80.00	0.00	0.00	0.00	0.00	0.00	100
2	77	78	25.00	75.00	0.00	0.00	0.00	0.00	0.00	100
2	79	80	20.00	80.00	0.00	0.00	0.00	0.00	0.00	100
2	81	81	3.00	95.20	1.80	0.00	0.00	0.00	0.00	100
2	82	82	0.00	96.10	3.90	0.00	0.00	0.00	0.00	100
2	83	83	2.60	84.10	13.10	0.20	0.00	0.00	0.00	100
2	84	84	0.00	72.80	25.00	2.20	0.00	0.00	0.00	100
2	85	85	0.00	62.90	25.80	6.60	4.70	0.00	0.00	100
2	86	86	0.00	49.50	13.10	23.80	9.10	0.00	4.50	100
2	87	87	0.00	26.40	12.80	20.40	22.30	12.30	5.80	100
2	88	88	0.00	5.00	9.20	28.00	37.00	13.60	7.20	100
2	89	89	0.00	1.40	7.70	33.10	30.70	20.90	6.20	100
2	90	90	0.10	1.20	2.00	41.20	32.50	18.70	4.30	100
2	91	91	0.00	0.10	1.50	43.50	36.20	14.20	4.50	100
2	92	92	0.48	0.87	0.76	54.15	31.82	11.86	0.06	100
2	93	93	0.00	0.00	1.10	58.00	30.08	10.82	0.00	100
2	94	94	0.00	0.00	0.00	62.13	27.21	10.66	0.00	100
2	95	95	0.00	0.00	0.00	63.92	25.36	10.72	0.00	100
2	96	96	0.00	0.00	0.00	63.00	25.00	12.00	0.00	100
2	97	97	0.00	0.00	0.00	69.08	20.00	10.92	0.00	100
2	98	98	0.00	0.00	0.00	75.16	15.00	9.84	0.00	100
2	99	99	0.00	0.00	0.00	81.24	10.00	8.76	0.00	100
2	00	00	0.00	0.00	0.00	87.32	5.00	7.68	0.00	100
2	01	03	0.00	0.00	0.00	93.40	0.00	6.60	0.00	100
2	04	50	0.00	0.00	0.00	93.40	0.00	6.60	0.00	100
3	65	78	100.00	0.00	0.00	0.00	0.00	0.00	0.00	100
3	79	80	0.00	100.00	0.00	0.00	0.00	0.00	0.00	100
3	81	81	3.00	95.20	1.80	0.00	0.00	0.00	0.00	100
3	82	82	0.00	96.10	3.90	0.00	0.00	0.00	0.00	100
3	83	83	2.60	84.10	13.10	0.20	0.00	0.00	0.00	100
3	84	84	0.00	72.80	25.00	2.20	0.00	0.00	0.00	100
3	85	85	0.00	62.90	25.80	6.60	4.70	0.00	0.00	100
3	86	86	0.00	49.50	13.10	23.80	9.10	0.00	4.50	100
3	87	87	0.00	26.40	12.80	20.40	22.30	12.30	5.80	100
3	88	88	0.00	5.00	9.20	28.00	37.00	13.60	7.20	100
3	89	89	0.00	1.40	7.70	33.10	30.70	20.90	6.20	100
3	90	90	0.10	1.20	2.00	41.20	32.50	18.70	4.30	100
3	91	91	0.00	0.10	1.50	43.50	36.20	14.20	4.50	100
3	92	92	0.48	0.87	0.76	54.15	31.82	11.86	0.06	100

3	93	93	0.00	0.00	1.10	58.00	30.08	10.82	0.00	100
3	94	94	0.00	0.00	0.00	62.13	27.21	10.66	0.00	100
3	95	95	0.00	0.00	0.00	63.92	25.36	10.72	0.00	100
3	96	96	0.00	0.00	0.00	63.00	25.00	12.00	0.00	100
3	97	97	0.00	0.00	0.00	69.08	20.00	10.92	0.00	100
3	98	98	0.00	0.00	0.00	75.16	15.00	9.84	0.00	100
3	99	99	0.00	0.00	0.00	81.24	10.00	8.76	0.00	100
3	00	00	0.00	0.00	0.00	87.32	5.00	7.68	0.00	100
3	01	03	0.00	0.00	0.00	93.40	0.00	6.60	0.00	100
3	04	50	0.00	0.00	0.00	93.40	0.00	6.60	0.00	100
4	68	81	100.00	0.00	0.00	0.00	0.00	0.00	0.00	100
4	82	86	95.00	5.00	0.00	0.00	0.00	0.00	0.00	100
4	87	87	70.00	30.00	0.00	0.00	0.00	0.00	0.00	100
4	88	89	60.00	40.00	0.00	0.00	0.00	0.00	0.00	100
4	90	95	7.00	93.00	0.00	0.00	0.00	0.00	0.00	100
4	96	99	5.00	95.00	0.00	0.00	0.00	0.00	0.00	100
4	00	00	2.00	98.00	0.00	0.00	0.00	0.00	0.00	100
4	01	04	2.00	98.00	0.00	0.00	0.00	0.00	0.00	100
4	05	20	0.00	100.00	0.00	0.00	0.00	0.00	0.00	100
5	65	50	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	65	50	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	65	50	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	65	20	100.00	0.00	0.00	0.00	0.00	0.00	0.00	100

Appendix G

Evaluation of CARB UC-FTP Database

The Off–Cycle Toxics Adjustment Factor Analysis

Background: Work Assignment 0-07 involves the estimation of on-road motor vehicle air toxic emissions, exposure, and cancer risk. The basic on-road emissions analysis requires an assessment of both on- and off-cycle emissions performance. As a key component of their Tier 2 emission standards study, the U.S. Environmental Protection Agency (EPA) has previously developed an approach for estimating off-cycle impacts on the criteria pollutants HC, CO, and NO_x.[1] Since that approach is carried over to the HC (as TOG) and CO components of Work Assignment 0-07, a similar approach to the consideration of off-cycle impacts on toxic emissions (which were not considered in the previous Tier 2 study) is required.

The EPA approach essentially involves the assumption that emissions measured over the Unified Cycle (UC) accurately reflect the aggressive driving aspects of actual on-road performance and, therefore, the relationship of UC measured emissions to Federal Test Procedure (FTP) measured emissions provides the necessary adjustment factors to account for off-cycle (aggressive driving) emission impacts. This appendix details the approach undertaken to derive the UC/FTP relationship for five toxic species: benzene, 1,3-butadiene, MTBE, formaldehyde, and acetaldehyde. The ultimate form of the derived relationships is expressed as, as described in Section 4 of the main report, the ratio of the UC toxics fraction of TOG to the FTP toxics fraction of TOG.

The EPA approach also involves the application of an additional set of adjustment factors to account for on-road air conditioning usage not reflected in either the standard FTP or UC. However, for HC (as TOG), the air conditioning adjustments are minor relative to the UC off-cycle aggressive driving adjustments. Whereas the aggressive driving TOG adjustments can be as high as 30 percent for some vehicle model years, air conditioning corrections are confined to a range of -2 percent to +4 percent. In the absence of specific speciated test data on which to base toxic air conditioning adjustment factors and because air conditioning represents a relatively constant load (when activated), it was assumed that on-cycle (i.e., FTP) toxic fractions are accurate over both on- and off-cycle air conditioning operation. Given the order-of-magnitude difference in aggressive driving and air conditioning impacts on TOG emission rates, any error associated with this assumption will be small.

Aggressive Driving Approach: A small database of toxic emissions measurements collected over the REP05, US06, and FTP cycles was provided by EPA staff for use in determining off-cycle aggressive driving toxics adjustment factors. Unfortunately, a basic review of the database revealed several areas of concern limiting its utility. Table A-1 provides an overview of the database and illustrates most of the limiting factors. First, all vehicles with reported

[1] "Tier 2 Study", Draft Report, EPA420-P-98-009, U.S. Environmental Protection Agency, April 23, 1998.

Table A-1
Description of REP05/US06 Database

Vehicles Tested			
Model Year	Model	Type	Test Fuel(s)
1995	Caravan	Gasoline LDT	2% MTBE
1993	Taurus	M-FFV	2% MTBE
1993	Spirit	M-FFV	2% MTBE
1993	Lumina	E-FFV	2% MTBE
1994	Dodge B250	Gasoline LDT	not reported
1995	Intrepid	Gasoline LDV	not reported
1995	Taurus	Gasoline LDV	not reported
1989	Camry	Gasoline LDV	Non-Oxy and 2% MTBE
1989	Grand Am	Gasoline LDV	Non-Oxy and 2% MTBE
1989	Taurus	Gasoline LDV	Non-Oxy and 2% MTBE
1989	Sundance	Gasoline LDV	Non-Oxy and 2% MTBE
not reported	Chevrolet C-20 Pickup	CNG	CNG
not reported	Crown Victoria	CNG	CNG
not reported	Dodge B150 Ram Wagon	CNG	CNG

Speciated Emissions Test Data Points				
Species	REP05/FTP	US06/FTP	REP05/US06	Comments
Formaldehyde	18	3	0	a
Acetaldehyde	18	3	0	a
1,3-Butadiene	17	0	0	a
Benzene	18	0	0	a
MTBE	7	0	0	b
TOG	4	3	0	

Comments:
a. REP05/FTP data points comprise 11 vehicles in total, 7 of which were tested on multiple fuels. 3 of 11 REP05/FTP vehicles and 6 of 18 data points are associated with CNG vehicle testing.
b. 3 of 7 REP05/FTP vehicles and data points are associated with CNG vehicle testing.

model years fall within the very narrow range of 1989-1995. Second, three of the eleven vehicles tested are CNG powered and, therefore, not reflective of typical on-road fleet impacts. Third, there is no mechanism inherent in the database to adjust for differences in the REP05 and US06 cycles (i.e., no vehicles were tested over both cycles). Fourth, only a fraction of the data includes simultaneous toxics species and TOG measurements. Finally, neither the REP05 or US06 test cycles are reflective of emissions performance over the UC used for TOG off-cycle adjustment factor development. Both REP05 and US06 incorporate much higher fractions of off-cycle driving than the UC (and, theoretically, on-road operation which the UC was designed to reflect). Therefore, while off-cycle to on-cycle toxics ratios can be developed from the data, a secondary method of determining the fraction of on-road operation accumulated in each mode would be required (as well as a method to equilibrate the two varying test cycles (i.e., the REP05 and the US06) in the EPA database.

Based on the deficiencies noted, supplemental sources of off-cycle toxics data were investigated and it was determined that the California Air Resources Board (CARB) had performed a substantial number of speciated emissions tests over both the UC and FTP cycles. Since such data alleviates several (but not all, as discussed below) of the deficiencies of the REP05/US06 database, the CARB UC/FTP database was obtained and utilized as the basis for the off-cycle (aggressive driving) adjustment factors used in the performance of this work assignment.

<u>The CARB FTP/UC Database</u>: CARB provided results from 36 speciated emissions tests, 18 of which were performed over the FTP cycle and 18 of which were performed over the UC. A total of 13 different test vehicles are represented. In all but one case, each of the 18 FTP tests can be matched with a corresponding UC test, where both tests are conducted on the same vehicle, using the same fuel, with only moderate mileage accumulation (in many cases, only the mileage associated with the first test cycle) between tests. However, for a single test pair, the fuel reported for the FTP test does not match the fuel reported for the UC test. Given the influence test fuel can play on measured emissions, this single mismatched test pair was excluded from all analysis under this work assignment. Table A-2 presents an overview of the CARB test data.

As indicated in Table A-2, of the 12 “matching fuel” vehicles in the database, 9 were tested once over both the FTP and the UC while operating on one of two fuels, either commercial unleaded gasoline (2 vehicles) or California Phase 2 Reformulated Gasoline (7 vehicles). Two of the remaining three matching fuel vehicles were tested twice over the FTP and twice over the UC, once while operating on indolene and once while operating on commercial unleaded gasoline. One matching fuel vehicle was tested four times over the FTP and four times over the UC, once each on California Phase 2 Reformulated Gasoline and indolene and twice on commercial unleaded gasoline. The “mismatched fuel” vehicle (see arbitrarily labeled tests 18A and 18B in Table A-2), which was excluded from all toxics adjustment factor analysis, was reported to have been tested on commercial unleaded gasoline over the FTP and California Phase 2 Reformulated Gasoline over the UC. Unfortunately CARB was unable to provide fuel specification data for any of the test fuels so the specific variation in fuel properties is not available. However, test dates indicate that some of the commercial unleaded gasoline testing was performed prior to the requirement that all California gasoline meet Phase 2 Reformulated Gasoline specifications.

Table A-2

Synopsis of the CARB FTP/UC Database

Test Number	Model Year	Vehicle Make	Vehicle Model	Engine Family	Odometer Reading	Test Type	Test Fuel	High Emitter?	THC (g/mi)	TOG (g/mi)	Benzene (mg/mi)	1,3-Butad (mg/mi)	MTBE (mg/mi)	Formald (mg/mi)	Acetald (mg/mi)
1A	1996	FORD	TAURUS GL	TFM3.0V8GKEK	43077	FTP	RFG	No	0.1257	0.1311	3.8733	0.4719	4.0072	1.5937	0.5032
1B					43088	UC			0.1309	0.1377	3.4630	0.2598	3.4306	3.9426	0.4645
2A	1995	TOTA	COROLLA DX	STY1.8VJG1GA	12302	FTP	UnL	No	0.1606	0.1662	4.6247	0.8189	3.6832	2.6499	0.5278
2B					12313	UC			0.1301	0.1345	4.8528	1.0670	2.3777	1.8564	0.4098
3A	1994	GM	SUNBIRD LE4DR	R1G2.0V7GFEA	53752	FTP	RFG	No	0.1924	0.2045	4.6924	0.9455	6.5115	4.4394	1.0985
3B					53774	UC			0.1344	0.1429	4.1695	0.6358	3.6821	4.0374	0.6821
4A	1993	FORD	TAURUS GL	PFM3.8V5FAC8	7429	FTP	Ind	No	0.0501	0.0536	1.7666	0.1902	0.1345	2.6240	0.2053
4B					7964	UC			0.1164	0.1244	5.8468	0.3080	0.0000	6.3267	0.5020
5A	1993	FORD	TAURUS GL	PFM3.8V5FAC8	7834	FTP	UnL	No	0.1223	0.1272	6.2116	0.7034	3.1396	2.9638	0.4069
5B					7798	UC			0.1239	0.1260	9.7737	0.4274	2.6549	0.4605	0.4898
6A	1993	FORD	TAURUS GL	PFM3.8V5FAC8	8010	FTP	UnL	No	0.0913	0.0923	3.9428	0.4036	3.1161	0.6365	0.1414
6B					7850	UC			0.1181	0.1209	9.3815	0.7331	2.1953	0.9556	0.5244
7A	1993	FORD	TAURUS GL	PFM3.8V5FAC8	7890	FTP	RFG	No	0.0886	0.0920	3.1039	0.4695	2.7508	2.0666	0.3862
7B					7901	UC			0.1005	0.1117	5.4411	0.2481	2.9428	9.6098	0.4014
8A	1992	CHRY	WRANGLER 2DR	NCR242T5FEFX	65196	FTP	RFG	No	0.2833	0.2941	8.2053	1.3462	10.8351	4.0166	1.2080
8B					65255	UC			0.3644	0.3763	9.0569	1.1907	17.9644	4.4172	1.0991
9A	1989	FORD	TRACER	KFM1.6V5FC9	104715	FTP	Ind	No	0.1847	0.1888	6.0074	0.8885	0.0000	2.4745	0.4316
9B					104497	UC			0.1844	0.1872	6.9607	0.9538	0.0000	0.8445	0.5624
10A	1989	FORD	TRACER	KFM1.6V5FC9	104661	FTP	UnL	No	0.2324	0.2531	6.3636	0.6818	4.7496	10.9043	0.7099
10B					104613	UC			0.2730	0.2870	9.1525	0.9992	2.4148	10.4562	0.9512
11A	1989	TOTA	CAMRY	KTY2.0V5FCC1	129092	FTP	UnL	No	0.2274	0.2318	7.9994	1.2267	0.0000	2.0930	0.7367
11B					129115	UC			0.3742	0.3835	21.8217	2.8594	0.0000	2.8130	1.7792
12A	1987	MAZD	626LXi 2DR	HTK2.0V5FAK3	223589	FTP	RFG	Yes	1.7677	1.8764	72.7795	17.5925	24.4603	42.0528	11.3426
12B					223628	UC			1.7501	1.8629	76.8858	15.4418	16.0411	43.7857	12.1923
13A	1984	FORD	P/U F-250	EFM4.9T1HGG5	36660	FTP	RFG	No	0.3766	0.3841	12.1466	0.7973	11.5648	3.6149	0.9507
13B					36671	UC			0.4903	0.4985	24.0186	1.0149	9.2366	3.6696	1.1920
14A	1984	MITS	COLT	EMT1.6V2FCA5	122337	FTP	RFG	Yes	1.4099	1.5309	35.7490	14.6033	70.4496	51.3210	11.6262
14B					122337	UC			1.6163	1.7264	42.4803	8.0979	80.0602	43.8942	10.2241
15A	1983	CHRY	VAN RAM150	DCR3.7T1AHS4	114222	FTP	RFG	Yes	2.2895	2.3704	59.8553	4.4287	21.4863	25.0328	7.7771
15B					114247	UC			2.3424	2.4041	82.2424	3.1607	12.3718	25.0180	7.6806
16A	1982	GM	CORVETTE	C1G5.7V5NBM2	131965	FTP	Ind	Yes	1.7809	1.8317	69.9380	5.3410	0.0000	21.8404	8.8994
16B					131974	UC			1.5220	1.5728	67.7398	3.9056	1.2878	24.6744	6.5080
17A	1982	GM	CORVETTE	C1G5.7V5NBM2	132030	FTP	UnL	Yes	1.4140	1.4803	58.0894	6.0390	13.5599	23.5275	7.8022
17B					131910	UC			1.4043	1.4656	59.3127	4.7875	20.4828	12.9383	7.2346
18A	1991	FORD	TAURUS	MFM3.0V5FX03	69189	FTP	UnL	No	0.4205	0.4328	13.2492	1.4970	8.5297	3.4716	1.2526
18B					69134	UC	RFG		0.3703	0.3828	10.7827	0.8301	8.0156	3.4596	1.1353

Fuel type "RFG" indicates California Phase 2 Reformulated Gasoline, "Ind" indicates indolene, and "UnL" indicates commercial unleaded gasoline.

"1,3-Butad" indicates 1,3-butadiene, "Formald" indicates formaldehyde, and "Acetald" indicates "acetaldehyde."

As mentioned above, most of the corresponding FTP and UC tests were performed with only moderate mileage accumulation between tests. Of the 10 vehicles tested once (including the mismatched fuel vehicle), the maximum reported mileage between FTP and UC test initiation is believed to be 59 miles (the uncertainty derives from the fact that identical FTP and UC start mileages are reported for one test vehicle). In all single test matched fuel cases, the FTP was performed first. For vehicles tested multiple times on different fuels, greater mileage accumulation is evident between tests on differing fuels to ensure that any emissions effects associated with the preceding test fuel do not affect the following test performance. Additionally, multiple fuel testing was not always performed sequentially (i.e., same-fuel FTP and UC tests were not always performed consecutively), so that accumulations of one to two hundred miles are observed between several corresponding multi-fuel tests, with a single test pair separated by a maximum of 535 miles (due to the performance of 5 tests on other fuels between the matching test pair).

The CARB database was subjected to a basic integrity check prior to off-cycle adjustment factor analysis. This check detected two potential problem areas. First, test pair 4A/4B (see Table A-2) was determined to be invalid. As evidenced by the emission measurements presented in Table A-2, the FTP/UC relationship for this test pair is an outlier. Further review of the CARB test data indicates that the CO_2 emission rate over the FTP (test 4A) is reported to be only 168 grams per mile, while that over the UC (test 4B) is a much more reasonable 439 grams per mile. Clearly there is a quality problem with this test pair that appears to be traceable to a test 4A dilution factor calculation error (given the apparent under-reporting of all test species). Since sufficient information to confirm or correct such an error is not included in the data provided by CARB, the test 4A/4B pair was dropped from the analysis database. The UC CO_2/FTP CO_2 relationship for all other test pairs varies from -2 percent to +13 percent (with both matching fuel test pairs indicating a negative relationship being high emitters), so that no other obvious data quality problems are apparent.

The second data integrity problem area was an apparent discrepancy in the treatment of THC, CH_4, and NMHC emission rates on all tests. Essentially, CARB appears to correct THC measurements for FID CH_4 "over-response," but does not apply this same correction to CH_4 itself. Since NMHC is then determined as THC minus CH_4, the reported CH_4 emission rate appears to be somewhat high (on the order of 5 percent or so depending on FID CH_4 response) and the reported NMHC emission rate appears to be correspondingly low. However, unlike the previous under-measurement problem with test 4A, this problem is easily resolved. Since TOG emissions are the basis for all off-cycle toxics fractions, only the THC (plus alcohol and carbonyl) measurement need be precise. Moreover, all information necessary to correct both the reported CH_4 and NMHC measurements is available in the data provided by CARB. Therefore, this potential problem area does not ultimately affect the off-cycle toxics analysis (but care was taken to ensure that all data used in the analysis was consistent).

Determination of Off-Cycle Toxic Adjustment Factors: As described above (and as shown in Table A-2), a total of 16 matched fuel UC/FTP speciated test pairs were available to support a determination of the required off-cycle toxics adjustment factors (test pairs 4A/4B and 18A/18B were excluded due to data integrity and fuel mismatch problems respectively). Ideally, off-cycle adjustment factor analysis would be conducted on a vehicle technology, vehicle class, and fuel specific basis to ensure that all vehicle- and fuel-specific influences were properly accounted for in the calculated adjustment factors. However, the size of the available database precludes such disaggregated treatment. Nevertheless, several precautions were taken to minimize any unaccounted for vehicle- and fuel-specific influences. First, all off-cycle adjustments are calculated in normalized form as the ratio of the UC toxic fraction to the FTP toxics fraction. Therefore, both vehicle- and fuel-specific influences will be controlled to the extent that such influences are consistent across the FTP and UC. Second, in determining MTBE ratios, all zero content MTBE fuels were excluded from analysis since exhaust MTBE emissions for such fuels will be at or near zero. Third, the CARB test data was collapsed so that each test vehicle is represented in the off-cycle adjustment database only once. Test results for vehicles that were tested multiple times were consolidated into a single UC/FTP test pair by arithmetically averaging individual test results. Finally, several statistical checks were applied to ensure no obvious problems with the aggregated treatment of the CARB data. Table A-3 presents the off-cycle toxics database after the application of the described quality control steps.

Following exclusion of suspect quality data, aggregation of multiple test vehicle results, and elimination of the zero MTBE content fuel results for MTBE adjustment factor analysis, the analysis database consists of:

- 8 normal emitter test pairs for benzene, 1,3-butadiene, formaldehyde, and acetaldehyde analysis,
- 7 normal emitter test pairs for MTBE analysis, and
- 4 high emitter test pairs for benzene, 1,3-butadiene, MTBE, formaldehyde, and acetaldehyde analysis.

Due to the small sample sizes available for adjustment factor development, an aggregated approach based on the development of single adjustment factors for normal and high emitters was employed. Such an approach allows for the development of model year specific adjustment factors through the appropriate weighting of the normal and high emitter adjustments (as described in Section 4), but explicitly discounts any inherent influences of vehicle technology, class, or fuel. Given the limitations imposed by database size, it is difficult to be certain that such overlooked influences are not significant, but basic analyses possible with the given data imply that they are no more significant than seemingly random variations in the dataset. To some extent, this is expected given the normalization approach employed in this analysis. While technology and fuel may influence emissions, much of that influence should be consistent across both the FTP and UC cycles and, therefore, "factored out" during the normalization process. This does not imply any loss in fuel or technology significance in the overall toxics exposure analysis, since the basic differences due to fuels and technology will be reflected in the basic emission rates to which the off-cycle adjustments are applied.

Table A-3
FTP/UC Database used for Off-Cycle Adjustment Analysis

Test Number	Model Year	Vehicle Make	Vehicle Model	Engine Family	Odometer Reading	Test Type	Test Fuel	High Emitter?	THC (g/mi)	TOG (g/mi)	Benzene (mg/mi)	1,3-Butad (mg/mi)	MTBE (mg/mi)	Formald (mg/mi)	Acetald (mg/mi)
1A	1996	FORD	TAURUS GL	TFM3.0V8GKEK	43077	FTP	RFG	No	0.1257	0.1311	3.8733	0.4719	4.0072	1.5937	0.5032
1B					43088	UC			0.1309	0.1377	3.4630	0.2598	3.4306	3.9426	0.4645
2A	1995	TOTA	COROLLA DX	STY1.8VJG1GA	12302	FTP	UnL	No	0.1606	0.1662	4.6247	0.8189	3.6832	2.6499	0.5278
2B					12313	UC			0.1301	0.1345	4.8528	1.0670	2.3777	1.8564	0.4098
3A	1994	GM	SUNBIRD LE4DR	R1G2.0V7GFEA	53752	FTP	RFG	No	0.1924	0.2045	4.6924	0.9455	6.5115	4.4394	1.0985
3B					53774	UC			0.1344	0.1429	4.1695	0.6358	3.6821	4.0374	0.6821
5-7A	1993	FORD	TAURUS GL	PFM3.8V5FAC8	7911	FTP	UnL/RFG	No	0.1007	0.1038	4.4194	0.5255	3.0021	1.8889	0.3115
5-7B					7850	UC			0.1142	0.1196	8.1988	0.4695	2.5976	3.6753	0.4719
8A	1992	CHRY	WRANGLER 2DR	NCR242T5FEFX	65196	FTP	RFG	No	0.2833	0.2941	8.2053	1.3462	10.8351	4.0166	1.2080
8B					65255	UC			0.3644	0.3763	9.0569	1.1907	17.9644	4.4172	1.0991
9-10A	1989	FORD	TRACER	KFM1.6V5FC9	104688	FTP	Ind/UnL	No	0.2085	0.2210	6.1855	0.7851		6.6684	0.5708
9-10B					104555	UC			0.2287	0.2371	8.0566	0.9765		5.6504	0.7568
10A	1989	FORD	TRACER	KFM1.6V5FC9	104661	FTP	UnL	No	0.2324	0.2531			4.7496		
10B					104613	UC			0.2730	0.2870			2.4148		
11A	1989	TOTA	CAMRY	KTY2.0V5FCC1	129092	FTP	UnL	No	0.2274	0.2318	7.9994	1.2267		2.0930	0.7367
11B					129115	UC			0.3742	0.3835	21.8217	2.8594		2.8130	1.7792
13A	1984	FORD	P/U F-250	EFM4.9T1HGG5	36660	FTP	RFG	No	0.3766	0.3841	12.1466	0.7973	11.5648	3.6149	0.9507
13B					36671	UC			0.4903	0.4985	24.0186	1.0149	9.2366	3.6696	1.1920
12A	1987	MAZD	626LXi 2DR	HTK2.0V5FAK3	223589	FTP	RFG	Yes	1.7677	1.8764	72.7795	17.5925	24.4603	42.0528	11.3426
12B					223628	UC			1.7501	1.8629	76.8858	15.4418	16.0411	43.7857	12.1923
14A	1984	MITS	COLT	EMT1.6V2FCA5	122337	FTP	RFG	Yes	1.4099	1.5309	35.7490	14.6033	70.4496	51.3210	11.6262
14B					122337	UC			1.6163	1.7264	42.4803	8.0979	80.0602	43.8942	10.2241
15A	1983	CHRY	VAN RAM150	DCR3.7T1AHS4	114222	FTP	RFG	Yes	2.2895	2.3704	59.8553	4.4287	21.4863	25.0328	7.7771
15B					114247	UC			2.3424	2.4041	82.2424	3.1607	12.3718	25.0180	7.6806
16-17A	1982	GM	CORVETTE	C1G5.7V5NBM2	131998	FTP	Ind/UnL	Yes	1.5974	1.6560	64.0137	5.6900		22.6840	8.3508
16-17B					131942	UC			1.4631	1.5192	63.5262	4.3466		18.8063	6.8713
17A	1982	GM	CORVETTE	C1G5.7V5NBM2	132030	FTP	UnL	Yes	1.4140	1.4803			13.5599		
17B					131910	UC			1.4043	1.4656			20.4828		

Fuel type "RFG" indicates California Phase 2 Reformulated Gasoline, "Ind" indicates indolene, and "UnL" indicates commercial unleaded gasoline.
"1,3-Butad" indicates 1,3-butadiene, "Formald" indicates formaldehyde, and "Acetald" indicates "acetaldehyde."
Test pairs 9-10A/9-10B, 11A/11B, and 16-17A/16-17B are excluded from MTBE adjustment factor development due to zero MTBE content fuel use.
Test pairs 10A/10B and 17A/17B are used only for MTBE adjustment factor development (both pairs exclude zero MTBE content fuel test results).
For multiple test pairs, the tabulated odometer readings are the arithmetic average of component test readings.

Some degree of assessment of the potential significance of fuel effects can be attained by examining the CARB data for the three vehicles that were tested multiple times on different fuels. CARB tested a 1993 Ford Taurus once on indolene, once on California Phase 2 Reformulated Gasoline, and twice on commercial unleaded gasoline. Comparing the variation in the ratio of the UC toxics fraction (of TOG) to the FTP toxics fraction (of TOG) when tested on the two commercial unleaded gasolines to the overall variation indicates that the unleaded variation comprises 58 percent of the overall variation for benzene, 81 percent of the overall variation for 1,3-butadiene, 92 percent of the overall variation for MTBE, 27 percent of the overall variation for formaldehyde, and 82 percent of the overall variation for acetaldehyde. With the exception of formaldehyde, almost as much variability is observed between results for the two commercial unleaded fuels as is observed over the entire four tests. While formaldehyde appears to be an exception, nearly all the difference can be tied to a single UC test result that is not supported by a similar difference in FTP results. Therefore, the source of the variation does not appear to be fuel related.

CARB also tested two other vehicles on two fuels each. A 1989 Ford Tracer tested on both indolene and commercial unleaded gasoline indicated total toxics fraction ratio variability across the two fuels of only 9 percent for benzene, 19 percent for 1,3-butadiene, and 10 percent for acetaldehyde. Once again, formaldehyde indicates significant variability, with a 146 percent difference. Data for MTBE is only available for one fuel. A 1982 Chevrolet Corvette also tested on both indolene and commercial unleaded gasoline indicates similar variabilities across fuels of only 9 percent for benzene, 6 percent for 1,3-butadiene, and 10 percent for acetaldehyde. Formaldehyde variability is again significant, but interestingly the variability is opposite in sign to that for the Tracer and of virtually identical magnitude (-58 percent versus +146 percent difference). As a result, it is not possible to identify any definitive fuel-specific influences within the small sample available for analysis. Additional inferences may have been possible had specific fuel specifications been available, but CARB did not respond to a request for such data. Nevertheless, it does appear that fuel effects are not the predominant influence for a normalization-based approach such as that employed in this analysis and the uncertainty associated with treating all fuels in the aggregate is expected to be only a small component of overall analysis uncertainty.

To assess the potential impacts of vehicle technology, a basic regression of the ratio of UC toxics fraction (of TOG) to FTP toxics fraction (of TOG) by vehicle model year was conducted. The results of this regression analysis are presented in the upper half of Table A-4. Notwithstanding the very small sample sizes, not a single model year coefficient or intercept is significant at over 90 percent confidence. A case for a formaldehyde relationship can be made over the entire 8 normal emitter vehicle dataset as both coefficient and intercept are significant at 90 percent confidence, but further examination indicates that this relationship is controlled by a single data point for a 1996 Ford Taurus. When excluded, the confidence level of both the coefficient and the intercept decline to just over 75 percent and “random” effects appear to dominate the model year relationship. Based on this, albeit simplistic, analysis, it does not appear that vehicle technology influences are a predominant factor, at least in the database available for this analysis. One additional observation is, however, critical. The database available for analysis does not include any pre-1981 model year vehicles. Therefore, potential

Table A-4
Database Regression Analysis Results

Emitter Category	Toxics Species	Number of Data Points	r^2	F	a	Confidence Level of a	b	Confidence Level of b	Zero Intercept Slope	Avg UC Fraction to Avg FTP Fraction	Slope/Avg Delta
UC/FTP Toxic Fraction Ratio = a (Vehicle Model Year) + b											
Normal Emitters	Benzene	8	0.239	1.887	-0.038	78%	77.181	79%			
	1,3-Butadiene	8	0.034	0.211	-0.017	34%	34.870	35%			
	MTBE	7	0.153	0.901	0.024	61%	-47.043	61%			
	Formaldehyde	8	0.393	3.882	0.091	90%	-179.436	90%			
	Acetaldehyde	8	0.090	0.590	-0.019	53%	39.523	54%			
High Emitters	Benzene	4	0.121	0.275	-0.023	35%	47.337	36%			
	1,3-Butadiene	4	0.062	0.133	0.020	25%	-39.418	25%			
	MTBE	4	0.352	1.086	-0.134	59%	267.275	59%			
	Formaldehyde	4	0.189	0.467	0.025	44%	-49.168	43%			
	Acetaldehyde	4	0.338	1.020	0.034	58%	-67.168	58%			
UC Toxics Fraction = a (FTP Toxics Fraction) + b											
Normal Emitters	Benzene	8	0.782	21.558	2.425	100%	-0.034	92%	1.350	1.315	-3%
	1,3-Butadiene	8	0.483	5.599	1.458	94%	-0.002	47%	1.060	1.037	-2%
	MTBE	7	0.758	15.628	1.893	99%	-0.031	92%	0.856	0.825	-4%
	Formaldehyde	8	0.336	3.032	0.811	87%	0.006	49%	1.113	1.163	5%
	Acetaldehyde	8	0.280	2.335	0.470	82%	0.002	87%	0.986	1.020	3%
High Emitters	Benzene	4	0.835	10.109	0.878	91%	0.008	53%	1.113	1.126	1%
	1,3-Butadiene	4	0.741	5.727	0.649	86%	0.000	13%	0.694	0.708	2%
	MTBE	4	0.943	33.381	1.018	97%	-0.001	16%	0.986	0.965	-2%
	Formaldehyde	4	0.879	14.547	0.695	94%	0.004	58%	0.861	0.894	4%
	Acetaldehyde	4	0.743	5.788	0.713	86%	0.001	43%	0.904	0.919	2%

influences associated with major catalyst technology differences cannot be ascertained. Too some extent, this problem is alleviated through the predominance of 1981 and later vehicles in the future year fleets addressed in the overall toxics exposure analysis. Nevertheless, a significant fraction of such vehicles are present in the 1990 analysis fleet. Therefore, given the complete absence of data for such vehicles, off-cycle adjustment factors have been set to unity for pre-1981 LDV's and pre-1984 LDT's as described in Section 4 of the main report.

Based on the negative assessments of fuel and model year influences, an aggregate treatment of the CARB test data appears to be justified. As outlined in Section 4 of the main report, the desired application of the off-cycle adjustment is multiplicative in design. However, before such application was accepted, a basic regression analysis of the CARB data was performed to ensure that no absolute offsets were present in the UC/FTP relations. The bottom half of Table A-4 presents the results of a regression analysis of the UC toxics fraction (of TOG) versus the FTP toxics fraction (of TOG). As indicated, significant intercepts were found in no cases at 95 percent confidence and only two cases at 90 percent confidence. Conversely, significant coefficients were found at 95 percent or greater confidence in 3 of 10 relations (including both of those where intercepts were significant at 90 percent confidence) and at 90 percent or greater confidence in 6 of 10 relations. All four remaining relations showed significant coefficients only between 80 and 90 percent confidence, but in all cases but one coefficient significance exceeded intercept significance (in most cases by substantial margins). While the calculated relations are not definitive in their confirmation of the superiority of a multiplicative approach in all cases, they strongly suggest that such an approach is as or more reliable than an approach which includes an emissions offset given available data.

The three rightmost columns of the bottom half of Table A-4 present results for two approaches to the determination of multiplicative off-cycle adjustment factors. One approach relies on zero intercept regression coefficients, while the second is simply the ratio of the arithmetic average of UC toxic fractions to the arithmetic average of FTP fractions. By definition, these two estimates must be similar and, as shown in Table 4, the observed variation is ±5 percent. Given this similarity and the fact that the regression statistics are based on very small datasets, the estimates derived through the arithmetic average approach were used for all subsequent toxics analysis. Table A-5 presents a final summary of the off-cycle adjustment factors and includes the minimum and maximum UC/FTP toxic fraction ratios for test data included in the arithmetic average statistics. With the exception of MTBE, the range of ratios tends to be much smaller for high emitters and, with the exception of 1,3-butadiene and acetaldehyde, closer to unity.

Clearly there is considerable uncertainty in the derived off-cycle adjustment factor estimates given the quantity of available data. This uncertainty extends to the issue of whether vehicle technology and fuel influences are, in fact, significant and just not identifiable given the relative scatter of data over such a small database. Moreover, normal emitter adjustment factors for both 1,3-butadiene and acetaldehyde are sufficiently close to unity such that the collection of additional data is required before even directional differences can be known with certainty. While additional data should be collected to support more finely detailed analysis in the future, the derived estimates appear reasonable, with the largest implied adjustment on the order of 30 percent.

Table A-5
Summary of Off-Cycle Toxics Adjustment Factor Analysis

Toxic Species	Parameter	Normal Emitters		High Emitters	
		Regression Coefficient	Arithmetic Average	Regression Coefficient	Arithmetic Average
Benzene	Ratio Estimate	1.350	1.315	1.113	1.126
	Minimum		0.851		1.054
	Maximum		1.649		1.355
	Data Points	8	8	4	4
1,3-Butadiene	Ratio Estimate	1.060	1.037	0.694	0.708
	Minimum		0.524		0.492
	Maximum		1.610		0.884
	Data Points	8	8	4	4
MTBE	Ratio Estimate	0.856	0.825	0.986	0.965
	Minimum		0.474		0.568
	Maximum		1.296		1.647
	Data Points	7	7	4	4
Formaldehyde	Ratio Estimate	1.113	1.163	0.861	0.894
	Minimum		0.782		0.758
	Maximum		2.354		1.049
	Data Points	8	8	4	4
Acetaldehyde	Ratio Estimate	0.986	1.020	0.904	0.919
	Minimum		0.711		0.780
	Maximum		1.460		1.083
	Data Points	8	8	4	4

Appendix H

Summary of MOBTOX5b Code Changes to Implement Revised Toxics Emissions Estimation Procedures and Description of Model Function

Appendix G
MOBTOX5b Usage and Description

MOBTOX5b Input file

MOBTOX5b input file should be similar to the standard MOBILE5b input file with the following exceptions:

1. The NMHFLG should be set to 7. In addition the LTXFLG on the same record should always be 1. The format for the NMHFLG record should be : I1, 1x, I1. The input record should look like:

```
7 1        NMHFLG=7 for Toxics output.
```

2. The Toxic-TOG curves, the evaporative toxic fractions and the off-cycle correction factors are read in from three separate files. The input format of these files are described in Appendix I for the evaporative fractions, Appendix H for the toxic-TOG curves, and Appendix A for the off-cycle corrections. The input file needs to reference these files by using the following three statements:

```
TX EVP FRACTIONS : EVAPFILE.EVP
TX EXH FRACTIONS : TX-TOGFILE.EXH
OFFCYCLE FACTORS : OFFCYCLEFILE.OFF
```

The format of these lines need to have the exact format and content as described above on the left side of the colon. The colon should be in column 18. The file names on the right side of the colon should name the input files describing the toxic factors.

An example input and an output file are included in Appendices J and K, respectively. MOBTOX5b input prompts have been modified to ask the user for only the input file name. The model output is written to a file with the same name with a '.out' suffix.

MOBTOX5b General Description

There are primarily three areas where the model code has been changed, they are input, toxic factor calculations, and model output.

Model input:

The subroutine gettx2.for has been modified to read in the three files for evaporative, toxic-TOG corrections and off-cycle factors. These factors are then stored in a common block for use in other subroutines.

Toxic factor calculations:

The hccalx.for subroutine was modified to estimate emissions for each of the five toxic emission factors. The subroutine calls the exhaust emission calculation routine, bef.for, and evaporative emission calculation routines, ccevrt.for, rnglos.for, rstlos.for, and rlrate.for to calculate hot-soak and diurnal emissions, running loss emissions, resting loss emissions and refueling emissions.

The subroutine bef.for calls the subroutine toxadj.for to apply the toxic-TOG curves and offcyc.for to apply the offcycle corrections. The evaporative corrections are applied by a call to the evpadj.for subroutine from hccalx.for for each of the evaporative components.

Model output:

Two output subroutines OUTDT3 and OUTDT4 have been modified to include the toxic emission factors. A sample of the model output is attached. The output file contains all the toxic factors included in the input. Emission factors for Benzene, Acetaldehyde, Formaldehyde, 1,3 Butadiene, and MTBE are contained in the model output. For Benzene and MTBE evaporative and exhaust emission factors are included for each vehicle type.

```
X6        I    Added variables to store values for July Runs
BD38      FOR  Added initializations for X6 Common Block
BD41      FOR  Initializations for TOX variables
BEF       FOR  Added calls to TOXADJ and OFFCYC routines
CCEVRT    FOR  No Change
DAT01     I    Contains Common block for TOX changes
DRIVER    FOR  Modified to automate Output file name
EVPADJ    FOR  Modified to do multiple Toxics
GETTX2    FOR  Reads in Evap and Exhaust Tox factors and Offcycle factors; Sets up TOX and
Offcycle arrays.
HCCALX    FOR  Modified to handle multiple Toxic calculations
IM90      OFF  Offcycle file used in Tox input file
LASTOUT   FOR  Writes out output header to the screen
NAMEOUT   FOR  Develops output file name
OFFCYC    FOR  Offcycle adjustments routine
ONESEC    FOR  Modified to run with only with NMHFLG=7 (File input)
OUTDT3    FOR  Outputs multiple Toxic EFs
OUTDT4    FOR  Outputs multiple toxic EFs
OUTTOX    FOR  Prints out Toxic/Off cycle factors used
PX90SB    EVP  Evap Toxic factor input file
PX96SB    EXH  Exhaust Toxic factor input file
SAVER     FOR  Saves output for Jul run
TOXADJ    FOR  Applies Toxic Emission corrections
VNAME     I    Header changes
ADJUST    FOR  Applies adjustments for JUL runs
```

Appendix I

Fuel Parameters Used in Toxics Emissions Estimates

The following fuel parameters are included in this appendix:

1. 1990 Baseline
2. 1996 Baseline
3. 2007/2020 Baseline
4. 2007/2020 30 ppm Sulfur Rule
5. 2007/2020 1% Benzene Cap (Scenario 4)
6. 2007/2020 25% Toxics Reduction Performance Standard (Scenario 5)
7. 1996 Min/Max Specifications (Sensitivity Analysis)

1990 Baseline Fuel Specifications

Area	Abbrev.	Year	Season	Scenario	RVP, psi	Aromatics	Olefins	Benzene %	Sulfur	E200 %	E300 %	MTBE %	ETBE %	EtOH %	TAME %	Oxygen wt
Atlanta	AT	1990	Summer	Baseline	8.5	27.9	10.5	1.16	344	40.7	79.0	0.0	0.0	0.0	0.0	0.00
Atlanta	AT	1990	Winter	Baseline	12.5	26.2	14.4	1.49	267	49.1	82.4	0.0	0.0	0.0	0.0	0.00
Chicago	CH	1990	Summer	Baseline	8.7	28.8	8.6	1.35	512	47.2	78.6	0.0	0.0	0.0	0.0	0.00
Chicago	CH	1990	Winter	Baseline	13.7	23.0	9.1	1.69	450	54.4	82.6	0.0	0.0	0.0	0.0	0.00
Denver	DN	1990	Summer	Baseline	8.3	24.8	12.2	1.41	375	45.1	79.4	0.0	0.0	0.0	0.0	0.00
Denver	DN	1990	Winter	Baseline	12.1	19.3	12.8	1.23	272	62.0	85.5	11.6	0.0	0.0	0.0	2.06
Houston	HS	1990	Summer	Baseline	8.3	30.2	10.9	1.36	375	46.7	79.4	0.5	0.0	0.0	0.0	0.10
Houston	HS	1990	Winter	Baseline	12.8	23.0	14.4	1.22	454	52.4	80.2	0.0	0.0	0.0	0.0	0.00
Minneapolis	MN	1990	Summer	Baseline	9.5	29.8	8.3	1.69	422	45.9	78.9	0.0	0.0	0.0	0.0	0.00
Minneapolis	MN	1990	Winter	Baseline	13.2	24.9	9.3	1.86	701	56.0	81.6	0.0	0.0	0.0	0.0	0.00
New York	NY	1990	Summer	Baseline	8.3	31.9	13.9	1.08	367	43.1	78.8	2.4	0.0	0.0	0.0	0.42
New York	NY	1990	Winter	Baseline	13.3	26.4	16.7	1.55	274	49.5	81.8	0.0	0.0	0.0	0.0	0.00
Philadelphia	PA	1990	Summer	Baseline	8.4	29.2	13.7	0.86	371	43.6	79.0	0.0	0.0	0.0	0.0	0.00
Philadelphia	PA	1990	Winter	Baseline	13.9	23.5	13.2	1.63	206	50.5	82.9	0.0	0.0	0.0	0.0	0.00
Phoenix	PX	1990	Summer	Baseline	8.1	33.0	5.9	2.15	123	41.1	78.5	0.0	0.0	0.0	0.0	0.00
Phoenix	PX	1990	Winter	Baseline	10.9	26.4	5.6	1.88	157	56.5	82.9	11.4	0.0	0.0	0.0	2.04
Spokane	SP	1990	Summer	Baseline	8.6	21.0	8.0	1.36	739	46.6	82.6	0.0	0.0	0.0	0.0	0.00
Spokane	SP	1990	Winter	Baseline	13.1	19.2	10.3	1.58	698	51.1	84.9	0.0	0.0	0.0	0.0	0.00
St. Louis	SL	1990	Summer	Baseline	8.8	28.9	8.9	1.11	372	45.2	78.9	0.0	0.0	0.0	0.0	0.00
St. Louis	SL	1990	Winter	Baseline	13.2	22.0	11.4	1.71	319	54.0	82.7	0.0	0.0	0.0	0.0	0.00
Western WA/OR - Win 95/96	WA	1990	Summer	Baseline	9.4	29.0	10.0	2.34	449	43.5	81.0	1.8	0.0	0.0	0.0	0.32
Western WA/OR - Win 95/96	WA	1990	Winter	Baseline	12.9	30.9	8.2	2.47	314	49.7	83.7	0.5	0.0	0.0	0.0	0.08
Western WA/OR - Win 96/97	WB	1990	Summer	Baseline	9.4	29.0	10.0	2.34	449	43.5	81.0	1.8	0.0	0.0	0.0	0.32
Western WA/OR - Win 96/97	WB	1990	Winter	Baseline	12.9	30.9	8.2	2.47	314	49.7	83.7	0.5	0.0	0.0	0.0	0.08
Northern California	CN	1990	Summer	Baseline	8.3	29.9	11.5	2.17	104	41.8	82.2	0.0	0.0	0.0	0.0	0.00
Northern California	CN	1990	Winter	Baseline	12.4	29.9	9.6	2.14	135	49.3	84.3	0.5	0.0	0.0	0.0	0.08
Southern California	CS	1990	Summer	Baseline	8.2	29.1	7.6	2.12	172	40.8	80.8	2.8	0.0	0.0	0.0	0.50
Southern California	CS	1990	Winter	Baseline	11.3	29.8	8.6	1.81	205	45.9	82.6	0.5	0.0	0.0	0.0	0.08
ID/MT/WY	ID	1990	Summer	Baseline	9.3	24.6	9.9	1.98	565	47.5	84.1	0.2	0.0	0.0	0.0	0.04
ID/MT/WY	ID	1990	Winter	Baseline	13.0	22.5	13.7	1.71	681	53.6	86.5	0.5	0.0	0.0	0.0	0.09
UT/NM/NV	UT	1990	Summer	Baseline	8.7	23.7	11.0	1.97	235	44.6	82.8	1.3	0.0	0.0	0.0	0.22
UT/NM/NV	UT	1990	Winter	Baseline	13.0	23.5	13.5	2.13	159	56.3	87.4	0.0	0.0	0.0	16.5	2.70
ND/SD/NE/IA/KS/Western MO	ND	1990	Summer	Baseline	8.8	26.6	9.6	1.50	328	47.4	81.3	0.7	0.0	1.5	0.0	0.64
ND/SD/NE/IA/KS/Western MO	ND	1990	Winter	Baseline	13.3	21.0	10.8	1.29	307	55.3	84.6	0.8	0.0	1.6	0.0	0.70
AR/MS/AL/SC/Northern LA	SE	1990	Summer	Baseline	8.6	28.8	12.8	1.62	363	43.0	79.5	1.5	0.0	0.0	0.0	0.27
AR/MS/AL/SC/Northern LA	SE	1990	Winter	Baseline	12.3	25.6	16.9	1.47	328	50.0	81.6	1.2	0.0	0.0	0.0	0.22
Florida	FL	1990	Summer	Baseline	9.2	31.6	9.0	1.40	363	44.1	79.2	1.5	0.0	0.0	0.0	0.27
Florida	FL	1990	Winter	Baseline	12.2	26.0	17.7	1.25	372	48.9	80.3	1.2	0.0	0.0	0.0	0.21
Northeast-NoRFG	NN	1990	Summer	Baseline	8.8	29.7	13.7	1.77	332	42.5	80.4	1.1	0.0	0.0	0.0	0.19
Northeast-NoRFG	NN	1990	Winter	Baseline	13.5	26.5	17.3	1.42	343	51.6	82.9	1.2	0.0	0.0	0.0	0.22
Northeast-RFG	NR	1990	Summer	Baseline	8.8	29.7	13.7	1.77	332	42.5	80.4	1.1	0.0	0.0	0.0	0.19
Northeast-RFG	NR	1990	Winter	Baseline	13.5	26.5	17.3	1.42	343	51.6	82.9	1.2	0.0	0.0	0.0	0.22
Ohio Valley-NoRFG	ON	1990	Summer	Baseline	9.7	26.8	10.5	1.59	383	46.8	80.3	1.3	0.0	2.0	0.0	0.93
Ohio Valley-NoRFG	ON	1990	Winter	Baseline	14.1	24.9	11.1	1.56	333	55.6	82.6	0.9	0.0	2.0	0.0	0.84
Ohio Valley-RFG	OR	1990	Summer	Baseline	9.7	26.8	10.5	1.59	383	46.8	80.3	1.3	0.0	2.0	0.0	0.93
Ohio Valley-RFG	OR	1990	Winter	Baseline	14.1	24.9	11.1	1.56	333	55.6	82.6	0.9	0.0	2.0	0.0	0.84
Northern MI/WI	MI	1990	Summer	Baseline	9.4	27.1	8.5	1.57	363	49.2	80.8	2.5	0.0	1.8	0.0	1.06
Northern MI/WI	MI	1990	Winter	Baseline	14.0	24.5	9.6	1.36	352	55.8	83.4	5.4	0.0	1.9	0.0	1.62
West Texas	WT	1990	Summer	Baseline	8.0	28.6	9.6	1.83	289	45.3	81.4	2.4	0.0	0.0	0.0	0.43
West Texas	WT	1990	Winter	Baseline	11.7	27.2	14.6	1.75	362	49.2	82.8	5.2	0.0	0.0	0.0	0.93

1996 Baseline Fuel Specifications

Area	Abbrev.	Year	Season	Scenario	RVP, psi	Aromatics	Olefins	Benzene %	Sulfur	E200 %	E300 %	MTBE %	ETBE %	EtOH %	TAME %	Oxygen wt
Atlanta	AT	1996	Summer	Baseline	7.2	32.1	11.2	0.87	343	36.9	79.8	0.7	0.0	0.0	0.0	0.13
Atlanta	AT	1996	Winter	Baseline	12.4	24.8	13.0	0.77	447	51.2	82.7	0.3	0.0	0.0	0.0	0.06
Chicago	CH	1996	Summer	Baseline	7.9	26.0	9.7	0.96	492	50.2	80.8	0.0	0.0	9.0	0.0	3.12
Chicago	CH	1996	Winter	Baseline	14.0	22.4	7.8	0.80	523	58.0	83.9	0.0	0.0	9.0	0.0	3.11
Denver	DN	1996	Summer	Baseline	8.8	27.1	8.8	1.33	296	50.1	83.1	0.0	0.0	0.0	0.0	0.00
Denver	DN	1996	Winter	Baseline	13.6	21.9	9.2	0.94	350	62.1	88.1	0.0	0.0	8.4	0.0	2.91
Houston	HS	1996	Summer	Baseline	7.1	27.4	13.0	0.71	261	47.8	79.8	9.8	0.0	0.0	0.0	1.74
Houston	HS	1996	Winter	Baseline	12.8	21.1	12.8	0.70	224	59.9	83.8	7.9	0.0	0.0	0.0	1.41
Minneapolis	MN	1996	Summer	Baseline	9.6	28.2	7.3	1.81	121	59.4	84.6	0.0	0.0	9.4	0.0	3.24
Minneapolis	MN	1996	Winter	Baseline	14.9	23.4	5.3	1.65	70	62.3	89.1	0.0	0.0	8.0	0.0	2.77
New York	NY	1996	Summer	Baseline	8.0	28.6	17.1	0.51	231	49.8	81.5	10.6	0.0	0.0	0.0	1.89
New York	NY	1996	Winter	Baseline	13.2	23.3	16.6	0.47	267	57.5	85.7	14.5	0.0	0.0	0.0	2.58
Philadelphia	PA	1996	Summer	Baseline	7.9	29.0	12.3	0.80	367	51.2	81.8	11.3	0.0	0.0	0.0	2.01
Philadelphia	PA	1996	Winter	Baseline	13.5	25.4	10.2	0.63	337	59.3	85.9	8.8	0.0	0.0	0.0	1.58
Phoenix	PX	1996	Summer	Baseline	6.8	36.1	6.8	1.07	118	45.7	76.2	0.8	0.0	0.0	0.0	0.14
Phoenix	PX	1996	Winter	Baseline	8.7	34.3	7.1	1.40	216	50.2	82.6	0.0	0.0	10.2	0.0	3.53
Spokane	SP	1996	Summer	Baseline	8.7	28.5	8.3	1.32	412	45.0	81.4	0.0	0.0	0.0	0.0	0.00
Spokane	SP	1996	Winter	Baseline	14.8	18.6	6.9	0.97	350	59.8	87.1	0.0	0.0	9.3	0.0	3.21
St. Louis	SL	1996	Summer	Baseline	6.8	29.9	12.0	0.70	492	39.0	78.8	0.0	0.0	0.0	0.0	0.00
St. Louis	SL	1996	Winter	Baseline	13.6	23.8	11.4	0.89	535	52.7	82.6	0.0	0.0	0.0	0.0	0.00
Western WA/OR - Win 95/96	WA	1996	Summer	Baseline	8.0	35.7	6.7	2.17	256	44.0	82.4	0.1	0.0	0.0	0.0	0.02
Western WA/OR - Win 95/96	WA	1996	Winter	Baseline	13.6	27.5	6.3	1.81	342	58.8	84.5	0.0	0.0	4.3	0.0	1.49
Western WA/OR - Win 96/97	WB	1996	Summer	Baseline	8.0	35.7	6.7	2.17	256	44.0	82.4	0.1	0.0	0.0	0.0	0.02
Western WA/OR - Win 96/97	WB	1996	Winter	Baseline	13.4	29.4	5.8	1.81	345	52.7	84.0	0.0	0.0	1.3	0.0	0.44
Northern California	CN	1996	Summer	Baseline	6.9	24.4	3.5	0.56	26	49.3	89.9	9.1	0.0	0.0	0.0	1.63
Northern California	CN	1996	Winter	Baseline	10.5	20.1	2.1	0.52	30	54.4	90.8	10.5	0.0	0.0	0.0	1.87
Southern California	CS	1996	Summer	Baseline	7.0	20.7	4.3	0.52	10	51.0	86.8	11.0	0.0	0.0	0.0	1.96
Southern California	CS	1996	Winter	Baseline	10.6	17.7	3.5	0.57	31	56.3	88.6	11.6	0.0	0.0	0.0	2.08
ID/MT/WY	ID	1996	Summer	Baseline	8.5	28.3	8.1	1.64	318	46.8	84.6	0.5	0.0	0.0	0.0	0.09
ID/MT/WY	ID	1996	Winter	Baseline	13.5	22.8	6.4	1.40	252	53.7	84.6	0.5	0.0	0.0	0.0	0.09
UT/NM/NV	UT	1996	Summer	Baseline	8.0	30.7	10.6	1.75	207	45.2	83.6	1.1	0.0	0.0	0.0	0.20
UT/NM/NV	UT	1996	Winter	Baseline	14.4	20.4	8.3	1.14	106	72.2	85.2	0.0	0.0	10.3	0.0	3.54
ND/SD/NE/IA/KS/Western MO	ND	1996	Summer	Baseline	8.3	29.0	8.0	1.33	229	45.4	81.8	0.1	0.0	1.7	0.0	0.59
ND/SD/NE/IA/KS/Western MO	ND	1996	Winter	Baseline	13.4	22.4	6.8	1.12	224	56.0	85.0	0.4	0.0	1.8	0.0	0.68
AR/MS/AL/SC/Northern LA	SE	1996	Summer	Baseline	7.7	30.7	13.2	0.84	349	38.8	78.1	0.5	0.0	0.0	0.0	0.08
AR/MS/AL/SC/Northern LA	SE	1996	Winter	Baseline	12.2	24.5	13.0	0.81	271	50.5	82.3	0.4	0.0	0.0	0.0	0.08
Florida	FL	1996	Summer	Baseline	7.6	33.6	10.1	0.79	280	40.3	79.4	0.5	0.0	0.0	0.0	0.09
Florida	FL	1996	Winter	Baseline	12.1	24.6	12.8	0.82	289	50.5	82.7	0.4	0.0	0.0	0.0	0.07
Northeast-NoRFG	NN	1996	Summer	Baseline	8.6	28.1	12.4	1.03	308	43.2	80.7	1.5	0.0	0.0	0.0	0.27
Northeast-NoRFG	NN	1996	Winter	Baseline	13.2	23.8	16.2	0.73	222	52.2	83.3	0.8	0.0	0.0	0.0	0.14
Northeast-RFG	NR	1996	Summer	Baseline	7.9	24.7	11.7	0.65	234	50.5	82.4	10.9	0.0	0.0	0.0	1.94
Northeast-RFG	NR	1996	Winter	Baseline	12.5	19.7	9.6	0.66	265	59.1	87.0	10.5	0.0	0.0	0.0	1.87
Ohio Valley-NoRFG	ON	1996	Summer	Baseline	8.7	30.2	10.4	1.24	334	45.3	80.3	0.9	0.0	1.5	0.0	0.68
Ohio Valley-NoRFG	ON	1996	Winter	Baseline	14.1	25.5	8.8	1.04	310	54.0	82.6	0.4	0.0	1.2	0.0	0.48
Ohio Valley-RFG	OR	1996	Summer	Baseline	7.8	27.3	8.1	0.99	300	45.5	81.1	9.5	0.0	0.0	0.0	1.69
Ohio Valley-RFG	OR	1996	Winter	Baseline	12.9	18.9	8.8	0.97	355	59.4	88.4	10.0	0.0	0.0	0.0	1.79
Northern MI/WI	MI	1996	Summer	Baseline	8.5	28.4	9.1	1.32	277	49.0	80.9	0.5	0.0	2.8	0.0	1.04
Northern MI/WI	MI	1996	Winter	Baseline	14.0	25.3	8.4	1.46	206	57.6	83.1	0.2	0.0	2.4	0.0	0.85
West Texas	WT	1996	Summer	Baseline	8.0	30.1	9.7	1.48	263	41.5	81.6	0.2	0.0	0.0	0.0	0.03
West Texas	WT	1996	Winter	Baseline	11.8	25.8	8.1	1.21	361	47.3	83.7	0.0	0.0	0.0	0.0	0.00

2007/2020 Baseline Fuel Specifications

Area	Abbrev.	Year	Season	Scenario	RVP, psi	Aromatic	Olefins	Benzene	Sulfur	E200 %	E300 %	MTBE %	ETBE %	EtOH %	TAME %	Oxygen
Atlanta	AT	2007	Summer	Baseline	7.0	32.1	11.2	0.87	150	36.9	79.8	0.6	0.0	0.0	0.0	0.10
Atlanta	AT	2007	Winter	Baseline	12.4	24.8	13.0	0.77	447	51.2	82.7	0.6	0.0	0.0	0.0	0.10
Chicago	CH	2007	Summer	Baseline	6.6	21.0	6.2	0.93	150	52.9	82.9	0.0	13.7	0.0	0.0	2.10
Chicago	CH	2007	Winter	Baseline	14.0	19.1	5.8	0.80	268	59.6	84.6	0.0	0.0	10.7	0.0	3.70
Denver	DN	2007	Summer	Baseline	8.8	27.1	8.8	1.33	296	50.1	83.1	0.0	0.0	0.0	0.0	0.00
Denver	DN	2007	Winter	Baseline	13.6	21.9	9.2	0.94	350	62.1	88.1	0.0	0.0	8.4	0.0	2.90
Houston	HS	2007	Summer	Baseline	6.7	23.4	9.6	0.78	145	50.3	82.7	11.2	0.0	0.0	0.0	2.00
Houston	HS	2007	Winter	Baseline	12.8	21.4	10.0	0.67	209	56.0	83.7	10.6	0.0	0.0	0.0	1.90
Minneapolis	MN	2007	Summer	Baseline	9.6	28.2	7.3	1.81	121	59.4	84.6	0.0	0.0	9.6	0.0	3.30
Minneapolis	MN	2007	Winter	Baseline	14.9	23.4	5.3	1.65	70	62.3	89.1	0.0	0.0	8.1	0.0	2.80
New York	NY	2007	Summer	Baseline	6.8	22.4	11.9	0.59	115	51.6	84.1	11.2	0.0	0.0	0.0	2.00
New York	NY	2007	Winter	Baseline	13.2	20.9	11.7	0.53	191	57.6	85.3	14.6	0.0	0.3	0.0	2.70
Philadelphia	PA	2007	Summer	Baseline	6.7	21.8	10.3	0.65	135	52.9	84.3	11.8	0.0	0.0	0.0	2.10
Philadelphia	PA	2007	Winter	Baseline	13.5	22.7	10.5	0.62	165	55.9	84.9	11.2	0.0	0.0	0.0	2.00
Phoenix	PX	2007	Summer	Baseline	6.8	20.0	3.9	0.55	20	51.0	89.0	0.0	0.0	6.1	0.0	2.10
Phoenix	PX	2007	Winter	Baseline	10.6	17.7	3.5	0.57	31	56.3	88.6	0.0	0.0	10.2	0.0	3.50
Spokane	SP	2007	Summer	Baseline	8.7	28.5	8.3	1.32	412	45.0	81.4	0.0	0.0	0.0	0.0	0.00
Spokane	SP	2007	Winter	Baseline	14.8	18.5	6.9	0.96	346	60.2	87.2	0.0	0.0	10.2	0.0	3.50
St. Louis	SL	2007	Summer	Baseline	6.4	25.1	11.2	0.72	145	45.0	79.9	0.0	13.7	0.0	0.0	2.10
St. Louis	SL	2007	Winter	Baseline	13.6	22.4	9.9	0.89	300	52.5	84.7	0.0	0.0	6.1	0.0	2.10
Western Washington/Oregon	WA	2007	Summer	Baseline	8.0	35.7	6.7	2.17	256	44.0	82.4	0.0	0.0	0.0	0.0	0.00
Western Washington/Oregon	WA	2007	Winter	Baseline	13.5	28.5	6.1	1.81	343	55.8	84.2	0.0	0.0	2.9	0.0	1.00
Western Washington/Oregon	WB	2007	Summer	Baseline	8.0	35.7	6.7	2.17	256	44.0	82.4	0.0	0.0	0.0	0.0	0.00
Western Washington/Oregon	WB	2007	Winter	Baseline	13.5	28.5	6.1	1.81	343	55.8	84.2	0.0	0.0	2.9	0.0	1.00
Northern California	CN	2007	Summer	Baseline	6.8	20.0	3.9	0.55	20	51.0	89.0	0.0	0.0	6.1	0.0	2.10
Northern California	CN	2007	Winter	Baseline	10.5	20.1	2.1	0.52	30	54.4	90.8	0.0	0.0	6.1	0.0	2.10
Southern California	CS	2007	Summer	Baseline	6.8	20.0	3.9	0.55	20	51.0	89.0	0.0	0.0	6.1	0.0	2.10
Southern California	CS	2007	Winter	Baseline	10.6	17.7	3.5	0.57	31	56.3	88.6	0.0	0.0	6.1	0.0	2.10
Idaho/Montana/Wyoming	ID	2007	Summer	Baseline	8.5	28.3	8.1	1.64	318	46.8	84.6	0.6	0.0	0.0	0.0	0.10
Idaho/Montana/Wyoming	ID	2007	Winter	Baseline	13.5	22.8	6.4	1.40	252	53.7	84.6	0.6	0.0	0.0	0.0	0.10
Utah/New Mexico/Nevada	UT	2007	Summer	Baseline	8.0	30.7	10.6	1.75	207	45.2	83.6	1.1	0.0	0.0	0.0	0.20
Utah/New Mexico/Nevada	UT	2007	Winter	Baseline	14.4	20.4	8.3	1.14	106	72.2	85.2	0.0	0.0	10.4	0.0	3.60
ND/SD/NE/IA/KS/Western MO	ND	2007	Summer	Baseline	8.3	29.0	8.0	1.33	229	45.4	81.8	0.0	0.0	1.7	0.0	0.60
ND/SD/NE/IA/KS/Western MO	ND	2007	Winter	Baseline	13.4	22.4	6.8	1.12	224	56.0	85.0	0.6	0.0	1.7	0.0	0.70
AR/MS/AL/SC/Northern LA	SE	2007	Summer	Baseline	7.7	30.7	13.2	0.84	349	38.8	78.1	0.6	0.0	0.0	0.0	0.10
AR/MS/AL/SC/Northern LA	SE	2007	Winter	Baseline	12.2	24.5	13.0	0.81	271	50.5	82.3	0.6	0.0	0.0	0.0	0.10
Florida	FL	2007	Summer	Baseline	7.6	33.6	10.1	0.79	280	40.3	79.4	0.6	0.0	0.0	0.0	0.10
Florida	FL	2007	Winter	Baseline	12.1	24.6	12.8	0.82	289	50.5	82.7	0.6	0.0	0.0	0.0	0.10
Northeastern states - non RFG	NN	2007	Summer	Baseline	8.6	28.1	12.4	1.03	308	43.2	80.7	1.7	0.0	0.0	0.0	0.30
Northeastern states - non RFG	NN	2007	Winter	Baseline	13.2	23.8	16.2	0.73	222	52.2	83.3	0.6	0.0	0.0	0.0	0.10
Northeastern states- with RFG	NR	2007	Summer	Baseline	6.7	20.9	10.9	0.67	135	52.6	83.5	11.2	0.0	0.0	0.0	2.00
Northeastern states- with RFG	NR	2007	Winter	Baseline	12.5	19.7	9.6	0.66	265	59.1	87.0	10.6	0.0	0.0	0.0	1.90
Ohio Valley - non-RFG	ON	2007	Summer	Baseline	8.7	30.2	10.4	1.24	334	45.3	80.3	1.1	0.0	1.5	0.0	0.70
Ohio Valley - non-RFG	ON	2007	Winter	Baseline	14.1	25.5	8.8	1.04	310	54.0	82.6	0.6	0.0	1.2	0.0	0.50
Ohio Valley - with RFG	OR	2007	Summer	Baseline	6.5	23.6	7.6	1.02	115	47.3	82.2	9.5	0.0	0.0	0.0	1.70
Ohio Valley - with RFG	OR	2007	Winter	Baseline	12.9	18.9	8.8	0.97	355	59.4	88.4	10.1	0.0	0.0	0.0	1.80
Northern MI/WI/MN	MI	2007	Summer	Baseline	8.5	28.4	9.1	1.32	277	49.0	80.9	0.6	0.0	2.9	0.0	1.10
Northern MI/WI/MN	MI	2007	Winter	Baseline	14.0	25.3	8.4	1.46	206	57.6	83.1	0.0	0.0	2.3	0.0	0.80
West Texas	WT	2007	Summer	Baseline	8.0	30.1	9.7	1.48	263	41.5	81.6	0.0	0.0	0.0	0.0	0.00
West Texas	WT	2007	Winter	Baseline	11.8	25.8	8.1	1.21	361	47.3	83.7	0.0	0.0	0.0	0.0	0.00

1996 Minimum-Maximum Fuel Specifications for Sensitivity Analysis

Area	Abbrev.	Year	Producer	Grade	Season	Scenario	RVP, psi	Aromatics	Olefins	Benzene %	Sulfur	E200 %	E300 %	MTBE %	ETBE %	EtOH %	TAME %	Oxygen wt	T50	T90
Cleveland	CL	1996	BP	Regular Unl.	Summer	Max S	8.6	31.4	10.4	1.70	820	44.0	82.2	0.0	0.0	0.0	0.0	0.00	212	333
Cleveland	CL	1996	Super Amer.	Regular Unl.	Summer	Min S	8.5	27.8	11.5	1.50	80	39.1	78.3	0.0	0.0	0.0	0.0	0.00	222	351
Minneapolis	MN	1996	Amoco	Premium Unl.	Summer	Max Aro	9.2	35.1	5.1	1.50	40	38.6	86.0	0.0	0.0	9.8	0.0	3.38	223	316
Minneapolis	MN	1996	Mobil	Premium Unl.	Summer	Min Aro	9.7	5.2	10.9	0.30	40	60.2	92.3	0.0	0.0	9.4	0.0	3.24	179	287
Philadelphia	PA	1996	Mobil	Regular Unl.	Summer	Max Ole	7.6	25.8	22.8	0.50	210	50.4	81.3	12.0	0.0	0.0	0.0	2.14	199	337
Philadelphia	PA	1996	Exxon	Regular Unl.	Summer	Min Ole	8.0	24.3	7.0	0.60	150	55.8	82.7	11.6	0.0	0.0	0.0	2.07	188	331
Seattle	SE	1996	Exxon	Premium Unl.	Summer	Max Bnz	8.2	55.6	6.9	4.20	10	33.3	87.5	0.0	0.0	0.0	0.0	0.00	234	309
Seattle	SE	1996	BP	Premium Unl.	Summer	Min Bnz	9.3	36.9	3.1	1.40	240	37.2	81.3	0.0	0.0	9.4	0.0	3.24	226	337

2007/2020 30 ppm Sulfur Fuel Specifications

Area	Abbrev.	Year	Season	Scenario	RVP, psi	Aromatic	Olefins	Benzene	Sulfur	E200 %	E300 %	MTBE %	ETBE %	EtOH %	TAME %	Oxygen
Atlanta	AT	2007	Summer	30 ppm	7.0	30.9	8.9	0.87	30	38.1	80.2	1.7	0.0	0.0	0.0	0.30
Atlanta	AT	2007	Winter	30 ppm	12.4	24.0	11.4	0.77	30	50.8	82.7	0.6	0.0	0.0	0.0	0.10
Chicago	CH	2007	Summer	30 ppm	6.6	24.1	6.2	0.93	30	51.2	82.7	0.0	13.7	0.0	0.0	2.10
Chicago	CH	2007	Winter	30 ppm	14.0	17.6	2.9	0.80	30	60.1	87.3	0.0	0.0	10.7	0.0	3.70
Denver	DN	2007	Summer	30 ppm	8.8	26.1	7.0	1.33	30	51.3	83.5	0.0	0.0	0.0	0.0	0.00
Denver	DN	2007	Winter	30 ppm	13.6	21.2	8.0	0.94	30	61.7	88.1	0.0	0.0	8.4	0.0	2.90
Houston	HS	2007	Summer	30 ppm	6.7	26.8	9.7	0.78	30	48.5	82.5	11.2	0.0	0.0	0.0	2.00
Houston	HS	2007	Winter	30 ppm	12.8	19.7	5.0	0.67	30	56.5	86.4	10.6	0.0	0.0	0.0	1.90
Minneapolis	MN	2007	Summer	30 ppm	9.6	27.2	5.8	1.81	30	60.6	85.1	0.0	0.0	9.6	0.0	3.30
Minneapolis	MN	2007	Winter	30 ppm	14.9	22.7	4.7	1.65	30	61.9	89.1	0.0	0.0	8.1	0.0	2.80
New York	NY	2007	Summer	30 ppm	6.8	25.8	11.9	0.59	30	49.9	83.8	11.2	0.0	0.0	0.0	2.00
New York	NY	2007	Winter	30 ppm	13.2	19.3	5.8	0.53	30	58.1	88.0	14.6	0.0	0.3	0.0	2.70
Philadelphia	PA	2007	Summer	30 ppm	6.7	25.0	10.3	0.65	30	51.1	84.1	11.8	0.0	0.0	0.0	2.10
Philadelphia	PA	2007	Winter	30 ppm	13.5	21.0	5.2	0.62	30	56.5	87.6	11.2	0.0	0.0	0.0	2.00
Phoenix	PX	2007	Summer	30 ppm	7.0	22.0	4.0	0.80	30	50.0	92.0	0.0	0.0	6.1	0.0	2.10
Phoenix	PX	2007	Winter	30 ppm	10.6	17.7	3.5	0.57	30	56.3	88.6	0.0	0.0	10.2	0.0	3.50
Spokane	SP	2007	Summer	30 ppm	8.7	27.5	6.6	1.32	30	46.2	81.8	0.0	0.0	0.0	0.0	0.00
Spokane	SP	2007	Winter	30 ppm	14.8	17.9	6.0	0.96	30	59.8	87.2	0.0	0.0	10.2	0.0	3.50
St. Louis	SL	2007	Summer	30 ppm	6.4	28.8	11.3	0.72	30	45.0	79.6	0.0	13.7	0.0	0.0	2.10
St. Louis	SL	2007	Winter	30 ppm	13.6	20.7	4.9	0.89	30	52.5	84.7	0.0	0.0	6.1	0.0	2.10
Western Washington/Oregon	WA	2007	Summer	30 ppm	8.0	34.5	5.3	2.17	30	45.2	82.8	0.0	0.0	0.0	0.0	0.00
Western Washington/Oregon	WA	2007	Winter	30 ppm	13.5	27.6	5.3	1.81	30	55.4	84.2	0.0	0.0	2.9	0.0	1.00
Western Washington/Oregon	WB	2007	Summer	30 ppm	8.0	34.5	5.3	2.17	30	45.2	82.8	0.0	0.0	0.0	0.0	0.00
Western Washington/Oregon	WB	2007	Winter	30 ppm	13.5	27.6	5.3	1.81	30	55.4	84.2	0.0	0.0	2.9	0.0	1.00
Northern California	CN	2007	Summer	30 ppm	7.0	22.0	4.0	0.80	30	50.0	92.0	0.0	0.0	6.1	0.0	2.10
Northern California	CN	2007	Winter	30 ppm	10.5	20.1	2.1	0.52	30	54.4	90.8	0.0	0.0	6.1	0.0	2.10
Southern California	CS	2007	Summer	30 ppm	7.0	22.0	4.0	0.80	30	50.0	92.0	0.0	0.0	6.1	0.0	2.10
Southern California	CS	2007	Winter	30 ppm	10.6	17.7	3.5	0.57	30	56.3	88.6	0.0	0.0	6.1	0.0	2.10
Idaho/Montana/Wyoming	ID	2007	Summer	30 ppm	8.5	27.3	6.5	1.64	30	48.0	85.0	1.1	0.0	0.0	0.0	0.20
Idaho/Montana/Wyoming	ID	2007	Winter	30 ppm	13.5	22.1	5.6	1.40	30	53.3	84.6	0.6	0.0	0.0	0.0	0.10
Utah/New Mexico/Nevada	UT	2007	Summer	30 ppm	8.0	29.6	8.5	1.75	30	46.4	84.0	2.2	0.0	0.0	0.0	0.40
Utah/New Mexico/Nevada	UT	2007	Winter	30 ppm	14.4	19.8	7.2	1.14	30	71.7	85.2	0.0	0.0	10.4	0.0	3.60
ND/SD/NE/IA/KS/Western MO	ND	2007	Summer	30 ppm	8.3	28.0	6.4	1.33	30	46.6	82.2	0.0	0.0	3.5	0.0	1.20
ND/SD/NE/IA/KS/Western MO	ND	2007	Winter	30 ppm	13.4	21.7	6.0	1.12	30	55.6	85.0	0.6	0.0	1.7	0.0	0.70
AR/MS/AL/SC/Northern LA	SE	2007	Summer	30 ppm	7.7	29.6	10.5	0.84	30	40.0	78.5	1.1	0.0	0.0	0.0	0.20
AR/MS/AL/SC/Northern LA	SE	2007	Winter	30 ppm	12.2	23.7	11.3	0.81	30	50.1	82.3	0.6	0.0	0.0	0.0	0.10
Florida	FL	2007	Summer	30 ppm	7.6	32.4	8.1	0.79	30	41.5	79.8	1.1	0.0	0.0	0.0	0.20
Florida	FL	2007	Winter	30 ppm	12.1	23.8	11.2	0.82	30	50.1	82.7	0.6	0.0	0.0	0.0	0.10
Northeastern states - non RFG	NN	2007	Summer	30 ppm	8.6	27.1	9.9	1.03	30	44.4	81.1	3.4	0.0	0.0	0.0	0.60
Northeastern states - non RFG	NN	2007	Winter	30 ppm	13.2	23.1	14.1	0.73	30	51.8	83.3	0.6	0.0	0.0	0.0	0.10
Northeastern states- with RFG	NR	2007	Summer	30 ppm	6.7	24.0	11.0	0.67	30	50.8	83.2	11.2	0.0	0.0	0.0	2.00
Northeastern states- with RFG	NR	2007	Winter	30 ppm	12.5	18.2	4.8	0.66	30	59.6	89.7	10.6	0.0	0.0	0.0	1.90
Ohio Valley - non-RFG	ON	2007	Summer	30 ppm	8.7	29.1	8.3	1.24	30	46.5	80.7	1.7	0.0	2.9	0.0	1.30
Ohio Valley - non-RFG	ON	2007	Winter	30 ppm	14.1	24.7	7.7	1.04	30	53.6	82.6	0.6	0.0	1.2	0.0	0.50
Ohio Valley - with RFG	OR	2007	Summer	30 ppm	6.5	27.1	7.6	1.02	30	45.6	81.9	9.5	0.0	0.0	0.0	1.70
Ohio Valley - with RFG	OR	2007	Winter	30 ppm	12.9	17.4	4.4	0.97	30	59.9	91.1	10.1	0.0	0.0	0.0	1.80
Northern MI/WI/MN	MI	2007	Summer	30 ppm	8.5	27.4	7.3	1.32	30	50.2	81.3	1.1	0.0	5.8	0.0	2.20
Northern MI/WI/MN	MI	2007	Winter	30 ppm	14.0	24.5	7.3	1.46	30	57.2	83.1	0.0	0.0	2.3	0.0	0.80
West Texas	WT	2007	Summer	30 ppm	8.0	29.1	7.8	1.48	30	42.7	82.0	0.6	0.0	0.0	0.0	0.10
West Texas	WT	2007	Winter	30 ppm	11.8	24.9	7.1	1.21	30	46.8	83.7	0.0	0.0	0.0	0.0	0.00

2007/2020 Benzene Cap Fuel Specifications

Area	Abbrev.	Year	Season	Scenario	RVP, psi	Aromatic	Olefins	Benzene	Sulfur	E200 %	E300 %	MTBE %	ETBE %	EtOH %	TAME %	Oxygen
Atlanta	AT	2007	Summer	1 pct benzene	7.0	30.9	8.9	0.95	30	38.1	80.2	1.7	0.0	0.0	0.0	0.30
Atlanta	AT	2007	Winter	1 pct benzene	12.4	24.0	11.4	0.95	30	50.8	82.7	0.6	0.0	0.0	0.0	0.10
Minneapolis	MN	2007	Summer	1 pct benzene	9.6	27.2	5.8	0.95	30	60.6	85.1	0.0	0.0	9.6	0.0	3.30
Minneapolis	MN	2007	Winter	1 pct benzene	14.9	22.7	4.7	0.95	30	61.9	89.1	0.0	0.0	8.1	0.0	2.80
Western Washington/Oregon	WA	2007	Summer	1 pct benzene	8.0	34.5	5.3	0.95	30	45.2	82.8	0.0	0.0	0.0	0.0	0.00
Western Washington/Oregon	WA	2007	Winter	1 pct benzene	13.5	27.6	5.3	0.95	30	55.4	84.2	0.0	0.0	2.9	0.0	1.00
Northern MI/WI/MN	MI	2007	Summer	1 pct benzene	8.5	27.4	7.3	0.95	30	50.2	81.3	1.1	0.0	5.8	0.0	2.20
Northern MI/WI/MN	MI	2007	Winter	1 pct benzene	14.0	24.5	7.3	0.95	30	57.2	83.1	0.0	0.0	2.3	0.0	0.80
ND/SD/NE/IA/KS/Western MO	ND	2007	Summer	1 pct benzene	8.3	28.0	6.4	0.95	30	46.6	82.2	0.0	0.0	3.5	0.0	1.20
ND/SD/NE/IA/KS/Western MO	ND	2007	Winter	1 pct benzene	13.4	21.7	6.0	0.95	30	55.6	85.0	0.6	0.0	1.7	0.0	0.70
Ohio Valley - non-RFG	ON	2007	Summer	1 pct benzene	8.7	29.1	8.3	0.95	30	46.5	80.7	1.7	0.0	2.9	0.0	1.30
Ohio Valley - non-RFG	ON	2007	Winter	1 pct benzene	14.1	24.7	7.7	0.95	30	53.6	82.6	0.6	0.0	1.2	0.0	0.50
Northeastern states - non RFG	NN	2007	Summer	1 pct benzene	8.6	27.1	9.9	0.95	30	44.4	81.1	3.4	0.0	0.0	0.0	0.60
Northeastern states - non RFG	NN	2007	Winter	1 pct benzene	13.2	23.1	14.1	0.95	30	51.8	83.3	0.6	0.0	0.0	0.0	0.10

2007/2020 25% Toxics Reduction Performance Standard Fuel Specifications

Area	Abbrev.	Year	Season	Scenario	RVP, psi	Aromatic	Olefins	Benzene	Sulfur	E200 %	E300 %	MTBE %	ETBE %	EtOH %	TAME %	Oxygen
Atlanta	AT	2007	Summer	RFG Perf Std	7.0	28.0	8.9	0.80	30	38.1	81.6	1.7	0.0	0.0	0.0	0.30
Atlanta	AT	2007	Winter	RFG Perf Std	12.4	20.0	11.4	0.60	30	50.8	83.9	0.6	0.0	0.0	0.0	0.10
Minneapolis	MN	2007	Summer	RFG Perf Std	9.6	27.2	5.8	0.95	30	60.6	85.1	0.0	0.0	9.6	0.0	3.30
Minneapolis	MN	2007	Winter	RFG Perf Std	14.9	22.7	4.7	0.90	30	61.9	89.1	0.0	0.0	8.1	0.0	2.80
Western Washington/Oregon	WA	2007	Summer	RFG Perf Std	8.0	28.0	5.3	0.75	30	45.2	86.0	0.0	0.0	0.0	0.0	0.00
Western Washington/Oregon	WA	2007	Winter	RFG Perf Std	13.5	24.0	5.3	0.60	30	55.4	85.3	0.0	0.0	2.9	0.0	1.00
Northern MI/WI/MN	MI	2007	Summer	RFG Perf Std	8.5	27.4	7.3	0.95	30	50.2	81.3	1.1	0.0	5.8	0.0	2.20
Northern MI/WI/MN	MI	2007	Winter	RFG Perf Std	14.0	24.0	7.4	0.60	30	57.2	83.3	0.0	0.0	2.3	0.0	0.80
ND/SD/NE/IA/KS/Western MO	ND	2007	Summer	RFG Perf Std	8.3	28.0	6.4	0.85	30	46.6	82.2	0.0	0.0	3.5	0.0	1.20
ND/SD/NE/IA/KS/Western MO	ND	2007	Winter	RFG Perf Std	13.4	21.7	6.0	0.75	30	55.6	85.0	0.6	0.0	1.7	0.0	0.70
Ohio Valley - non-RFG	ON	2007	Summer	RFG Perf Std	8.7	28.0	8.3	0.85	30	46.5	81.2	1.7	0.0	2.9	0.0	1.30
Ohio Valley - non-RFG	ON	2007	Winter	RFG Perf Std	14.1	22.0	7.7	0.60	30	53.6	83.4	0.6	0.0	1.2	0.0	0.50
Northeastern states - non RFG	NN	2007	Summer	RFG Perf Std	8.6	27.2	9.9	0.80	30	44.4	81.1	3.4	0.0	0.0	0.0	0.60
Northeastern states - non RFG	NN	2007	Winter	RFG Perf Std	13.2	20.0	14.1	0.60	30	58.0	85.5	0.6	0.0	0.0	0.0	0.10

Appendix J

Development of Fuel Specification Estimates

APPENDIX

2007/2020 Fuels Modeling Scenarios

I. Baseline and Low Sulfur Fuels

A. Conventional gasoline areas:

1. The 1996 values become the 2007/2020 baseline (no sulfur controls) values:

2. The baseline numbers are adjusted by a multiplicative or additive factor to estimate the 30 ppm values.

The factors below were derived from information in a February 26, 1999 Mathpro report to API investigating the costs of meeting a 40 ppm sulfur standard. The methodology for deriving the factors was to look at estimated reference (no sulfur standard) case properties and estimated 40 ppm properties (average of two desulfurization technologies). Linear relationship was assumed between sulfur changes and other property changes, and 30 ppm properties were estimated from these relationships. The multiplicative factors are the 30 ppm property values divided by the reference property values, and the additive factors are the 30 ppm values - the basecase values. E200 and E300 are additive, others are multiplicative. The adjustment factors used for conventional gasoline and for RFG (discussed later) are shown below:

	Adjustment factors 30ppm				
	conv summer	conv winter	RFG summer	RFG winter	
RVP	1.00	1.00	1.00	1.00	multiplicative
Oxygen	2.03	1.00	1.00	1.00	multiplicative
Aromatics	0.96	0.97	1.15	0.92	multiplicative
Benzene	1.00	1.00	1.00	1.00	multiplicative
Olefins	0.80	0.87	1.01	0.50	multiplicative
Sulfur	n/a	n/a	n/a	n/a	
E200	1.19	-0.41	-1.77	0.52	additive
E300	0.41	0.00	-0.27	2.72	additive

Multiplicative factor = 30 ppm case/basecase
Additive factor = 30 ppm case - basecase

For RFG, the process becomes more complicated. Between 1996 and 2007/2020 there is a transition from Phase I simple model to Phase I complex model in 1998, and a transition from Phase 1 to Phase 2 complex model in 2000. The status of the oxygenate mandate, and the use of MTBE is also uncertain. (Although the oxygen situation may well change, these projections assume that theoxygen mandate will remain in place and that MTBE usage will remain constant between 1998 and 2007/2020.)

B1. Federal RFG Summer:

For individual RFG cities, 1998 summer RFG survey results, rather than 1996 AAMA results were used for projections. In other cases (e.g. Northeastern States with RFG), the 1996 data were used.

To get the 2007/2020 basecase, the summer values were adjusted to meet Phase II RFG performance standards

RVP was lowered until the VOC standard was met and/or 6.4 psi (complex model limit) was hit.

Sulfur was initially assumed 150 ppm, and was lowered, if necessary, to meet the NOx performance standard.

Other properties are likely to change as a result of the transition from Phase I to Phase II RFG. The following methodology was used to estimate the 2007/2020 values for the properties other than RVP and sulfur:

1. National average values for Phase I RFG were estimated from 1998 RFG Survey data. (1998 is the first year that this survey measured all complex model properties):

	RFG I Summer-natl
Oxygen	2.2
Aromatics	26
Benzene	0.68
Olefins	10.3
E200	49.4
E300	82.7

2. The Mathpro RFG II reference case sulfur for summer RFG was 180 ppm. Since we are assuming 150 ppm or lower in each RFG area for the baseline, adjusted sets of Mathpro reference properties values at 150 and lower (e.g. 145, 140, etc) were calculated by using linear relationships between the 180 ppm and

the 40 ppm properties. (While there is no strong technical basis for assuming that other reference case properties will shift in this manner as a function of sulfur level, if the assumption is incorrect the effect on the calculations is small.)

3. Multiplicative or additive adjustment factors were calculated to apply to the 1998 or 1996 city or area-specific Phase I properties (other than RVP and Sulfur) to transform them to 2007/2020 Phase II baseline values. The multiplicative adjustment factors are the Mathpro reference values for each property, adjusted for sulfur in step 2, divided by the 1998 RFG survey national averages. The additive adjustment factors are the reference property values minus the 1998 survey national average values. Again E200 and E300 are additive, others are multiplicative consistent with the 30 ppm adjustments. The specific set of factors to use, are determined by the sulfur level needed to bring NOx performance to standard. The current to 2007/2020 baseline adjustment factors for summer RFG are shown below:

	sulfur	115	120	125	130	135	140	145	150
multi.	Oxygen	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
multi.	Aromatics	0.86	0.86	0.86	0.85	0.85	0.84	0.84	0.84
multi.	Benzene	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
multi.	Olefins	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
add	E200	1.83	1.89	1.95	2.01	2.07	2.13	2.19	2.25
add	E300	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15

4. The 30 ppm adjustment factors for summer RFG, shown in the first table (see conventional gasoline areas) were applied to the 2007/2020 baselines to estimate the 2007/2020 30 ppm cases.

B2. Winter RFG:

Since 1998 Phase 1 winter RFG generally met Phase 2 standards for toxics and NOx performance, it was assumed for most areas that the 2007/2020 baseline winter RFG would be identical to Phase I RFG, and unadjusted survey results were used for these estimates.

The 30 ppm adjustment factors for winter RFG, shown in the first table, were applied to the 2007/2020 baselines to estimate the 2007/2020 30 ppm cases.

Special cases:

It is known that California will not use MTBE in 2007/2020. Also, property values for California gasoline are more tightly constrained than Federal RFG properties, so there is likely to be less area to area and year to year variation. For Northern and Southern California, it was assumed that the 2007/2020 baseline summer gasoline would look like the average California reformulated gasoline seen in the 1996 API surveys, but with ethanol at 2.1% oxygen weight as the oxygenate. Winter gasoline was assumed to look like the NIPER survey gasoline, but with ethanol as the oxygenate. The current average sulfur levels are less than 30 ppm. For the 30 ppm case, it was assumed that the summer gasoline values would be the current "average limit" property specifications, which include a 30 ppm sulfur specification. Winter 30 ppm properties were assumed to be the same as winter 2007/2020 baseline properties.

It was assumed that RFG areas using ethanol in Phase I would use ETBE during the summer for Phase II, and ethanol during the winter.

Phoenix summer gasoline was assumed to be like Southern California gasoline, but with winter oxygen at 3.5% from ethanol.

No data are available yet for St. Louis complex model RFG, and the 1996 data are for conventional gasoline. Estimating 2007/2020 baseline values involved more guesswork . The 1996 data were projected to the 2007/2020 baseline as if they were RFG data, and sulfur, rvp and E200 were adjusted to meet VOC, toxics and NOx performance requirements.

II. Benzene Control Scenario

For those areas selected for modeling of a benzene control scenario, it was assumed that benzene would change from the level in the 30 ppm sulfur case to 0.95 volume percent (the averaged standard for RFG) and that other parameters be identical to those projected for the 30 ppm sulfur case. This resulted in a fuel benzene decrease for all areas except Atlanta.

III. Toxics Performance Standard:

For selected areas, fuel property projections were made in order to model a 25% toxics performance standard. A fuel meeting this standard must provide a 25% or better toxics emission reduction from statutory baseline fuel emissions as calculated by the Phase II complex model. The starting point for these projections were the 30 ppm sulfur fuel projections, and the fuel property changes necessary to achieve the required performance standard were estimated as follows:

Summer fuel property projections for a toxics performance standard strategy were based on cost estimates for individual parameter changes contained in the RFG regulatory impact analysis supplemented, for benzene, with information from a WSPA study of CARB Phase 2 Gasoline. (E.G. reducing aromatics content from 28 to 24 vol. % would have a cost of 0.305 cents per gallon per unit reduction) Fuel property interrelationship factors, also in the RIA were used to estimate changes in other "uncontrolled" properties which would change as a result of a change in the "controlled" parameter. (E.G. the change in E300 resulting from this change in aromatics). The average cost associated with an individual property change divided by the complex model toxics reduction associated with the change was used to calculate the cost effectiveness of each toxics reduction strategy, and the strategies were ranked by cost-effectiveness.

Parameter change strategies were applied sequentially and cumulatively to the 30ppm fuel for each of the areas selected for control option modeling and calculated complex model results at each stage. The hierarchy of parameter change strategies and cost per unit change in the parameter used for summer and winter were :

Property change	Cost/unit change
Summer	cents per gal.
Bz down to 0.95	1.024
Aro down to 28	0.066
Bz 0.95-0.8	2.275
Bz 0.80-0.60	3.413
RVP down to 7.3	0.412
Aro 28-24	0.305
RVP 7.3-7.1	0.416
Aro 24-20	0.367
RVP 7.1-6.5	0.427

Property change	Cost/unit change
Winter	cents per gal.
Bz down to 0.95	1.024
Bz 0.95 0.8	2.275
Bz 0.8-0.6	3.413
Aro down to 24	0.305
Aro 24-20	0.367
E200 50-58	0.125
E200 58-61	0.439
E200 61-64	0.989

The effect of each strategy on each areas's fuel varies. For example, if the starting point fuel in a given area had less than 0.95 volume percent benzene, the first parameter change strategy, benzene reduction to 0.95 percent would have no effect on the fuel properties, hence no effect on performance or cost.

Appendix K

Sample Toxic-TOG “Curves” for 2007 Phoenix Summertime Fuel

IV	MYA	MYB	TOG-N	TOG-H	BZ-N	BZ-H	AC-N	AC-H	FR-N	FR-H	BD-N	BD-H	MT-N	MT-H	TF-N	TF-H
1	1965	1974	0.000	10.00	0.00	165.34	0.00	95.77	0.00	225.12	0.00	93.50	0.00	0.00	0.00	9.46
1	1975	1975	0.000	10.00	0.00	168.92	0.00	101.91	0.00	186.03	0.00	47.16	0.00	0.00	0.00	9.67
1	1976	1977	0.000	10.00	0.00	169.15	0.00	102.29	0.00	183.59	0.00	44.26	0.00	0.00	0.00	9.68
1	1978	1979	0.000	10.00	0.00	169.37	0.00	102.67	0.00	181.15	0.00	41.36	0.00	0.00	0.00	9.69
1	1980	1980	0.000	10.00	0.00	169.60	0.00	103.06	0.00	178.70	0.00	38.47	0.00	0.00	0.00	9.71
1	1981	1981	0.637	4.04	12.55	102.78	4.23	29.83	6.71	45.79	1.83	24.59	0.00	0.00	0.51	3.60
1	1982	1982	0.625	4.04	12.25	100.68	4.32	30.56	6.89	47.34	1.84	23.97	0.00	0.00	0.50	3.62
1	1983	1983	0.625	4.04	12.45	104.54	4.07	29.21	6.42	44.48	1.81	25.12	0.00	0.00	0.49	3.58
1	1984	1984	0.636	4.04	13.14	113.40	3.54	26.13	5.39	37.92	1.74	27.77	0.00	0.00	0.47	3.50
1	1985	1985	0.641	4.04	13.10	112.54	3.64	26.43	5.59	38.56	1.76	27.51	0.00	0.00	0.48	3.51
1	1986	1986	0.638	4.04	13.20	115.02	3.39	25.56	5.29	36.73	1.75	28.25	0.00	0.00	0.47	3.48
1	1987	1987	0.609	4.04	12.67	115.35	3.32	25.45	5.06	36.48	1.70	28.35	0.00	0.00	0.44	3.48
1	1988	1988	0.567	4.04	11.92	116.16	3.07	25.17	4.73	35.88	1.63	28.59	0.00	0.00	0.41	3.47
1	1989	1989	0.555	4.04	11.60	116.02	3.01	25.22	4.66	35.98	1.59	28.55	0.00	0.00	0.40	3.48
1	1990	1990	0.532	4.04	11.10	116.11	2.95	25.18	4.54	35.91	1.54	28.58	0.00	0.00	0.39	3.47
1	1991	1991	0.511	4.04	10.67	116.16	2.90	25.17	4.40	35.88	1.50	28.59	0.00	0.00	0.37	3.47
1	1992	1992	0.517	4.04	10.72	116.02	2.91	25.21	4.46	35.98	1.50	28.55	0.00	0.00	0.38	3.48
1	1993	1993	0.496	4.04	10.30	116.16	2.88	25.17	4.30	35.88	1.45	28.59	0.00	0.00	0.36	3.47
1	1994	1994	0.431	4.04	8.72	116.16	2.45	25.17	3.66	35.88	1.23	28.59	0.00	0.00	0.31	3.47
1	1995	1995	0.364	4.04	7.15	116.16	2.01	25.17	3.00	35.88	1.00	28.59	0.00	0.00	0.25	3.47
1	1996	1996	0.331	4.04	6.36	116.16	1.79	25.17	2.68	35.88	0.89	28.59	0.00	0.00	0.22	3.47
1	1997	1997	0.331	4.04	6.36	116.16	1.79	25.17	2.68	35.88	0.89	28.59	0.00	0.00	0.22	3.47
1	1998	1998	0.331	4.04	6.36	116.16	1.79	25.17	2.68	35.88	0.89	28.59	0.00	0.00	0.22	3.47
1	1999	1999	0.331	4.04	6.36	116.16	1.79	25.17	2.68	35.88	0.89	28.59	0.00	0.00	0.22	3.47
1	2000	2000	0.331	4.04	6.36	116.16	1.79	25.17	2.68	35.88	0.89	28.59	0.00	0.00	0.22	3.47
1	2001	2001	0.099	4.04	1.61	116.16	0.45	25.17	0.68	35.88	0.23	28.59	0.00	0.00	0.06	3.47
1	2002	2002	0.099	4.04	1.61	116.16	0.45	25.17	0.68	35.88	0.23	28.59	0.00	0.00	0.06	3.47
1	2003	2003	0.099	4.04	1.61	116.16	0.45	25.17	0.68	35.88	0.23	28.59	0.00	0.00	0.06	3.47
1	2004	2004	0.099	4.04	1.61	116.16	0.45	25.17	0.68	35.88	0.23	28.59	0.00	0.00	0.06	3.47
1	2005	2005	0.099	4.04	1.61	116.16	0.45	25.17	0.68	35.88	0.23	28.59	0.00	0.00	0.06	3.47
1	2006	2006	0.099	4.04	1.61	116.16	0.45	25.17	0.68	35.88	0.23	28.59	0.00	0.00	0.06	3.47
1	2007	2007	0.099	4.04	1.61	116.16	0.45	25.17	0.68	35.88	0.23	28.59	0.00	0.00	0.06	3.47
1	2008	2050	0.099	4.04	1.61	116.16	0.45	25.17	0.68	35.88	0.23	28.59	0.00	0.00	0.06	3.47
2	1965	1974	0.000	10.00	0.00	165.34	0.00	95.77	0.00	225.12	0.00	93.50	0.00	0.00	0.00	9.46
2	1975	1975	0.000	10.00	0.00	168.48	0.00	101.14	0.00	190.92	0.00	52.95	0.00	0.00	0.00	9.64
2	1976	1976	0.000	10.00	0.00	168.92	0.00	101.91	0.00	186.03	0.00	47.16	0.00	0.00	0.00	9.67
2	1977	1978	0.000	10.00	0.00	168.70	0.00	101.52	0.00	188.47	0.00	50.05	0.00	0.00	0.00	9.66
2	1979	1980	0.000	10.00	0.00	168.92	0.00	101.91	0.00	186.03	0.00	47.16	0.00	0.00	0.00	9.67
2	1981	1981	0.635	4.04	10.82	69.34	6.49	41.36	11.17	71.10	2.36	15.31	0.00	0.00	0.61	3.91
2	1982	1982	0.635	4.04	10.88	70.40	6.44	41.10	10.95	69.76	2.23	14.91	0.00	0.00	0.61	3.91
2	1983	1983	0.633	4.04	11.06	74.83	6.10	39.46	10.40	66.96	2.26	16.86	0.00	0.00	0.59	3.86
2	1984	1984	0.624	4.04	11.24	81.49	5.58	37.24	9.32	61.55	2.06	18.23	0.00	0.00	0.56	3.80
2	1985	1985	0.590	4.04	10.88	86.21	5.00	35.60	8.28	58.06	1.91	19.64	0.00	0.00	0.52	3.76
2	1986	1986	0.570	4.04	10.80	92.59	4.51	33.37	7.34	53.33	1.81	21.55	0.00	0.00	0.48	3.70
2	1987	1987	0.645	4.04	12.82	103.59	4.09	29.54	6.86	45.19	1.93	24.83	0.00	0.00	0.52	3.59
2	1988	1988	0.617	4.04	12.85	113.78	3.27	26.00	5.36	37.64	1.77	27.88	0.00	0.00	0.46	3.50
2	1989	1989	0.650	4.04	13.54	115.49	3.17	25.40	5.40	36.37	1.83	28.39	0.00	0.00	0.48	3.48
2	1990	1990	0.620	4.04	12.94	115.54	3.09	25.38	5.21	36.36	1.77	28.43	0.00	0.00	0.46	3.48
2	1991	1991	0.592	4.04	12.43	116.11	3.02	25.18	4.94	35.91	1.70	28.58	0.00	0.00	0.44	3.47
2	1992	1992	0.559	4.04	11.71	115.51	2.95	25.38	4.80	36.45	1.64	28.51	0.00	0.00	0.41	3.48

2	1993	1993	0.553	4.04	11.61	116.16	2.91	25.17	4.68	35.88	1.61	28.59	0.00	0.00	0.41	3.47
2	1994	1994	0.477	4.04	9.79	116.16	2.47	25.17	3.96	35.88	1.36	28.59	0.00	0.00	0.34	3.47
2	1995	1995	0.404	4.04	8.03	116.16	2.03	25.17	3.25	35.88	1.11	28.59	0.00	0.00	0.28	3.47
2	1996	1996	0.371	4.04	7.24	116.16	1.81	25.17	2.93	35.88	1.00	28.59	0.00	0.00	0.26	3.47
2	1997	1997	0.368	4.04	7.16	116.16	1.81	25.17	2.91	35.88	0.99	28.59	0.00	0.00	0.25	3.47
2	1998	1998	0.365	4.04	7.08	116.16	1.81	25.17	2.89	35.88	0.98	28.59	0.00	0.00	0.25	3.47
2	1999	1999	0.362	4.04	7.00	116.16	1.81	25.17	2.87	35.88	0.97	28.59	0.00	0.00	0.25	3.47
2	2000	2000	0.359	4.04	6.92	116.16	1.81	25.17	2.85	35.88	0.96	28.59	0.00	0.00	0.25	3.47
2	2001	2001	0.134	4.04	2.45	116.16	0.65	25.17	1.01	35.88	0.34	28.59	0.00	0.00	0.09	3.47
2	2002	2002	0.134	4.04	2.45	116.16	0.65	25.17	1.01	35.88	0.34	28.59	0.00	0.00	0.09	3.47
2	2003	2003	0.134	4.04	2.45	116.16	0.65	25.17	1.01	35.88	0.34	28.59	0.00	0.00	0.09	3.47
2	2004	2004	0.134	4.04	2.45	116.16	0.65	25.17	1.01	35.88	0.34	28.59	0.00	0.00	0.09	3.47
2	2005	2005	0.134	4.04	2.45	116.16	0.65	25.17	1.01	35.88	0.34	28.59	0.00	0.00	0.09	3.47
2	2006	2006	0.134	4.04	2.45	116.16	0.65	25.17	1.01	35.88	0.34	28.59	0.00	0.00	0.09	3.47
2	2007	2007	0.134	4.04	2.45	116.16	0.65	25.17	1.01	35.88	0.34	28.59	0.00	0.00	0.09	3.47
2	2008	2050	0.134	4.04	2.45	116.16	0.65	25.17	1.01	35.88	0.34	28.59	0.00	0.00	0.09	3.47
3	1965	1978	0.000	10.00	0.00	165.34	0.00	95.77	0.00	225.12	0.00	93.50	0.00	0.00	0.00	9.46
3	1979	1980	0.000	10.00	0.00	169.82	0.00	103.44	0.00	176.26	0.00	35.57	0.00	0.00	0.00	9.72
3	1981	1981	0.635	4.04	10.82	69.34	6.49	41.36	11.17	71.10	2.36	15.31	0.00	0.00	0.61	3.91
3	1982	1982	0.635	4.04	10.88	70.40	6.44	41.10	10.95	69.76	2.23	14.91	0.00	0.00	0.61	3.91
3	1983	1983	0.633	4.04	11.06	74.83	6.10	39.46	10.40	66.96	2.26	16.86	0.00	0.00	0.59	3.86
3	1984	1984	0.624	4.04	11.24	81.49	5.58	37.24	9.32	61.55	2.06	18.23	0.00	0.00	0.56	3.80
3	1985	1985	0.590	4.04	10.88	86.21	5.00	35.60	8.28	58.06	1.91	19.64	0.00	0.00	0.52	3.76
3	1986	1986	0.570	4.04	10.80	92.59	4.51	33.37	7.34	53.33	1.81	21.55	0.00	0.00	0.48	3.70
3	1987	1987	0.645	4.04	12.82	103.59	4.09	29.54	6.86	45.19	1.93	24.83	0.00	0.00	0.52	3.59
3	1988	1988	0.617	4.04	12.85	113.78	3.27	26.00	5.36	37.64	1.77	27.88	0.00	0.00	0.46	3.50
3	1989	1989	0.650	4.04	13.54	115.49	3.17	25.40	5.40	36.37	1.83	28.39	0.00	0.00	0.48	3.48
3	1990	1990	0.620	4.04	12.94	115.54	3.09	25.38	5.21	36.36	1.77	28.43	0.00	0.00	0.46	3.48
3	1991	1991	0.592	4.04	12.43	116.11	3.02	25.18	4.94	35.91	1.70	28.58	0.00	0.00	0.44	3.47
3	1992	1992	0.559	4.04	11.71	115.51	2.95	25.38	4.80	36.45	1.64	28.51	0.00	0.00	0.41	3.48
3	1993	1993	0.553	4.04	11.61	116.16	2.91	25.17	4.68	35.88	1.61	28.59	0.00	0.00	0.41	3.47
3	1994	1994	0.552	4.04	11.55	116.16	2.91	25.17	4.67	35.88	1.60	28.59	0.00	0.00	0.41	3.47
3	1995	1995	0.553	4.04	11.56	116.16	2.91	25.17	4.68	35.88	1.60	28.59	0.00	0.00	0.41	3.47
3	1996	1996	0.466	4.04	9.47	116.16	2.37	25.17	3.83	35.88	1.31	28.59	0.00	0.00	0.33	3.47
3	1997	1997	0.368	4.04	7.16	116.16	1.81	25.17	2.91	35.88	0.99	28.59	0.00	0.00	0.25	3.47
3	1998	1998	0.365	4.04	7.08	116.16	1.81	25.17	2.89	35.88	0.98	28.59	0.00	0.00	0.25	3.47
3	1999	1999	0.362	4.04	7.00	116.16	1.81	25.17	2.87	35.88	0.97	28.59	0.00	0.00	0.25	3.47
3	2000	2000	0.359	4.04	6.92	116.16	1.81	25.17	2.85	35.88	0.96	28.59	0.00	0.00	0.25	3.47
3	2001	2001	0.356	4.04	6.83	116.16	1.81	25.17	2.83	35.88	0.95	28.59	0.00	0.00	0.24	3.47
3	2002	2002	0.356	4.04	6.83	116.16	1.81	25.17	2.83	35.88	0.95	28.59	0.00	0.00	0.24	3.47
3	2003	2003	0.356	4.04	6.83	116.16	1.81	25.17	2.83	35.88	0.95	28.59	0.00	0.00	0.24	3.47
3	2004	2004	0.356	4.04	6.83	116.16	1.81	25.17	2.83	35.88	0.95	28.59	0.00	0.00	0.24	3.47
3	2005	2005	0.356	4.04	6.83	116.16	1.81	25.17	2.83	35.88	0.95	28.59	0.00	0.00	0.24	3.47
3	2006	2006	0.356	4.04	6.83	116.16	1.81	25.17	2.83	35.88	0.95	28.59	0.00	0.00	0.24	3.47
3	2007	2007	0.356	4.04	6.83	116.16	1.81	25.17	2.83	35.88	0.95	28.59	0.00	0.00	0.24	3.47
3	2008	2050	0.356	4.04	6.83	116.16	1.81	25.17	2.83	35.88	0.95	28.59	0.00	0.00	0.24	3.47
4	1968	1981	0.000	10.00	0.00	165.34	0.00	106.94	0.00	348.73	0.00	75.21	0.00	0.00	0.00	9.46
4	1982	1986	0.000	10.00	0.00	172.29	0.00	106.33	0.00	339.36	0.00	72.65	0.00	0.00	0.00	9.47
4	1987	1987	0.000	10.00	0.00	207.02	0.00	103.25	0.00	292.49	0.00	59.83	0.00	0.00	0.00	9.54
4	1988	1989	0.000	10.00	0.00	220.92	0.00	102.02	0.00	273.74	0.00	54.71	0.00	0.00	0.00	9.56
4	1990	1995	0.000	10.00	0.00	294.56	0.00	95.50	0.00	174.38	0.00	27.54	0.00	0.00	0.00	9.70

4	1996	1999	0.000	10.00	0.00	297.34	0.00	95.25	0.00	170.63	0.00	26.51	0.00	0.00	0.00	9.71
4	2000	2000	0.000	10.00	0.00	301.51	0.00	94.89	0.00	165.01	0.00	24.98	0.00	0.00	0.00	9.71
4	2001	2004	0.000	10.00	0.00	301.51	0.00	94.89	0.00	165.01	0.00	24.98	0.00	0.00	0.00	9.71
4	2005	2020	0.000	10.00	0.00	304.29	0.00	94.64	0.00	161.26	0.00	23.95	0.00	0.00	0.00	9.72
5	1965	2050	0.000	10.00	0.00	200.00	0.00	123.00	0.00	386.00	0.00	90.00	0.00	0.00	0.00	10.00
6	1965	2050	0.000	10.00	0.00	200.00	0.00	123.00	0.00	386.00	0.00	90.00	0.00	0.00	0.00	10.00
7	1965	2050	0.000	10.00	0.00	105.00	0.00	288.00	0.00	782.00	0.00	61.00	0.00	0.00	0.00	10.00
8	1965	2020	0.000	10.00	0.00	165.34	0.00	95.77	0.00	225.12	0.00	93.50	0.00	0.00	0.00	9.46

Appendix L

Sample Evaporative Fraction Input File for 2007 Phoenix Summertime Fuel

PX07SB.EVP - Phoenix 07 Summer Baseline Evap Fractions
1
2050

0.0045	0.0042	0.0043	0.0045	0.0042	0.0045	0.0042	0.0043	0.0045	0.0042	Benzene
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	MTBE

Appendix M

Sample MOBTOX5b Input File For Phoenix

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1          PROMPT - No prompting, vertical
MOBTOX5 -- PX07SB.INP
1          TAMFLG - Default tampering rates
1          SPDFLG - One speed per scenario
3          VMFLAG - One VMT mix all scenarios
4          MYMRFG - Input mileage accum. rates and reg. dist.
2          NEWFLG - Input new exhaust emission rates
2          IMFLAG - One I/M program
1          ALHFLG - No corrections
8          ATPFLG - ATP, pressure, and purge
2          RLFLAG - Refueling with onboard VRS and Stage II
1          LOCFLG - One LAP record for each scenario
1          TEMFLG - Use default ambient exhaust temperatures
3          OUTFMT - 112-column descriptive
1          PRTFLG - Output HC only
1          IDLFLG - Do not output idle EFs
7 1        NMHFLG
2          HCFLAG - Component and total EFs printed
395.383.127.023.000.002.065.005
14910 .14174 .13475 .12810 .12178 .11577 .11006 .10463 .09947 .09456
08989 .08546 .08124 .07723 .07342 .06980 .06636 .06308 .05997 .05701
05420 .05152 .04898 .04656 .04427       LDGV
19496 .18384 .17308 .16267 .15260 .14289 .13352 .12451 .11584 .10752
09955 .09194 .08467 .07775 .07118 .06496 .05909 .05356 .04839 .04357
03909 .03497 .03120 .02777 .02470       LDGT1
21331 .19865 .18500 .17228 .16044 .14942 .13915 .12959 .12068 .11239
10466 .09747 .09077 .08453 .07872 .07331 .06827 .06358 .05921 .05514
05135 .04782 .04454 .04148 .03863       LDGT2
20112 .18813 .17602 .16470 .15413 .14427 .13505 .12645 .11841 .11090
10388 .09732 .09120 .08548 .08012 .07512 .07045 .06608 .06199 .05817
05460 .05126 .04813 .04521 .04248       HDGV
14910 .14174 .13475 .12810 .12178 .11577 .11006 .10463 .09947 .09456
08989 .08546 .08124 .07723 .07342 .06980 .06636 .06308 .05997 .05701
05420 .05152 .04898 .04656 .04427       LDDV
26720 .24262 .22033 .20012 .18177 .16513 .15004 .13634 .12390 .11262
10238 .09307 .08463 .07696 .07000 .06367 .05792 .05270 .04796 .04364
03973 .03616 .03293 .02998 .02731       LDDT
62211 .56358 .51067 .46283 .41958 .38047 .34510 .31311 .28417 .25799
23430 .21286 .19346 .17590 .16001 .14562 .13259 .12079 .11011 .10042
09166 .08371 .07651 .06999 .06407       HDDV
04786 .04475 .04164 .03853 .03543 .03232 .02921 .02611 .02300 .01989
01678 .01368 .00000 .00000 .00000 .00000 .00000 .00000 .00000 .00000
00000 .00000 .00000 .00000 .00000       MC
 .036 .072 .072 .072 .072 .071 .070 .069 .067 .064
 .060 .055 .047 .037 .029 .023 .018 .015 .012 .009
 .007 .006 .005 .004 .010       LDGV
 .040 .079 .078 .077 .076 .074 .071 .067 .062 .057
 .051 .044 .038 .031 .025 .020 .015 .011 .009 .008
 .008 .008 .007 .007 .037       LDGT1
 .040 .075 .070 .065 .061 .057 .053 .049 .046 .043
 .040 .037 .035 .032 .030 .028 .026 .024 .023 .021
 .020 .018 .017 .016 .075       LDGT2
 .060 .081 .074 .068 .063 .058 .054 .049 .046 .042
 .039 .036 .033 .031 .028 .026 .024 .022 .020 .019
 .017 .016 .015 .014 .063       HDGV
 .036 .072 .072 .072 .072 .071 .070 .069 .067 .064
 .060 .055 .047 .037 .029 .023 .018 .015 .012 .009
 .007 .006 .005 .004 .010       LDDV
 .040 .079 .078 .077 .076 .074 .071 .067 .062 .057
 .051 .044 .038 .031 .025 .020 .015 .011 .009 .008
 .008 .008 .007 .007 .037       LDDT
 .060 .081 .074 .068 .063 .058 .054 .049 .046 .042
 .039 .036 .033 .031 .028 .026 .024 .022 .020 .019
 .017 .016 .015 .014 .063       HDDV
 .144 .168 .135 .109 .088 .070 .056 .045 .036 .029
 .023 .097 .000 .000 .000 .000 .000 .000 .000 .000
 .000 .000 .000 .000 .000       MC
0107           ZM    DR1    DR2 Flex Pt  File: NTR_IM_B.BER
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1	1	1	65	67	7.488	0.186			LDGV
1	1	1	68	69	4.576	0.258			
1	1	1	70	71	3.099	0.382			
1	1	1	72	74	3.491	0.165			
1	1	1	75	75	1.068	0.282			
1	1	1	76	77	1.071	0.283			
1	1	1	78	79	1.074	0.284			
1	1	1	80	80	0.371	0.211			
1	1	1	81	81	0.464	0.120	0.005	14.63	
1	1	1	82	82	0.460	0.119	0.006	14.63	
1	1	1	83	83	0.336	0.064			
1	1	1	84	84	0.346	0.061			
1	1	1	85	85	0.350	0.057			
1	1	1	86	86	0.358	0.046			
1	1	1	87	87	0.360	0.045			
1	1	1	88	88	0.228	0.036			
1	1	1	89	89	0.231	0.037			
1	1	1	90	90	0.228	0.036			
1	1	1	91	91	0.224	0.035			
1	1	1	92	92	0.226	0.035			
1	1	1	93	93	0.224	0.035			
1	1	1	94	94	0.197	0.031			
1	1	1	95	95	0.169	0.028			
1	1	1	96	00	0.156	0.026	0.024	9.05	
1	1	1	01	50	0.064	0.014	0.016	14.64	
1	2	1	65	67	7.488	0.186			LDGT1
1	2	1	68	69	4.576	0.258			
1	2	1	70	71	3.099	0.382			
1	2	1	72	74	3.470	0.176			
1	2	1	75	75	1.802	0.270			
1	2	1	76	76	1.813	0.272			
1	2	1	77	78	1.807	0.271			
1	2	1	79	80	0.876	0.282			
1	2	1	81	81	1.406	0.086			
1	2	1	82	82	1.406	0.086			
1	2	1	83	83	1.423	0.087			
1	2	1	84	84	0.495	0.061			
1	2	1	85	85	0.485	0.061			
1	2	1	86	86	0.456	0.062			
1	2	1	87	87	0.446	0.066			
1	2	1	88	88	0.334	0.049			
1	2	1	89	89	0.333	0.047			
1	2	1	90	90	0.319	0.045			
1	2	1	91	91	0.293	0.044			
1	2	1	92	92	0.313	0.042			
1	2	1	93	93	0.312	0.042			
1	2	1	94	94	0.264	0.037			
1	2	1	95	95	0.216	0.033			
1	2	1	96	00	0.192	0.031	0.027	11.84	
1	2	1	01	50	0.073	0.015	0.017	17.20	
1	3	1	65	69	9.885	0.186			LDGT2
1	3	1	70	73	6.486	0.258			
1	3	1	74	78	6.486	0.176			
1	3	1	79	80	0.887	0.286			
1	3	1	81	81	1.404	0.086			
1	3	1	82	82	1.404	0.086			
1	3	1	83	83	1.427	0.088			
1	3	1	84	84	0.501	0.061			
1	3	1	85	85	0.502	0.063			
1	3	1	86	86	0.487	0.067			
1	3	1	87	87	0.470	0.069			
1	3	1	88	88	0.349	0.051			
1	3	1	89	89	0.344	0.048			
1	3	1	90	90	0.336	0.048			
1	3	1	91	91	0.293	0.044			
1	3	1	92	95	0.313	0.042			
1	3	1	96	96	0.264	0.038			
1	3	1	97	00	0.216	0.034	0.029	13.93	

```
1 3 1 01 50  0.214  0.034  0.028  13.93
1 4 1 80 80  4.285  0.203                     HDGV
1 4 1 81 83  4.289  0.201
1 4 1 84 84  4.366  0.205
1 4 1 85 85  3.148  0.065
1 4 1 86 86  2.791  0.065
1 4 1 87 87  1.347  0.126
1 4 1 88 89  1.194  0.036
1 4 1 90 90  0.879  0.042
1 4 1 91 97  0.851  0.039
1 4 1 98 50  0.863  0.039
1 5 1 65 74  1.406  0.089                     LDDV
1 5 1 75 79  0.454  0.078
1 5 1 80 93  0.310  0.033
1 5 1 94 94  0.261  0.028
1 5 1 95 95  0.213  0.023
1 5 1 96 96  0.189  0.020
1 5 1 97 97  0.189  0.020
1 5 1 98 98  0.189  0.020
1 5 1 99 99  0.189  0.020
1 5 1 00 00  0.189  0.020
1 5 1 01 50  0.057  0.006
1 6 1 65 80  0.916  0.089                     LDDT
1 6 1 81 95  0.458  0.044
1 6 1 96 96  0.369  0.036
1 6 1 97 97  0.281  0.027
1 6 1 98 98  0.281  0.027
1 6 1 99 99  0.281  0.027
1 6 1 00 00  0.281  0.027
1 6 1 01 50  0.281  0.027
1 7 1 88 88  0.879  0.000                     HDDV
1 7 1 89 89  0.886  0.000
1 7 1 90 90  0.746  0.000
1 7 1 91 91  0.652  0.000
1 7 1 92 92  0.653  0.000
1 7 1 93 93  0.632  0.000
1 7 1 94 94  0.362  0.000
1 7 1 95 95  0.359  0.000
1 7 1 96 50  0.357  0.000
78 20 67 03 03 03 096 111 1112 1111
88 67 50 2222 12  096 22111221
88 81 50 2222 12  096
97 97 50 2221 12  096
95 1 080 080
TX EVP FRACTIONS : EVP\PX07SB.EVP
TX EXH EMISSIONS : EXH\PX07SB_B.EXH
OFFCYCLE FACTORS : OFF\NTRIM07B.OFF
1 07 19.6 74.0 20.6 27.3 20.6  7
PX07SB.INP Spr   B 061. 087. 06.8 06.8 20 1 1 1 1
1 07 19.6 95.0 20.6 27.3 20.6  7
PX07SB.INP Sum   B 084. 106. 06.8 06.8 20 1 1 1 1
```

Appendix N

Sample MOBTOX5b Output For Phoenix

```
1MOBTOX5 -- PX07SB.INP
 M5TOXRAD based on Mobile5b(27FEB98)Mods by Radian 7/98
0
-M 49 Warning:
+                1.00     MYR sum not = 1. (will normalize)
-M 49 Warning:
+                1.00     MYR sum not = 1. (will normalize)
-M 49 Warning:
+               0.998     MYR sum not = 1. (will normalize)
-M 49 Warning:
+                1.00     MYR sum not = 1. (will normalize)
-M 49 Warning:
+               0.998     MYR sum not = 1. (will normalize)
 Reading I/M credits information
     Annual Idle Only 220/1.2 Cutpoints IDLE.IMC
-M121 Warning:
+              NO emission credit from evaporative control system inspection
               will be given unless gas cap inspection also required.
-M114 Warning:
+              Purge Check emission benefits assume the use of a dynomometer and
               the IM240 transient test procedure driving cycle.
-M109 Warning:
+              The user supplied inspection frequencies are not equal.
               ATP inspection frequency:                Biennial
               I/M program #1 inspection frequency:     Annual
               I/M program #2 inspection frequency:     NA
               Pressure Check inspection frequency:     Biennial
               Purge Check inspection frequency:        Biennial

 Evap Toxic emission frac. data read from file : EVP\PX07SB.EVP

 Exhaust Toxic emission data read from file    : EXH\PX07SB_B.EXH

 Off Cycle data read from file                 : OFF\NTRIM07B.OFF

EVP\PX07SB.EVP       : PX07SB.EVP - Phoenix 07 Summer Baseline Evap Fractions

EXH\PX07SB_B.EXH     :   IV     MYA     MYB   TOG-N   TOG-H    BZ-N    BZ-H    AC-N    AC-H    FR-N

OFF\NTRIM07B.OFF     : Off-Cycle Corrections - 2007 Baseline - Non-OTR - With     UC/FTP Toxics Mass Fr

 Benzene       & TOG Emissions for LDGVs from files : EXH\PX07SB_B.EX EVP\PX07SB.EVP  OFF\NTRIM07B.OF
 Year   TX-Lo  TX-Hi    TOG-Hi TOG-Lo  TXEVHS   TXEVDI TXEVRF  TXEVRN EVPTXRST  AGG1    AGG2   AGG3    AGG-TOX
 1965   0.000 165.340   0.000  10.000   0.004   0.004   0.004   0.004   0.004   0.049   0.000   0.000   1.000
 1966   0.000 165.340   0.000  10.000   0.004   0.004   0.004   0.004   0.004   0.049   0.000   0.000   1.000
 1967   0.000 165.340   0.000  10.000   0.004   0.004   0.004   0.004   0.004   0.049   0.000   0.000   1.000
 1968   0.000 165.340   0.000  10.000   0.004   0.004   0.004   0.004   0.004   0.049   0.000   0.000   1.000
 1969   0.000 165.340   0.000  10.000   0.004   0.004   0.004   0.004   0.004   0.049   0.000   0.000   1.000
 1970   0.000 165.340   0.000  10.000   0.004   0.004   0.004   0.004   0.004   0.049   0.000   0.000   1.000
 1971   0.000 165.340   0.000  10.000   0.004   0.004   0.004   0.004   0.004   0.049   0.000   0.000   1.000
 1972   0.000 165.340   0.000  10.000   0.004   0.004   0.004   0.004   0.004   0.049   0.000   0.000   1.000
```

1973	0.000	165.340	0.000	10.000	0.004	0.004	0.004	0.004	0.004	0.049	0.000	0.000	1.000
1974	0.000	165.340	0.000	10.000	0.004	0.004	0.004	0.004	0.004	0.049	0.000	0.000	1.000
1975	0.000	168.920	0.000	10.000	0.004	0.004	0.004	0.004	0.004	0.052	0.000	0.000	1.000
1976	0.000	169.150	0.000	10.000	0.004	0.004	0.004	0.004	0.004	0.052	0.000	0.000	1.000
1977	0.000	169.150	0.000	10.000	0.004	0.004	0.004	0.004	0.004	0.052	0.000	0.000	1.000
1978	0.000	169.370	0.000	10.000	0.004	0.004	0.004	0.004	0.004	0.052	0.000	0.000	1.000
1979	0.000	169.370	0.000	10.000	0.004	0.004	0.004	0.004	0.004	0.052	0.000	0.000	1.000
1980	0.000	169.600	0.000	10.000	0.004	0.004	0.004	0.004	0.004	0.053	0.000	0.000	1.000
1981	12.550	102.780	0.637	4.040	0.004	0.004	0.004	0.004	0.004	0.117	-0.015	0.000	1.127
1982	12.250	100.680	0.625	4.040	0.004	0.004	0.004	0.004	0.004	0.115	-0.014	0.000	1.127
1983	12.450	104.540	0.625	4.040	0.004	0.004	0.004	0.004	0.004	0.116	-0.002	0.000	1.133
1984	13.140	113.400	0.636	4.040	0.004	0.004	0.004	0.004	0.004	0.114	-0.003	0.000	1.134
1985	13.100	112.540	0.641	4.040	0.004	0.004	0.004	0.004	0.004	0.110	-0.003	0.000	1.136
1986	13.200	115.020	0.638	4.040	0.004	0.004	0.004	0.004	0.004	0.098	-0.003	0.000	1.143
1987	12.670	115.350	0.609	4.040	0.004	0.004	0.004	0.004	0.004	0.097	-0.003	0.000	1.144
1988	11.920	116.160	0.567	4.040	0.004	0.004	0.004	0.004	0.004	0.063	0.002	0.000	1.158
1989	11.600	116.020	0.555	4.040	0.004	0.004	0.004	0.004	0.004	0.066	0.002	0.000	1.158
1990	11.100	116.110	0.532	4.040	0.004	0.004	0.004	0.004	0.004	0.065	0.002	0.000	1.161
1991	10.670	116.160	0.511	4.040	0.004	0.004	0.004	0.004	0.004	0.064	0.002	0.000	1.164
1992	10.720	116.020	0.517	4.040	0.004	0.004	0.004	0.004	0.004	0.066	0.002	0.000	1.165
1993	10.300	116.160	0.496	4.040	0.004	0.004	0.004	0.004	0.004	0.065	0.002	0.000	1.168
1994	8.720	116.160	0.431	4.040	0.004	0.004	0.004	0.004	0.004	0.067	0.002	0.000	1.177
1995	7.150	116.160	0.364	4.040	0.004	0.004	0.004	0.004	0.004	0.069	0.001	0.000	1.187
1996	6.360	116.160	0.331	4.040	0.004	0.004	0.004	0.004	0.004	0.069	0.001	0.000	1.192
1997	6.360	116.160	0.331	4.040	0.004	0.004	0.004	0.004	0.004	0.007	0.001	0.000	1.196
1998	6.360	116.160	0.331	4.040	0.004	0.004	0.004	0.004	0.004	0.001	0.001	0.000	1.201
1999	6.360	116.160	0.331	4.040	0.004	0.004	0.004	0.004	0.004	0.001	0.001	0.000	1.259
2000	6.360	116.160	0.331	4.040	0.004	0.004	0.004	0.004	0.004	0.001	0.001	0.000	1.315
2001	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.065	0.001	0.000	1.315
2002	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.044	0.001	0.000	1.315
2003	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.015	0.000	0.000	1.315
2004	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315
2005	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315
2006	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315
2007	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315
2008	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315
2009	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315
2010	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315
2011	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315
2012	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315
2013	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315
2014	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315
2015	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315
2016	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315
2017	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315
2018	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315
2019	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315
2020	1.610	116.160	0.099	4.040	0.004	0.004	0.004	0.004	0.004	0.002	0.000	0.000	1.315

Acetaldehyde & TOG Emissions for LDGVs from file : EXH\PX07SB_B.EX OFF\NTRIM07B.OF

Year	TX-Lo	TX-Hi	TOG-Hi	TOG-Lo	AGG1	AGG2	AGG3	AGG-TOX

1965	0.000	95.770	0.000	10.000	0.049	0.000	0.000	1.000
1966	0.000	95.770	0.000	10.000	0.049	0.000	0.000	1.000
1967	0.000	95.770	0.000	10.000	0.049	0.000	0.000	1.000
1968	0.000	95.770	0.000	10.000	0.049	0.000	0.000	1.000
1969	0.000	95.770	0.000	10.000	0.049	0.000	0.000	1.000
1970	0.000	95.770	0.000	10.000	0.049	0.000	0.000	1.000
1971	0.000	95.770	0.000	10.000	0.049	0.000	0.000	1.000
1972	0.000	95.770	0.000	10.000	0.049	0.000	0.000	1.000
1973	0.000	95.770	0.000	10.000	0.049	0.000	0.000	1.000
1974	0.000	95.770	0.000	10.000	0.049	0.000	0.000	1.000
1975	0.000	101.910	0.000	10.000	0.052	0.000	0.000	1.000
1976	0.000	102.290	0.000	10.000	0.052	0.000	0.000	1.000
1977	0.000	102.290	0.000	10.000	0.052	0.000	0.000	1.000
1978	0.000	102.670	0.000	10.000	0.052	0.000	0.000	1.000
1979	0.000	102.670	0.000	10.000	0.052	0.000	0.000	1.000
1980	0.000	103.060	0.000	10.000	0.053	0.000	0.000	1.000
1981	4.230	29.830	0.637	4.040	0.117	-0.015	0.000	0.919
1982	4.320	30.560	0.625	4.040	0.115	-0.014	0.000	0.919
1983	4.070	29.210	0.625	4.040	0.116	-0.002	0.000	0.923
1984	3.540	26.130	0.636	4.040	0.114	-0.003	0.000	0.924
1985	3.640	26.430	0.641	4.040	0.110	-0.003	0.000	0.924
1986	3.390	25.560	0.638	4.040	0.098	-0.003	0.000	0.928
1987	3.320	25.450	0.609	4.040	0.097	-0.003	0.000	0.929
1988	3.070	25.170	0.567	4.040	0.063	0.002	0.000	0.936
1989	3.010	25.220	0.555	4.040	0.066	0.002	0.000	0.936
1990	2.950	25.180	0.532	4.040	0.065	0.002	0.000	0.938
1991	2.900	25.170	0.511	4.040	0.064	0.002	0.000	0.939
1992	2.910	25.210	0.517	4.040	0.066	0.002	0.000	0.940
1993	2.880	25.170	0.496	4.040	0.065	0.002	0.000	0.941
1994	2.450	25.170	0.431	4.040	0.067	0.002	0.000	0.946
1995	2.010	25.170	0.364	4.040	0.069	0.001	0.000	0.951
1996	1.790	25.170	0.331	4.040	0.069	0.001	0.000	0.954
1997	1.790	25.170	0.331	4.040	0.007	0.001	0.000	0.956
1998	1.790	25.170	0.331	4.040	0.001	0.001	0.000	0.959
1999	1.790	25.170	0.331	4.040	0.001	0.001	0.000	0.990
2000	1.790	25.170	0.331	4.040	0.001	0.001	0.000	1.020
2001	0.450	25.170	0.099	4.040	0.065	0.001	0.000	1.020
2002	0.450	25.170	0.099	4.040	0.044	0.001	0.000	1.020
2003	0.450	25.170	0.099	4.040	0.015	0.000	0.000	1.020
2004	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020
2005	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020
2006	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020
2007	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020
2008	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020
2009	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020
2010	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020
2011	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020
2012	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020
2013	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020
2014	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020
2015	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020

2016	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020
2017	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020
2018	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020
2019	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020
2020	0.450	25.170	0.099	4.040	0.002	0.000	0.000	1.020

Formaldehyde & TOG Emissions for LDGVs from file : EXH\PX07SB_B.EX OFF\NTRIM07B.OF

Year	TX-Lo	TX-Hi	TOG-Hi	TOG-Lo	AGG1	AGG2	AGG3	AGG-TOX
1965	0.000	225.120	0.000	10.000	0.049	0.000	0.000	1.000
1966	0.000	225.120	0.000	10.000	0.049	0.000	0.000	1.000
1967	0.000	225.120	0.000	10.000	0.049	0.000	0.000	1.000
1968	0.000	225.120	0.000	10.000	0.049	0.000	0.000	1.000
1969	0.000	225.120	0.000	10.000	0.049	0.000	0.000	1.000
1970	0.000	225.120	0.000	10.000	0.049	0.000	0.000	1.000
1971	0.000	225.120	0.000	10.000	0.049	0.000	0.000	1.000
1972	0.000	225.120	0.000	10.000	0.049	0.000	0.000	1.000
1973	0.000	225.120	0.000	10.000	0.049	0.000	0.000	1.000
1974	0.000	225.120	0.000	10.000	0.049	0.000	0.000	1.000
1975	0.000	186.030	0.000	10.000	0.052	0.000	0.000	1.000
1976	0.000	183.590	0.000	10.000	0.052	0.000	0.000	1.000
1977	0.000	183.590	0.000	10.000	0.052	0.000	0.000	1.000
1978	0.000	181.150	0.000	10.000	0.052	0.000	0.000	1.000
1979	0.000	181.150	0.000	10.000	0.052	0.000	0.000	1.000
1980	0.000	178.700	0.000	10.000	0.053	0.000	0.000	1.000
1981	6.710	45.790	0.637	4.040	0.117	-0.015	0.000	0.895
1982	6.890	47.340	0.625	4.040	0.115	-0.014	0.000	0.895
1983	6.420	44.480	0.625	4.040	0.116	-0.002	0.000	0.904
1984	5.390	37.920	0.636	4.040	0.114	-0.003	0.000	0.906
1985	5.590	38.560	0.641	4.040	0.110	-0.003	0.000	0.908
1986	5.290	36.730	0.638	4.040	0.098	-0.003	0.000	0.918
1987	5.060	36.480	0.609	4.040	0.097	-0.003	0.000	0.920
1988	4.730	35.880	0.567	4.040	0.063	0.002	0.000	0.939
1989	4.660	35.980	0.555	4.040	0.066	0.002	0.000	0.940
1990	4.540	35.910	0.532	4.040	0.065	0.002	0.000	0.944
1991	4.400	35.880	0.511	4.040	0.064	0.002	0.000	0.948
1992	4.460	35.980	0.517	4.040	0.066	0.002	0.000	0.950
1993	4.300	35.880	0.496	4.040	0.065	0.002	0.000	0.953
1994	3.660	35.880	0.431	4.040	0.067	0.002	0.000	0.967
1995	3.000	35.880	0.364	4.040	0.069	0.001	0.000	0.981
1996	2.680	35.880	0.331	4.040	0.069	0.001	0.000	0.987
1997	2.680	35.880	0.331	4.040	0.007	0.001	0.000	0.994
1998	2.680	35.880	0.331	4.040	0.001	0.001	0.000	1.001
1999	2.680	35.880	0.331	4.040	0.001	0.001	0.000	1.083
2000	2.680	35.880	0.331	4.040	0.001	0.001	0.000	1.163
2001	0.680	35.880	0.099	4.040	0.065	0.001	0.000	1.163
2002	0.680	35.880	0.099	4.040	0.044	0.001	0.000	1.163
2003	0.680	35.880	0.099	4.040	0.015	0.000	0.000	1.163
2004	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163
2005	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163
2006	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163
2007	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163

2008	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163
2009	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163
2010	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163
2011	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163
2012	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163
2013	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163
2014	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163
2015	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163
2016	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163
2017	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163
2018	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163
2019	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163
2020	0.680	35.880	0.099	4.040	0.002	0.000	0.000	1.163

1,3 Butadiene & TOG Emissions for LDGVs from file : EXH\PX07SB_B.EX OFF\NTRIM07B.OF

Year	TX-Lo	TX-Hi	TOG-Hi	TOG-Lo	AGG1	AGG2	AGG3	AGG-TOX
1965	0.000	93.500	0.000	10.000	0.049	0.000	0.000	1.000
1966	0.000	93.500	0.000	10.000	0.049	0.000	0.000	1.000
1967	0.000	93.500	0.000	10.000	0.049	0.000	0.000	1.000
1968	0.000	93.500	0.000	10.000	0.049	0.000	0.000	1.000
1969	0.000	93.500	0.000	10.000	0.049	0.000	0.000	1.000
1970	0.000	93.500	0.000	10.000	0.049	0.000	0.000	1.000
1971	0.000	93.500	0.000	10.000	0.049	0.000	0.000	1.000
1972	0.000	93.500	0.000	10.000	0.049	0.000	0.000	1.000
1973	0.000	93.500	0.000	10.000	0.049	0.000	0.000	1.000
1974	0.000	93.500	0.000	10.000	0.049	0.000	0.000	1.000
1975	0.000	47.160	0.000	10.000	0.052	0.000	0.000	1.000
1976	0.000	44.260	0.000	10.000	0.052	0.000	0.000	1.000
1977	0.000	44.260	0.000	10.000	0.052	0.000	0.000	1.000
1978	0.000	41.360	0.000	10.000	0.052	0.000	0.000	1.000
1979	0.000	41.360	0.000	10.000	0.052	0.000	0.000	1.000
1980	0.000	38.470	0.000	10.000	0.053	0.000	0.000	1.000
1981	1.830	24.590	0.637	4.040	0.117	-0.015	0.000	0.709
1982	1.840	23.970	0.625	4.040	0.115	-0.014	0.000	0.709
1983	1.810	25.120	0.625	4.040	0.116	-0.002	0.000	0.720
1984	1.740	27.770	0.636	4.040	0.114	-0.003	0.000	0.723
1985	1.760	27.510	0.641	4.040	0.110	-0.003	0.000	0.725
1986	1.750	28.250	0.638	4.040	0.098	-0.003	0.000	0.738
1987	1.700	28.350	0.609	4.040	0.097	-0.003	0.000	0.739
1988	1.630	28.590	0.567	4.040	0.063	0.002	0.000	0.763
1989	1.590	28.550	0.555	4.040	0.066	0.002	0.000	0.764
1990	1.540	28.580	0.532	4.040	0.065	0.002	0.000	0.770
1991	1.500	28.590	0.511	4.040	0.064	0.002	0.000	0.774
1992	1.500	28.550	0.517	4.040	0.066	0.002	0.000	0.776
1993	1.450	28.590	0.496	4.040	0.065	0.002	0.000	0.780
1994	1.230	28.590	0.431	4.040	0.067	0.002	0.000	0.797
1995	1.000	28.590	0.364	4.040	0.069	0.001	0.000	0.814
1996	0.890	28.590	0.331	4.040	0.069	0.001	0.000	0.822
1997	0.890	28.590	0.331	4.040	0.007	0.001	0.000	0.830
1998	0.890	28.590	0.331	4.040	0.001	0.001	0.000	0.839
1999	0.890	28.590	0.331	4.040	0.001	0.001	0.000	0.940

2000	0.890	28.590	0.331	4.040	0.001	0.001	0.000	1.037
2001	0.230	28.590	0.099	4.040	0.065	0.001	0.000	1.037
2002	0.230	28.590	0.099	4.040	0.044	0.001	0.000	1.037
2003	0.230	28.590	0.099	4.040	0.015	0.000	0.000	1.037
2004	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037
2005	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037
2006	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037
2007	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037
2008	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037
2009	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037
2010	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037
2011	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037
2012	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037
2013	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037
2014	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037
2015	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037
2016	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037
2017	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037
2018	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037
2019	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037
2020	0.230	28.590	0.099	4.040	0.002	0.000	0.000	1.037

MTBE & TOG Emissions for LDGVs from files : EXH\PX07SB_B.EX EVP\PX07SB.EVP OFF\NTRIM07B.OF

Year	TX-Lo	TX-Hi	TOG-Hi	TOG-Lo	TXEVHS	TXEVDI	TXEVRF	TXEVRN	EVPTXRST	AGG1	AGG2	AGG3	AGG-TOX
1965	0.000	0.000	0.000	10.000	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.000	1.000
1966	0.000	0.000	0.000	10.000	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.000	1.000
1967	0.000	0.000	0.000	10.000	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.000	1.000
1968	0.000	0.000	0.000	10.000	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.000	1.000
1969	0.000	0.000	0.000	10.000	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.000	1.000
1970	0.000	0.000	0.000	10.000	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.000	1.000
1971	0.000	0.000	0.000	10.000	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.000	1.000
1972	0.000	0.000	0.000	10.000	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.000	1.000
1973	0.000	0.000	0.000	10.000	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.000	1.000
1974	0.000	0.000	0.000	10.000	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.000	1.000
1975	0.000	0.000	0.000	10.000	0.000	0.000	0.000	0.000	0.000	0.052	0.000	0.000	1.000
1976	0.000	0.000	0.000	10.000	0.000	0.000	0.000	0.000	0.000	0.052	0.000	0.000	1.000
1977	0.000	0.000	0.000	10.000	0.000	0.000	0.000	0.000	0.000	0.052	0.000	0.000	1.000
1978	0.000	0.000	0.000	10.000	0.000	0.000	0.000	0.000	0.000	0.052	0.000	0.000	1.000
1979	0.000	0.000	0.000	10.000	0.000	0.000	0.000	0.000	0.000	0.052	0.000	0.000	1.000
1980	0.000	0.000	0.000	10.000	0.000	0.000	0.000	0.000	0.000	0.053	0.000	0.000	1.000
1981	0.000	0.000	0.637	4.040	0.000	0.000	0.000	0.000	0.000	0.117	-0.015	0.000	0.964
1982	0.000	0.000	0.625	4.040	0.000	0.000	0.000	0.000	0.000	0.115	-0.014	0.000	0.964
1983	0.000	0.000	0.625	4.040	0.000	0.000	0.000	0.000	0.000	0.116	-0.002	0.000	0.960
1984	0.000	0.000	0.636	4.040	0.000	0.000	0.000	0.000	0.000	0.114	-0.003	0.000	0.959
1985	0.000	0.000	0.641	4.040	0.000	0.000	0.000	0.000	0.000	0.110	-0.003	0.000	0.958
1986	0.000	0.000	0.638	4.040	0.000	0.000	0.000	0.000	0.000	0.098	-0.003	0.000	0.952
1987	0.000	0.000	0.609	4.040	0.000	0.000	0.000	0.000	0.000	0.097	-0.003	0.000	0.952
1988	0.000	0.000	0.567	4.040	0.000	0.000	0.000	0.000	0.000	0.063	0.002	0.000	0.941
1989	0.000	0.000	0.555	4.040	0.000	0.000	0.000	0.000	0.000	0.066	0.002	0.000	0.941
1990	0.000	0.000	0.532	4.040	0.000	0.000	0.000	0.000	0.000	0.065	0.002	0.000	0.939
1991	0.000	0.000	0.511	4.040	0.000	0.000	0.000	0.000	0.000	0.064	0.002	0.000	0.937

1992	0.000	0.000	0.517	4.040	0.000	0.000	0.000	0.000	0.000	0.066	0.002	0.000	0.936
1993	0.000	0.000	0.496	4.040	0.000	0.000	0.000	0.000	0.000	0.065	0.002	0.000	0.934
1994	0.000	0.000	0.431	4.040	0.000	0.000	0.000	0.000	0.000	0.067	0.002	0.000	0.927
1995	0.000	0.000	0.364	4.040	0.000	0.000	0.000	0.000	0.000	0.069	0.001	0.000	0.920
1996	0.000	0.000	0.331	4.040	0.000	0.000	0.000	0.000	0.000	0.069	0.001	0.000	0.916
1997	0.000	0.000	0.331	4.040	0.000	0.000	0.000	0.000	0.000	0.007	0.001	0.000	0.913
1998	0.000	0.000	0.331	4.040	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.909
1999	0.000	0.000	0.331	4.040	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.866
2000	0.000	0.000	0.331	4.040	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.825
2001	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.065	0.001	0.000	0.825
2002	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.044	0.001	0.000	0.825
2003	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.015	0.000	0.000	0.825
2004	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825
2005	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825
2006	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825
2007	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825
2008	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825
2009	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825
2010	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825
2011	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825
2012	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825
2013	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825
2014	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825
2015	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825
2016	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825
2017	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825
2018	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825
2019	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825
2020	0.000	0.000	0.099	4.040	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.825

TOG & TOG Emissions for LDGVs from file : EXH\PX07SB_B.EX OFF\NTRIM07B.OF

Year	TX-Lo	TX-Hi	TOG-Hi	TOG-Lo	AGG1	AGG2	AGG3	AGG-TOX
1965	0.000	9.460	0.000	10.000	0.049	0.000	0.000	1.000
1966	0.000	9.460	0.000	10.000	0.049	0.000	0.000	1.000
1967	0.000	9.460	0.000	10.000	0.049	0.000	0.000	1.000
1968	0.000	9.460	0.000	10.000	0.049	0.000	0.000	1.000
1969	0.000	9.460	0.000	10.000	0.049	0.000	0.000	1.000
1970	0.000	9.460	0.000	10.000	0.049	0.000	0.000	1.000
1971	0.000	9.460	0.000	10.000	0.049	0.000	0.000	1.000
1972	0.000	9.460	0.000	10.000	0.049	0.000	0.000	1.000
1973	0.000	9.460	0.000	10.000	0.049	0.000	0.000	1.000
1974	0.000	9.460	0.000	10.000	0.049	0.000	0.000	1.000
1975	0.000	9.670	0.000	10.000	0.052	0.000	0.000	1.000
1976	0.000	9.680	0.000	10.000	0.052	0.000	0.000	1.000
1977	0.000	9.680	0.000	10.000	0.052	0.000	0.000	1.000
1978	0.000	9.690	0.000	10.000	0.052	0.000	0.000	1.000
1979	0.000	9.690	0.000	10.000	0.052	0.000	0.000	1.000
1980	0.000	9.710	0.000	10.000	0.053	0.000	0.000	1.000
1981	0.510	3.600	0.637	4.040	0.117	-0.015	0.000	1.000
1982	0.500	3.620	0.625	4.040	0.115	-0.014	0.000	1.000
1983	0.490	3.580	0.625	4.040	0.116	-0.002	0.000	1.000

1984	0.470	3.500	0.636	4.040	0.114	-0.003	0.000	1.000
1985	0.480	3.510	0.641	4.040	0.110	-0.003	0.000	1.000
1986	0.470	3.480	0.638	4.040	0.098	-0.003	0.000	1.000
1987	0.440	3.480	0.609	4.040	0.097	-0.003	0.000	1.000
1988	0.410	3.470	0.567	4.040	0.063	0.002	0.000	1.000
1989	0.400	3.480	0.555	4.040	0.066	0.002	0.000	1.000
1990	0.390	3.470	0.532	4.040	0.065	0.002	0.000	1.000
1991	0.370	3.470	0.511	4.040	0.064	0.002	0.000	1.000
1992	0.380	3.480	0.517	4.040	0.066	0.002	0.000	1.000
1993	0.360	3.470	0.496	4.040	0.065	0.002	0.000	1.000
1994	0.310	3.470	0.431	4.040	0.067	0.002	0.000	1.000
1995	0.250	3.470	0.364	4.040	0.069	0.001	0.000	1.000
1996	0.220	3.470	0.331	4.040	0.069	0.001	0.000	1.000
1997	0.220	3.470	0.331	4.040	0.007	0.001	0.000	1.000
1998	0.220	3.470	0.331	4.040	0.001	0.001	0.000	1.000
1999	0.220	3.470	0.331	4.040	0.001	0.001	0.000	1.000
2000	0.220	3.470	0.331	4.040	0.001	0.001	0.000	1.000
2001	0.060	3.470	0.099	4.040	0.065	0.001	0.000	1.000
2002	0.060	3.470	0.099	4.040	0.044	0.001	0.000	1.000
2003	0.060	3.470	0.099	4.040	0.015	0.000	0.000	1.000
2004	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000
2005	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000
2006	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000
2007	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000
2008	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000
2009	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000
2010	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000
2011	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000
2012	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000
2013	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000
2014	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000
2015	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000
2016	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000
2017	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000
2018	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000
2019	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000
2020	0.060	3.470	0.099	4.040	0.002	0.000	0.000	1.000

-M170 Warning:
+ Exhaust emissions for gasoline fueled vehicles beginning in 1995 have been reduced as a result of Gasoline Detergent Additive Regulations (1994).

-M154 Warning:
+ Refueling emissions for LDGV and LDGT after 1998 model year have been reduced as a result of the Onboard Refueling Vapor Recovery Regulations (1994).

0 Emission Factor Modification Profile
+

Eqn.	Reg	Veh	Pol	First	Last	Base	DR1	DR2	KINK	Altered
1	1	1	1	1965	1967	7.4880	0.1860			Yes
2	1	1	1	1968	1969	4.5760	0.2580			Yes

3	1	1	1	1970	1971	3.0990	0.3820			Yes
4	1	1	1	1972	1974	3.4910	0.1650			Yes
5	1	1	1	1975	1975	1.0680	0.2820			Yes
6	1	1	1	1976	1977	1.0710	0.2830			Yes
7	1	1	1	1978	1979	1.0740	0.2840			Yes
8	1	1	1	1980	1980	0.3710	0.2110			Yes
9	1	1	1	1981	1981	0.4640	0.1200	0.0050	14.6300	Yes
10	1	1	1	1982	1982	0.4600	0.1190	0.0060	14.6300	Yes
11	1	1	1	1983	1983	0.3360	0.0640			Yes
12	1	1	1	1984	1984	0.3460	0.0610			Yes
13	1	1	1	1985	1985	0.3500	0.0570			Yes
14	1	1	1	1986	1986	0.3580	0.0460			Yes
15	1	1	1	1987	1987	0.3600	0.0450			Yes
16	1	1	1	1988	1988	0.2280	0.0360			Yes
17	1	1	1	1989	1989	0.2310	0.0370			Yes
18	1	1	1	1990	1990	0.2280	0.0360			Yes
19	1	1	1	1991	1991	0.2240	0.0350			Yes
20	1	1	1	1992	1992	0.2260	0.0350			Yes
21	1	1	1	1993	1993	0.2240	0.0350			Yes
22	1	1	1	1994	1994	0.1970	0.0310			Yes
23	1	1	1	1995	1995	0.1690	0.0280			Yes
24	1	1	1	1996	2000	0.1560	0.0260	0.0240	9.0500	Yes
25	1	1	1	2001	2050	0.0640	0.0140	0.0160	14.6400	Yes
26	1	2	1	1965	1967	7.4880	0.1860			Yes
27	1	2	1	1968	1969	4.5760	0.2580			Yes
28	1	2	1	1970	1971	3.0990	0.3820			Yes
29	1	2	1	1972	1974	3.4700	0.1760			Yes
30	1	2	1	1975	1975	1.8020	0.2700			Yes
31	1	2	1	1976	1976	1.8130	0.2720			Yes
32	1	2	1	1977	1978	1.8070	0.2710			Yes
33	1	2	1	1979	1980	0.8760	0.2820			Yes
34	1	2	1	1981	1981	1.4060	0.0860			Yes
35	1	2	1	1982	1982	1.4060	0.0860			Yes
36	1	2	1	1983	1983	1.4230	0.0870			Yes
37	1	2	1	1984	1984	0.4950	0.0610			Yes
38	1	2	1	1985	1985	0.4850	0.0610			Yes
39	1	2	1	1986	1986	0.4560	0.0620			Yes
40	1	2	1	1987	1987	0.4460	0.0660			Yes
41	1	2	1	1988	1988	0.3340	0.0490			Yes
42	1	2	1	1989	1989	0.3330	0.0470			Yes
43	1	2	1	1990	1990	0.3190	0.0450			Yes
44	1	2	1	1991	1991	0.2930	0.0440			Yes
45	1	2	1	1992	1992	0.3130	0.0420			Yes
46	1	2	1	1993	1993	0.3120	0.0420			Yes
47	1	2	1	1994	1994	0.2640	0.0370			Yes
48	1	2	1	1995	1995	0.2160	0.0330			Yes
49	1	2	1	1996	2000	0.1920	0.0310	0.0270	11.8400	Yes
50	1	2	1	2001	2050	0.0730	0.0150	0.0170	17.2000	Yes
51	1	3	1	1965	1969	9.8850	0.1860			Yes
52	1	3	1	1970	1973	6.4860	0.2580			Yes
53	1	3	1	1974	1978	6.4860	0.1760			Yes

54	1	3	1	1979	1980	0.8870	0.2860			Yes
55	1	3	1	1981	1981	1.4040	0.0860			Yes
56	1	3	1	1982	1982	1.4040	0.0860			Yes
57	1	3	1	1983	1983	1.4270	0.0880			Yes
58	1	3	1	1984	1984	0.5010	0.0610			Yes
59	1	3	1	1985	1985	0.5020	0.0630			Yes
60	1	3	1	1986	1986	0.4870	0.0670			Yes
61	1	3	1	1987	1987	0.4700	0.0690			Yes
62	1	3	1	1988	1988	0.3490	0.0510			Yes
63	1	3	1	1989	1989	0.3440	0.0480			Yes
64	1	3	1	1990	1990	0.3360	0.0480			Yes
65	1	3	1	1991	1991	0.2930	0.0440			Yes
66	1	3	1	1992	1995	0.3130	0.0420			Yes
67	1	3	1	1996	1996	0.2640	0.0380			Yes
68	1	3	1	1997	2000	0.2160	0.0340	0.0290	13.9300	Yes
69	1	3	1	2001	2050	0.2140	0.0340	0.0280	13.9300	Yes
70	1	4	1	1980	1980	4.1179	0.1951			Yes
71	1	4	1	1981	1983	3.9044	0.1830			Yes
72	1	4	1	1984	1984	3.9600	0.1859			Yes
73	1	4	1	1985	1985	2.8206	0.0582			Yes
74	1	4	1	1986	1986	2.4952	0.0581			Yes
75	1	4	1	1987	1987	1.2083	0.1130			Yes
76	1	4	1	1988	1989	1.0680	0.0322			Yes
77	1	4	1	1990	1990	0.7849	0.0375			Yes
78	1	4	1	1991	1997	0.7571	0.0347			Yes
79	1	4	1	1998	2050	0.7638	0.0345			Yes
80	1	5	1	1965	1974	1.4060	0.0890			Yes
81	1	5	1	1975	1979	0.4540	0.0780			Yes
82	1	5	1	1980	1993	0.3100	0.0330			Yes
83	1	5	1	1994	1994	0.2610	0.0280			Yes
84	1	5	1	1995	1995	0.2130	0.0230			Yes
85	1	5	1	1996	1996	0.1890	0.0200			Yes
86	1	5	1	1997	1997	0.1890	0.0200			Yes
87	1	5	1	1998	1998	0.1890	0.0200			Yes
88	1	5	1	1999	1999	0.1890	0.0200			Yes
89	1	5	1	2000	2000	0.1890	0.0200			Yes
90	1	5	1	2001	2050	0.0570	0.0060			Yes
91	1	6	1	1965	1980	0.9160	0.0890			Yes
92	1	6	1	1981	1995	0.4580	0.0440			Yes
93	1	6	1	1996	1996	0.3690	0.0360			Yes
94	1	6	1	1997	1997	0.2810	0.0270			Yes
95	1	6	1	1998	1998	0.2810	0.0270			Yes
96	1	6	1	1999	1999	0.2810	0.0270			Yes
97	1	6	1	2000	2000	0.2810	0.0270			Yes
98	1	6	1	2001	2050	0.2810	0.0270			Yes
99	1	7	1	1988	1988	1.8740	0.0000			Yes
100	1	7	1	1989	1989	1.8597	0.0000			Yes
101	1	7	1	1990	1990	1.5412	0.0000			Yes
102	1	7	1	1991	1991	1.3366	0.0000			Yes
103	1	7	1	1992	1992	1.3275	0.0000			Yes
104	1	7	1	1993	1993	1.2849	0.0000			Yes

```
  105   1   7   1   1994  1994     0.7359    0.0000                        Yes
  106   1   7   1   1995  1995     0.7320    0.0000                        Yes
  107   1   7   1   1996  2050     0.7269    0.0000                        Yes
0I/M program selected:

0    Start year (January 1):             1978
     Pre-1981 MYR stringency rate:        20%
     First model year covered:           1967
     Last model year covered:            2003
     Waiver rate (pre-1981):              3.%
     Waiver rate (1981 and newer):        3.%
     Compliance Rate:                    96.%
     Inspection type:                    Test Only
     Inspection frequency                Annual
     Vehicle types covered:              LDGV - No
                                        LDGT1 - No
                                        LDGT2 - No
                                         HDGV - Yes
     1981 & later MYR test type:         Idle
     Cutpoints, HC:  220.000   CO:    1.200   NOx:  999.000
  Low alt, Annl and Bien Insp Freq TECH 1 & 2 I/M cred data
     Annual Idle Only 220/1.2 Cutpoints IDLE.IMC
0Functional Check Program Description:
0Check Start Model Yrs Vehicle Classes Covered    Inspection        Comp   Eff
      (Jan1) Covered   LDGV LDGT1 LDGT2 HDGV   Type        Freq     Rate   Adj
 Press 1988  1981-2050 Yes  Yes   Yes   Yes Test Only     Biennial  96.0%  1.00
 Purge 1997  1997-2050 Yes  Yes   Yes   No  Test Only     Biennial  96.0%  1.00
 ATP   1988  1967-2050 Yes  Yes   Yes   Yes Test Only     Biennial  96.0%  1.00
0Air pump system disablements:       Yes  Catalyst removals:                  Yes
 Fuel inlet restrictor disablements: No   Tailpipe lead deposit test:         No
 EGR disablement:                    No   Evaporative system disablements:    Yes
 PCV system disablements:            Yes  Missing gas caps:                   No
0TOG HC emission factors include evaporative HC emission factors.
0_______________________________________________________________________________________________________________
0Emission factors are as of July 1st of the indicated calendar year.
0User supplied  basic exhaust emissions rates,  mileage accrual distributions, veh registration distributions.

0Cal. Year: 2007        I/M Program: Yes       Ambient Temp: 80.6 (F)              Region: Low
                   Anti-tam. Program: Yes     Operating Mode: 20.6 / 27.3 / 20.6   Altitude:  500. Ft.
                    Reformulated Gas: No
0PX07SB.INP Spr                                Minimum Temp:  61. (F)        Maximum Temp:  87. (F)
                         Period 1 RVP:  6.8      Period 2 RVP:  6.8       Period 2 Start Yr: 2020
0  Veh. Type:       LDGV     LDGT1     LDGT2      LDGT      HDGV      LDDV      LDDT      HDDV      MC     All Veh
+                  ______    ______    ______    ______    ______    ______    ______    ______    ______   ______
 Veh. Speeds:     19.6      19.6      19.6                19.6      19.6      19.6      19.6      19.6
     VMT Mix:      0.395     0.383     0.127               0.023     0.000     0.002     0.065     0.005
0Composite Toxic Emission Factors (mg/Mile)
  = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
 Total    Bnz     10.03     12.55     21.20     14.71     38.49      4.49     10.75      8.84     44.94    13.168
 Exhst    Bnz      9.23     11.75     20.15     13.84     35.93      4.49     10.75      8.84     35.70    12.304
 Evap.    Bnz      0.33      0.37      0.46      0.39      1.70                                    7.77     0.408
```

Refuel	Bnz	0.07	0.12	0.16	0.13	0.34					0.101
Runing	Bnz	0.29	0.23	0.30	0.25	0.40					0.250
Rsting	Bnz	0.11	0.09	0.12	0.10	0.12				1.47	0.105
Exhst	Act	1.87	2.37	4.32	2.85	13.04	2.76	6.61	24.24	20.68	4.186
Exhst	Frm	2.95	3.85	6.87	4.61	27.80	8.66	20.76	65.81	48.61	8.717
Exhst	But	1.24	1.66	2.73	1.92	4.91	2.02	4.84	5.13	20.19	2.028
Total	MTB	0.00	0.00	0.00	10.22	0.00	0.00	0.00	0.00	0.00	0.000
Exhst	MTB	0.00	0.00	0.00	1.80	0.00	0.00	0.00	0.00	0.00	0.000
Evap.	MTB	0.00	0.00	0.00	3.57	0.00				0.00	0.000
Refuel	MTB	0.00	0.00	0.00	0.75	0.00					0.000
Runing	MTB	0.00	0.00	0.00	3.33	0.00					0.000
Rsting	MTB	0.00	0.00	0.00	0.76	0.00				0.00	0.000

0Composite Emission Factors (gm/Mile)

Total	TOG	0.42	0.49	0.80	0.57	1.87	0.22	0.54	0.84	4.17	0.575
Exhst	TOG	0.25	0.32	0.58	0.39	1.29	0.22	0.54	0.84	2.04	0.391
Evap.	TOG	0.06	0.07	0.09	0.07	0.38				1.77	0.080
Refuel	TOG	0.02	0.03	0.04	0.03	0.08					0.024
Runing	TOG	0.06	0.05	0.07	0.06	0.09					0.056
Rsting	TOG	0.03	0.02	0.03	0.02	0.03				0.35	0.025

-M170 Warning:
+ Exhaust emissions for gasoline fueled vehicles beginning in 1995 have been reduced as a result of Gasoline Detergent Additive Regulations (1994).

-M154 Warning:
+ Refueling emissions for LDGV and LDGT after 1998 model year have been reduced as a result of the Onboard Refueling Vapor Recovery Regulations (1994).

0Emission factors are as of July 1st of the indicated calendar year.
0User supplied basic exhaust emissions rates, mileage accrual distributions, veh registration distributions.

0Cal. Year: 2007 I/M Program: Yes Ambient Temp:101.4 (F) Region: Low
Anti-tam. Program: Yes Operating Mode: 20.6 / 27.3 / 20.6 Altitude: 500. Ft.
Reformulated Gas: No
0PX07SB.INP Sum Minimum Temp: 84. (F) Maximum Temp: 106. (F)
Period 1 RVP: 6.8 Period 2 RVP: 6.8 Period 2 Start Yr: 2020

0 Veh. Type:		LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	All Veh
Veh. Speeds:		19.6	19.6	19.6		19.6	19.6	19.6	19.6	19.6	
VMT Mix:		0.395	0.383	0.127		0.023	0.000	0.002	0.065	0.005	

0Composite Toxic Emission Factors (mg/Mile)

Total	Bnz	12.08	15.24	25.39	17.77	46.19	4.49	10.75	8.84	54.42	15.762
Exhst	Bnz	10.53	13.40	22.94	15.78	40.92	4.49	10.75	8.84	35.33	13.919
Evap.	Bnz	0.53	0.58	0.74	0.62	3.15				16.47	0.678
Refuel	Bnz	0.09	0.15	0.21	0.16	0.45					0.129

Runing	Bnz	0.74	0.94	1.28	1.03	1.45					0.849
Rsting	Bnz	0.20	0.17	0.22	0.18	0.22				2.62	0.186

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Exhst	Act	2.13	2.69	4.90	3.24	15.15	2.76	6.61	24.24	20.47	4.536

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Exhst	Frm	3.36	4.38	7.80	5.23	33.07	8.66	20.76	65.81	48.11	9.318

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Exhst	But	1.41	1.89	3.11	2.19	5.93	2.02	4.84	5.13	19.98	2.256

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Total	MTB	0.00	0.00	0.00	10.22	0.00	0.00	0.00	0.00	0.00	0.000
Exhst	MTB	0.00	0.00	0.00	1.80	0.00	0.00	0.00	0.00	0.00	0.000
Evap.	MTB	0.00	0.00	0.00	3.57	0.00				0.00	0.000
Refuel	MTB	0.00	0.00	0.00	0.75	0.00					0.000
Runing	MTB	0.00	0.00	0.00	3.33	0.00					0.000
Rsting	MTB	0.00	0.00	0.00	0.76	0.00				0.00	0.000

= =

0Composite Emission Factors (gm/Mile)

Total	TOG	0.62	0.77	1.20	0.87	2.67	0.22	0.54	0.84	6.39	0.842
Exhst	TOG	0.28	0.37	0.66	0.44	1.49	0.22	0.54	0.84	2.02	0.437
Evap.	TOG	0.11	0.12	0.15	0.13	0.71				3.75	0.142
Refuel	TOG	0.02	0.03	0.05	0.04	0.10					0.030
Runing	TOG	0.16	0.21	0.28	0.23	0.32					0.189
Rsting	TOG	0.05	0.04	0.05	0.04	0.05				0.62	0.044

Appendix O

County-Level Population, VMT, and Emissions Mapping

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
1	1	1001	AL	Autauga, AL	U1	SE	34222	40294	44081	47779	377.699	456.619	568.098	712.299
1	3	1003	AL	Baldwin, AL	U1	SE	98280	124476	136174	147599	983.531	1030.724	1276.427	1598.851
1	5	1005	AL	Barbour, AL	R	SE	25417	26587	29086	31526	205.187	232.799	286.503	356.078
1	7	1007	AL	Bibb, AL	R	SE	16576	18301	20020	21700	146.294	191.492	235.886	293.319
1	9	1009	AL	Blount, AL	U1	SE	39248	44248	48406	52467	557.978	563.123	692.482	860.662
1	11	1011	AL	Bullock, AL	R	SE	11042	11237	12293	13325	92.976	121.079	149.120	185.403
1	13	1013	AL	Butler, AL	R	SE	21892	21721	23762	25755	273.919	245.592	302.495	376.131
1	15	1015	AL	Calhoun, AL	U2	SE	116032	116941	127930	138664	1254.634	1572.674	1870.655	2271.712
1	17	1017	AL	Chambers, AL	U2	SE	36876	36832	40294	43674	425.448	258.381	317.549	394.348
1	19	1019	AL	Cherokee, AL	R	SE	19543	21298	23299	25254	218.702	273.264	336.824	418.988
1	21	1021	AL	Chilton, AL	R	SE	32458	35793	39157	42442	447.615	413.105	509.043	633.113
1	23	1023	AL	Choctaw, AL	R	SE	16018	15912	17407	18867	196.310	257.772	317.848	395.481
1	25	1025	AL	Clarke, AL	R	SE	27240	28311	30971	33570	250.834	294.225	362.346	450.507
1	27	1027	AL	Clay, AL	R	SE	13252	13749	15041	16303	159.747	213.259	262.963	327.180
1	29	1029	AL	Cleburne, AL	R	SE	12730	13897	15203	16479	176.966	163.442	201.403	250.495
1	31	1031	AL	Coffee, AL	U2	SE	40240	41731	45653	49484	296.601	308.116	378.861	470.627
1	33	1033	AL	Colbert, AL	U2	SE	51666	52850	57816	62667	562.036	750.255	905.724	1106.582
1	35	1035	AL	Conecuh, AL	R	SE	14054	14079	15402	16694	218.839	175.262	215.949	268.569
1	37	1037	AL	Coosa, AL	R	SE	11063	11484	12563	13617	132.633	178.032	219.526	273.142
1	39	1039	AL	Covington, AL	R	SE	36478	37236	40735	44153	308.103	356.121	438.396	544.939
1	41	1041	AL	Crenshaw, AL	R	SE	13635	13644	14926	16178	146.298	182.789	225.277	280.217
1	43	1043	AL	Cullman, AL	R	SE	67613	73294	80182	86909	885.629	897.484	1106.059	1375.759
1	45	1045	AL	Dale, AL	U2	SE	49633	49182	53804	58318	371.330	421.697	526.948	661.595
1	47	1047	AL	Dallas, AL	U2	SE	48130	47275	51718	56057	409.069	381.747	469.486	583.263
1	49	1049	AL	DeKalb, AL	R	SE	54651	57309	62695	67955	724.005	655.650	807.756	1004.526
1	51	1051	AL	Elmore, AL	U1	SE	49210	58692	64207	69594	601.753	591.103	741.763	934.834
1	53	1053	AL	Escambia, AL	R	SE	35518	36349	39764	43101	431.326	337.311	415.191	516.057
1	55	1055	AL	Etowah, AL	U2	SE	99840	103674	113417	122933	1166.017	1392.072	1659.119	2013.455
1	57	1057	AL	Fayette, AL	R	SE	17962	18145	19851	21516	181.942	216.175	266.329	331.208
1	59	1059	AL	Franklin, AL	R	SE	27814	29356	32115	34809	251.706	287.183	353.610	439.613
1	61	1061	AL	Geneva, AL	R	SE	23647	24659	26977	29240	230.936	313.870	386.814	481.128
1	63	1063	AL	Greene, AL	R	SE	10153	9938	10872	11784	185.759	163.389	201.467	250.676
1	65	1065	AL	Hale, AL	R	SE	15498	16263	17791	19284	159.519	206.004	253.880	315.793
1	67	1067	AL	Henry, AL	R	SE	15374	15599	17064	18496	133.701	165.326	203.599	253.147
1	69	1069	AL	Houston, AL	U2	SE	81331	84616	92567	100334	826.912	1177.258	1458.620	1821.879
1	71	1071	AL	Jackson, AL	R	SE	47796	50329	55059	59678	459.337	530.993	654.001	813.181
1	73	1073	AL	Jefferson, AL	U1	SE	651520	657643	719446	779808	7377.655	9246.557	11178.632	13753.744
1	75	1075	AL	Lamar, AL	R	SE	15715	15753	17233	18679	173.819	252.896	311.836	387.991
1	77	1077	AL	Lauderdale, AL	U2	SE	79661	83587	91442	99114	835.459	1166.751	1409.754	1723.272
1	79	1079	AL	Lawrence, AL	R	SE	31513	33118	36231	39271	329.681	460.865	576.701	726.269
1	81	1081	AL	Lee, AL	U2	SE	87146	96879	105983	114875	912.262	1233.195	1500.510	1852.502
1	83	1083	AL	Limestone, AL	R	SE	54135	59762	65378	70864	604.790	632.065	799.128	1015.932
1	85	1085	AL	Lowndes, AL	R	SE	12658	12849	14057	15236	223.379	203.701	251.175	312.519
1	87	1087	AL	Macon, AL	R	SE	24928	23545	25757	27918	296.006	226.581	278.842	346.549

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1	89	1089	AL	Madison, AL	U2	SE	238912	267524	292665	317220	2329.138	3112.935	3883.452	4897.595
1	91	1091	AL	Marengo, AL	R	SE	23084	23443	25646	27798	219.951	228.255	281.003	349.320
1	93	1093	AL	Marion, AL	R	SE	29830	30673	33555	36370	289.901	347.130	427.615	531.751
1	95	1095	AL	Marshall, AL	R	SE	70832	77741	85047	92183	545.756	653.121	803.813	999.022
1	97	1097	AL	Mobile, AL	U1	SE	378643	395471	432636	468935	3601.269	4727.302	5775.070	7174.950
1	99	1099	AL	Monroe, AL	R	SE	23968	24155	26425	28642	224.948	286.107	352.475	438.343
1	101	1101	AL	Montgomery, AL	U1	SE	209085	216381	236716	256576	1788.098	2467.009	3046.335	3802.348
1	103	1103	AL	Morgan, AL	U2	SE	100043	107124	117191	127023	1168.971	1623.097	2006.291	2507.780
1	105	1105	AL	Perry, AL	R	SE	12759	12659	13848	15010	144.209	145.349	179.035	222.638
1	107	1107	AL	Pickens, AL	R	SE	20699	20926	22893	24813	228.307	302.507	372.915	463.913
1	109	1109	AL	Pike, AL	R	SE	27595	28460	31134	33747	215.587	257.665	317.131	394.164
1	111	1111	AL	Randolph, AL	R	SE	19881	19917	21789	23617	193.384	229.324	282.486	351.274
1	113	1113	AL	Russell, AL	U2	SE	46860	50168	54882	59487	480.954	748.652	904.545	1105.691
1	115	1115	AL	St. Clair, AL	U1	SE	49811	59263	64832	70271	609.443	603.310	741.500	921.288
1	117	1117	AL	Shelby, AL	U1	SE	99363	130291	142535	154494	930.481	1403.517	1708.434	2110.605
1	119	1119	AL	Sumter, AL	R	SE	16174	16023	17529	19000	207.885	163.487	201.287	250.223
1	121	1121	AL	Talladega, AL	U2	SE	74109	76455	83640	90657	807.907	649.748	799.101	992.765
1	123	1123	AL	Tallapoosa, AL	U2	SE	38826	39959	43714	47382	324.741	344.953	424.470	527.519
1	125	1125	AL	Tuscaloosa, AL	U2	SE	150522	159297	174268	188889	1566.583	2001.006	2474.416	3098.415
1	127	1127	AL	Walker, AL	U1	SE	67670	70295	76901	83354	677.468	820.352	1010.703	1256.938
1	129	1129	AL	Washington, AL	R	SE	16694	17482	19125	20729	196.097	268.650	331.262	412.174
1	131	1131	AL	Wilcox, AL	R	SE	13568	13541	14814	16057	172.010	218.344	269.233	334.979
1	133	1133	AL	Winston, AL	R	SE	22053	23647	25870	28040	219.347	292.236	360.149	447.956
2	13	2013	AK	Aleutians East Borough,	R	SP	2464	2342	2741	3198	22.176	20.792	27.045	34.772
2	16	2016	AK	Aleutians West Census	U2	SP	9478	5377	6291	7340	45.801	42.940	55.856	71.814
2	20	2020	AK	Anchorage Borough, AK	U2	SP	226338	247517	289617	337927	1336.699	1880.359	2380.811	2996.916
2	50	2050	AK	Bethel Census Area, AK	R	SP	13656	15505	18142	21168	132.077	114.090	148.668	191.349
2	60	2060	AK	Bristol Bay Borough, AK	R	SP	1410	1350	1580	1843	8.806	9.539	10.884	14.018
2	68	2068	AK	Denali Borough, AK	R	SP	1764	1977	2314	2700	8.200	8.883	10.136	13.054
2	70	2070	AK	Dillingham Census Area	R	SP	4012	4393	5140	5997	71.760	45.848	59.810	77.029
2	90	2090	AK	Fairbanks North Star Bo	U2	SP	77720	83361	97540	113810	491.913	419.512	545.421	701.040
2	100	2100	AK	Haines Borough, AK	R	SP	2117	2172	2541	2965	26.116	24.192	31.561	40.636
2	110	2110	AK	Juneau Borough, AK	U2	SP	26751	29538	34563	40328	91.115	65.453	84.439	108.030
2	122	2122	AK	Kenai Peninsula Boroug	U2	SP	40802	46595	54521	63615	345.977	261.623	340.492	437.896
2	130	2130	AK	Ketchikan Gateway Boro	U2	SP	13828	13812	16161	18857	97.599	76.324	99.247	127.573
2	150	2150	AK	Kodiak Island Borough,	R	SP	13309	14644	17134	19992	102.759	89.075	115.953	149.161
2	164	2164	AK	Lake and Peninsula Bor	R	SP	1668	1761	2060	2404	16.718	15.675	20.389	26.214
2	170	2170	AK	Matanuska-Susitna Boro	R	SP	39683	52298	61193	71400	276.957	385.233	502.277	646.694
2	180	2180	AK	Nome Census Area, AK	R	SP	8288	8810	10308	12028	101.620	60.061	78.216	100.632
2	185	2185	AK	North Slope Borough, A	U2	SP	5979	7018	8212	9581	65.278	38.080	49.559	63.737
2	188	2188	AK	Northwest Arctic Boroug	R	SP	6113	6552	7666	8945	75.099	42.700	55.598	71.523
2	201	2201	AK	Prince of Wales-Outer K	R	SP	6278	7031	8227	9600	59.413	71.744	93.590	120.542
2	220	2220	AK	Sitka Borough, AK	U2	SP	8588	8494	9938	11596	36.406	21.483	27.723	35.473
2	232	2232	AK	Skagway-Yakutat-Ango	R	SP	3680	3776	4418	5155	54.066	50.109	65.371	84.188

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2	240	2240	AK	Southeast Fairbanks Ce	R	SP	5913	5613	6568	7663	88.239	67.573	88.149	113.531
2	261	2261	AK	Valdez-Cordova Census	R	SP	9952	10335	12093	14110	96.274	80.463	104.837	134.912
2	270	2270	AK	Wade Hampton Census	R	SP	5791	6638	7767	9062	72.524	66.177	86.332	111.188
2	280	2280	AK	Wrangell-Petersburg Ce	R	SP	7042	6973	8160	9521	58.105	50.745	58.908	75.782
2	282	2282	AL	Yakutat Borough, AL	U2	SP	705	815	953	1112	7.075	6.178	7.172	9.227
2	290	2290	AL	Yukon-Koyukuk Census	R	SP	6714	6148	7194	8394	121.828	96.883	126.388	162.769
4	1	4001	AZ	Apache, AZ	R	PX	61591	68403	84369	96433	1425.238	1376.966	1892.276	2565.154
4	3	4003	AZ	Cochise, AZ	U2	PX	97624	110159	135871	155300	1497.592	1033.681	1418.774	1921.874
4	5	4005	AZ	Coconino, AZ	U2	PX	96591	111272	137244	156870	1299.298	1136.771	1551.813	2089.732
4	7	4007	AZ	Gila, AZ	U2	PX	40216	47211	58231	66557	721.769	669.600	919.838	1246.645
4	9	4009	AZ	Graham, AZ	R	PX	26554	30448	37555	42925	495.411	514.733	707.245	958.646
4	11	4011	AZ	Greenlee, AZ	R	PX	8008	9198	11345	12967	199.831	173.834	238.880	323.818
4	12	4012	AZ	La Paz, AZ	R	PX	13844	14764	18210	20814	701.172	695.269	920.020	1204.767
4	13	4013	AZ	Maricopa, AZ	U1	PX	2122101	2614184	3224362	3685433	17099.216	23216.850	31798.340	43149.254
4	15	4015	AZ	Mohave, AZ	U2	PX	93497	123829	152732	174572	943.576	537.096	813.769	1197.061
4	17	4017	AZ	Navajo, AZ	R	PX	77674	92454	114033	130340	1619.548	1622.350	2229.318	3021.912
4	19	4019	AZ	Pima, AZ	U1	PX	666957	763980	942300	1077045	5375.176	6519.341	8532.387	11111.717
4	21	4021	AZ	Pinal, AZ	U2	PX	116397	139492	172051	196653	1662.716	1800.499	2502.796	3426.477
4	23	4023	AZ	Santa Cruz, AZ	U2	PX	29676	36699	45265	51738	275.342	354.578	486.802	659.520
4	25	4025	AZ	Yavapai, AZ	U2	PX	107714	139072	171532	196061	1474.010	1290.044	1771.124	2399.557
4	27	4027	AZ	Yuma, AZ	U2	PX	106895	126713	156289	178638	705.615	699.676	925.850	1212.401
5	1	5001	AR	Arkansas, AR	U2	SE	21653	20917	23172	24871	157.744	171.461	212.452	264.746
5	3	5003	AR	Ashley, AR	U2	SE	24319	24406	27038	29020	187.368	233.772	290.116	361.880
5	5	5005	AR	Baxter, AR	R	SE	31186	35808	39669	42576	224.953	401.290	498.943	623.053
5	7	5007	AR	Benton, AR	U2	SE	97499	125362	138879	149059	569.002	903.471	1205.458	1601.644
5	9	5009	AR	Boone, AR	R	SE	28297	31454	34845	37399	203.994	340.038	422.621	527.627
5	11	5011	AR	Bradley, AR	U2	SE	11793	11592	12841	13783	94.485	109.450	135.794	169.360
5	13	5013	AR	Calhoun, AR	R	SE	5826	5759	6380	6848	59.273	98.420	122.530	153.137
5	15	5015	AR	Carroll, AR	R	SE	18654	21829	24182	25955	142.431	270.191	336.147	419.926
5	17	5017	AR	Chicot, AR	U2	SE	15713	15206	16845	18080	112.353	117.177	145.108	180.774
5	19	5019	AR	Clark, AR	R	SE	21437	22022	24396	26184	245.138	222.926	276.814	345.399
5	21	5021	AR	Clay, AR	R	SE	18107	17494	19380	20801	162.147	207.143	257.374	321.259
5	23	5023	AR	Cleburne, AR	R	SE	19411	22019	24393	26182	140.797	250.060	310.915	388.254
5	25	5025	AR	Cleveland, AR	R	SE	7781	8245	9134	9803	76.715	131.445	163.648	204.516
5	27	5027	AR	Columbia, AR	R	SE	25691	25282	28008	30061	197.336	278.922	346.442	432.366
5	29	5029	AR	Conway, AR	R	SE	19151	19878	22021	23635	245.462	232.414	288.875	360.676
5	31	5031	AR	Craighead, AR	U2	SE	68956	75793	83965	90119	451.258	527.473	653.364	814.064
5	33	5033	AR	Crawford, AR	R	SE	42493	48538	53771	57712	488.072	595.259	761.312	975.324
5	35	5035	AR	Crittenden, AR	U1	SE	49939	49726	55087	59125	525.019	651.779	815.723	1026.076
5	37	5037	AR	Cross, AR	R	SE	19225	19447	21544	23123	158.324	210.914	261.987	326.974
5	39	5039	AR	Dallas, AR	R	SE	9614	9238	10234	10984	75.389	96.643	119.977	149.673
5	41	5041	AR	Desha, AR	U2	SE	16798	15476	17145	18402	130.985	137.507	170.432	212.422
5	43	5043	AR	Drew, AR	R	SE	17369	17690	19597	21033	131.336	180.546	224.186	279.744
5	45	5045	AR	Faulkner, AR	U1	SE	60006	74225	82228	88256	544.776	645.413	824.444	1053.057

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5	47	5047	AR	Franklin, AR	R	SE	14897	16245	17997	19316	209.133	205.473	255.568	319.214
5	49	5049	AR	Fulton, AR	R	SE	10037	10828	11996	12875	95.849	161.545	201.082	251.259
5	51	5051	AR	Garland, AR	U2	SE	73397	81800	90620	97263	486.038	645.956	801.101	998.862
5	53	5053	AR	Grant, AR	R	SE	13948	15439	17104	18358	110.890	192.542	239.486	299.120
5	55	5055	AR	Greene, AR	U2	SE	31804	35005	38779	41621	219.806	279.430	346.538	432.080
5	57	5057	AR	Hempstead, AR	R	SE	21621	21899	24260	26038	280.403	231.237	287.185	358.386
5	59	5059	AR	Hot Spring, AR	R	SE	26115	28214	31256	33547	336.889	312.147	387.944	484.326
5	61	5061	AR	Howard, AR	R	SE	13569	13824	15315	16438	107.354	164.708	204.721	255.599
5	63	5063	AR	Independence, AR	R	SE	31192	32666	36188	38841	250.612	399.165	496.287	619.735
5	65	5065	AR	Izard, AR	R	SE	11364	12697	14066	15097	104.996	191.973	239.004	298.694
5	67	5067	AR	Jackson, AR	R	SE	18944	17921	19854	21309	167.326	219.403	272.630	340.314
5	69	5069	AR	Jefferson, AR	U2	SE	85487	82720	91639	98356	627.175	962.528	1099.160	1284.540
5	71	5071	AR	Johnson, AR	R	SE	18221	20744	22981	24666	235.732	226.689	281.800	351.864
5	73	5073	AR	Lafayette, AR	R	SE	9643	9164	10152	10896	84.589	162.900	202.810	253.453
5	75	5075	AR	Lawrence, AR	R	SE	17455	17458	19340	20758	142.575	196.843	244.556	305.246
5	77	5077	AR	Lee, AR	R	SE	13053	12575	13931	14952	118.890	138.314	171.770	214.347
5	79	5079	AR	Lincoln, AR	R	SE	13690	14253	15790	16947	130.355	231.267	287.924	359.828
5	81	5081	AR	Little River, AR	R	SE	13966	13317	14753	15834	113.921	164.305	204.185	254.900
5	83	5083	AR	Logan, AR	R	SE	20557	21147	23427	25144	156.011	243.274	302.329	377.424
5	85	5085	AR	Lonoke, AR	U1	SE	39268	47841	52999	56884	415.036	445.128	568.794	726.670
5	87	5087	AR	Madison, AR	R	SE	11618	12916	14308	15357	110.894	196.264	244.344	305.378
5	89	5089	AR	Marion, AR	R	SE	12001	14074	15591	16734	110.515	202.735	252.402	315.434
5	91	5091	AR	Miller, AR	U2	SE	38467	39531	43793	47003	426.916	509.950	613.138	746.731
5	93	5093	AR	Mississippi, AR	U2	SE	57525	51509	57062	61245	550.603	440.620	545.787	680.036
5	95	5095	AR	Monroe, AR	R	SE	11333	10498	11630	12483	181.653	132.568	164.735	205.651
5	97	5097	AR	Montgomery, AR	R	SE	7841	8406	9312	9995	75.772	132.459	164.910	206.090
5	99	5099	AR	Nevada, AR	R	SE	10101	10044	11126	11942	140.657	119.556	148.579	185.489
5	101	5101	AR	Newton, AR	R	SE	7666	8047	8914	9568	75.625	129.501	161.229	201.497
5	103	5103	AR	Ouachita, AR	R	SE	30574	28471	31540	33852	217.258	316.504	392.998	490.370
5	105	5105	AR	Perry, AR	R	SE	7969	9245	10242	10993	70.845	134.622	167.602	209.458
5	107	5107	AR	Phillips, AR	U2	SE	28830	27803	30801	33059	229.102	248.154	307.699	383.624
5	109	5109	AR	Pike, AR	R	SE	10086	10432	11557	12404	101.144	170.384	212.127	265.095
5	111	5111	AR	Poinsett, AR	R	SE	24664	24611	27264	29263	215.103	285.870	355.220	443.414
5	113	5113	AR	Polk, AR	R	SE	17347	19318	21400	22969	138.800	216.903	269.643	336.688
5	115	5115	AR	Pope, AR	U2	SE	45883	50457	55897	59994	462.405	440.028	546.075	681.159
5	117	5117	AR	Prairie, AR	R	SE	9518	9318	10323	11080	174.867	160.790	200.180	250.165
5	119	5119	AR	Pulaski, AR	U1	SE	349569	350304	388074	416520	3418.588	4635.496	5835.338	7388.124
5	121	5121	AR	Randolph, AR	R	SE	16558	17539	19430	20854	132.710	194.173	241.296	301.224
5	123	5123	AR	St. Francis, AR	R	SE	28497	28401	31463	33770	361.549	295.549	366.981	457.905
5	125	5125	AR	Saline, AR	U1	SE	64183	74229	82232	88260	650.578	687.323	876.838	1119.114
5	127	5127	AR	Scott, AR	R	SE	10205	10758	11918	12791	80.575	130.339	162.050	202.357
5	129	5129	AR	Searcy, AR	R	SE	7841	7793	8633	9266	86.264	132.459	164.910	206.090
5	131	5131	AR	Sebastian, AR	U2	SE	99590	105057	116384	124915	884.150	1211.359	1536.004	1957.726
5	133	5133	AR	Sevier, AR	R	SE	13637	14633	16211	17399	112.997	165.939	206.254	257.520

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5	135	5135	AR	Sharp, AR	R	SE	14109	16284	18040	19363	122.561	185.427	230.579	287.966
5	137	5137	AR	Stone, AR	R	SE	9775	10773	11934	12809	87.971	165.130	205.585	256.928
5	139	5139	AR	Union, AR	R	SE	46719	45664	50587	54296	341.086	467.334	580.141	723.769
5	141	5141	AR	Van Buren, AR	R	SE	14008	15325	16977	18221	130.237	236.639	294.612	368.185
5	143	5143	AR	Washington, AR	U2	SE	113409	133608	148013	158863	972.986	1646.214	2178.977	2881.532
5	145	5145	AR	White, AR	R	SE	54676	62078	68772	73813	390.953	613.686	762.408	951.612
5	147	5147	AR	Woodruff, AR	R	SE	9520	9037	10012	10746	91.087	123.135	153.103	191.189
5	149	5149	AR	Yell, AR	R	SE	17759	18899	20937	22471	147.027	248.243	308.788	385.706
6	1	6001	CA	Alameda, CA	U1	CN	1304346	1361535	1535158	1942290	9409.200	11071.465	13997.509	17813.599
6	3	6003	CA	Alpine, CA	R	CN	1113	1192	1344	1700	48.261	26.872	35.504	46.731
6	5	6005	CA	Amador, CA	R	CN	30039	33868	38187	48314	284.618	486.868	643.127	846.390
6	7	6007	CA	Butte, CA	U2	CN	182120	192440	216980	274524	1455.456	1155.595	1540.935	2046.822
6	9	6009	CA	Calaveras, CA	R	CN	31998	38754	43696	55284	304.558	682.811	902.075	1187.280
6	11	6011	CA	Colusa, CA	R	CN	16275	18425	20774	26284	449.236	276.033	364.635	479.891
6	13	6013	CA	Contra Costa, CA	U1	CN	803732	885611	998545	1263363	5797.191	6767.166	8562.549	10902.262
6	15	6015	CA	Del Norte, CA	R	CN	23460	27596	31115	39366	211.130	371.338	490.511	645.542
6	17	6017	CA	El Dorado, CA	U1	CN	125995	151385	170690	215958	1637.073	1729.413	2450.768	3418.573
6	19	6019	CA	Fresno, CA	U1	CN	667490	741981	836598	1058468	5529.017	6409.944	8464.677	11097.082
6	21	6021	CA	Glenn, CA	R	CN	24798	26139	29473	37289	381.582	337.130	445.281	585.984
6	23	6023	CA	Humboldt, CA	U2	CN	119118	122779	138436	175149	1070.186	1106.400	1460.888	1922.169
6	25	6025	CA	Imperial, CA	U2	CS	109303	138791	156490	197992	1252.982	670.730	884.886	1163.710
6	27	6027	CA	Inyo, CA	R	CS	18281	18297	20631	26102	447.499	229.448	303.038	398.780
6	29	6029	CA	Kern, CA	U1	CS	544981	616659	695295	879691	5342.569	4582.644	6082.975	8007.695
6	31	6031	CA	Kings, CA	U2	CN	101469	113486	127958	161893	906.292	778.188	1027.308	1351.524
6	33	6033	CA	Lake, CA	R	CN	50631	54654	61624	77967	376.888	769.268	1016.125	1337.263
6	35	6035	CA	Lassen, CA	R	CN	27598	33029	37241	47117	465.682	493.853	652.387	858.613
6	37	6037	CA	Los Angeles, CA	U1	CS	8863052	9104909	10265968	12988552	64631.052	80080.629	98504.193	122794.035
6	39	6039	CA	Madera, CA	U2	CN	88090	110562	124661	157721	936.275	972.226	1297.851	1712.517
6	41	6041	CA	Marin, CA	U1	CN	230096	234893	264846	335085	1899.045	2221.230	2680.839	3271.196
6	43	6043	CA	Mariposa, CA	R	CN	14302	15545	17527	22175	208.366	345.312	456.222	600.477
6	45	6045	CA	Mendocino, CA	R	CN	80345	83719	94395	119428	966.029	1330.800	1757.932	2313.577
6	47	6047	CA	Merced, CA	U2	CN	178403	193592	218278	276167	2141.745	1526.449	2006.720	2634.818
6	49	6049	CA	Modoc, CA	R	CN	9678	10068	11352	14362	143.076	157.109	207.532	273.121
6	51	6051	CA	Mono, CA	R	CN	9956	10452	11785	14911	300.398	133.632	176.501	232.255
6	53	6053	CA	Monterey, CA	U1	CN	355660	361015	407051	515003	3084.493	3054.554	3954.066	5157.723
6	55	6055	CA	Napa, CA	U1	CN	110765	118054	133108	168409	654.273	933.568	1249.581	1669.063
6	57	6057	CA	Nevada, CA	R	CN	78510	88859	100190	126761	873.774	1299.834	1717.030	2259.738
6	59	6059	CA	Orange, CA	U1	CS	2410668	2636459	2972660	3761024	20297.267	21578.588	28539.732	37347.121
6	61	6061	CA	Placer, CA	U1	CN	172796	214522	241878	306025	2467.230	2125.505	2993.312	4159.591
6	63	6063	CA	Plumas, CA	R	CN	19739	20753	23399	29605	259.835	375.381	495.897	652.664
6	65	6065	CA	Riverside, CA	U1	CS	1170413	1408166	1587735	2008810	13378.886	11184.657	16047.642	22581.204
6	67	6067	CA	Sacramento, CA	U1	CN	1041219	1113868	1255908	1588981	8104.812	10066.981	14014.023	19336.895
6	69	6069	CA	San Benito, CA	U2	CN	36697	45996	51862	65616	349.000	430.780	568.919	748.639
6	71	6071	CA	San Bernardino, CA	U1	CS	1418380	1587612	1790064	2264798	14242.201	13743.626	19653.745	27599.705

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6	73	6073	CA	San Diego, CA	U1	CS	2498016	2690559	3033660	3838201	22345.061	24272.707	32746.160	44130.415
6	75	6075	CA	San Francisco, CA	U1	CN	723959	731114	824346	1042967	3050.352	6224.497	7487.116	9116.743
6	77	6077	CA	San Joaquin, CA	U1	CN	480628	533665	601717	761296	4199.542	3984.591	5179.196	6739.864
6	79	6079	CA	San Luis Obispo, CA	U2	CN	217162	230987	260442	329513	2181.333	1402.960	1977.086	2718.935
6	81	6081	CA	San Mateo, CA	U1	CN	649623	687666	775357	980985	4738.975	5693.320	6852.282	8346.821
6	83	6083	CA	Santa Barbara, CA	U1	CS	369608	387257	436641	552440	3113.958	2865.501	3720.714	4789.676
6	85	6085	CA	Santa Clara, CA	U1	CN	1497577	1593114	1796268	2272647	10233.506	14342.957	18189.032	23147.504
6	87	6087	CA	Santa Cruz, CA	U1	CN	229734	238952	269423	340875	1742.937	2155.048	2851.366	3739.127
6	89	6089	CA	Shasta, CA	U2	CN	147036	160872	181386	229491	1587.638	2361.787	3299.562	4547.640
6	91	6091	CA	Sierra, CA	R	CN	3318	3420	3856	4879	89.917	80.111	105.840	139.310
6	93	6093	CA	Siskiyou, CA	R	CN	43531	44156	49787	62990	769.818	731.868	966.777	1272.358
6	95	6095	CA	Solano, CA	U1	CN	339471	366513	413251	522847	3118.517	3382.678	4496.068	5980.119
6	97	6097	CA	Sonoma, CA	U1	CN	388222	422839	476760	603199	2277.524	4151.887	5653.944	7622.561
6	99	6099	CA	Stanislaus, CA	U1	CN	370522	414490	467346	591288	3094.552	3034.123	4081.722	5428.009
6	101	6101	CA	Sutter, CA	U2	CN	64415	75848	85521	108201	595.358	680.549	886.972	1150.654
6	103	6103	CA	Tehama, CA	R	CN	49625	53365	60170	76127	731.311	766.116	1011.970	1331.790
6	105	6105	CA	Trinity, CA	R	CN	13063	13178	14858	18799	142.269	174.669	230.700	303.600
6	107	6107	CA	Tulare, CA	U1	CN	311921	347282	391567	495412	2556.108	3070.591	4064.861	5329.864
6	109	6109	CA	Tuolumne, CA	R	CN	48456	52666	59382	75131	481.479	861.112	1137.534	1497.113
6	111	6111	CA	Ventura, CA	U1	CS	669016	717832	809370	1024019	5600.653	5913.237	7894.209	10498.589
6	113	6113	CA	Yolo, CA	U1	CN	141210	151142	170415	215610	1314.097	974.960	1259.363	1625.776
6	115	6115	CA	Yuba, CA	U2	CN	58228	61085	68874	87140	480.135	647.821	845.208	1097.164
8	1	8001	CO	Adams, CO	U1	DN	265038	308776	365983	403822	1900.551	2631.841	3465.346	4566.823
8	3	8003	CO	Alamosa, CO	U2	DN	13617	14266	16909	18657	130.336	160.214	215.037	286.256
8	5	8005	CO	Arapahoe, CO	U1	DN	391511	452960	536879	592387	2253.284	3935.160	5175.363	6815.496
8	7	8007	CO	Archuleta, CO	R	DN	5345	8062	9556	10544	76.596	136.545	183.390	244.222
8	9	8009	CO	Baca, CO	R	DN	4556	4421	5240	5781	113.275	116.388	156.319	208.174
8	11	8011	CO	Bent, CO	R	DN	5048	5418	6422	7086	76.284	128.957	173.201	230.653
8	13	8013	CO	Boulder, CO	U1	DN	225339	256434	303944	335369	1464.303	1844.138	2487.746	3341.833
8	15	8015	CO	Chaffee, CO	R	DN	12684	14688	17409	19209	193.565	206.508	277.266	369.180
8	17	8017	CO	Cheyenne, CO	R	DN	2397	2294	2719	3000	45.006	61.235	82.243	109.524
8	19	8019	CO	Clear Creek, CO	R	DN	7619	8732	10349	11419	152.764	194.637	261.411	348.138
8	21	8021	CO	Conejos, CO	R	DN	7453	7773	9213	10165	162.924	190.396	255.716	340.551
8	23	8023	CO	Costilla, CO	R	DN	3190	3578	4241	4680	64.197	81.494	109.451	145.757
8	25	8025	CO	Crowley, CO	R	DN	3946	4219	5001	5518	62.463	100.806	135.389	180.304
8	27	8027	CO	Custer, CO	R	DN	1926	3097	3671	4050	31.942	49.203	66.082	88.009
8	29	8029	CO	Delta, CO	R	DN	20980	25129	29784	32864	376.748	441.900	593.433	790.242
8	31	8031	CO	Denver, CO	U1	DN	467610	494503	586119	646718	3609.128	4527.461	5947.382	7826.583
8	33	8033	CO	Dolores, CO	R	DN	1504	1677	1988	2193	34.658	38.421	51.604	68.714
8	35	8035	CO	Douglas, CO	U1	DN	60391	116840	138487	152805	457.343	798.147	1064.459	1413.744
8	37	8037	CO	Eagle, CO	R	DN	21928	30518	36172	39912	278.440	404.628	543.326	723.477
8	39	8039	CO	Elbert, CO	R	DN	9646	16401	19440	21450	143.190	246.419	330.958	440.762
8	41	8041	CO	El Paso, CO	U1	DN	397014	468180	554919	612293	2522.579	3435.039	4629.966	6205.406
8	43	8043	CO	Fremont, CO	U2	DN	32273	41430	49105	54183	268.230	339.854	456.079	607.091

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8	45	8045	CO	Garfield, CO	R	DN	29974	36534	43302	47779	336.913	413.191	554.675	738.476
8	47	8047	CO	Gilpin, CO	R	DN	3070	3839	4550	5021	51.027	78.426	105.334	140.267
8	49	8049	CO	Grand, CO	R	DN	7966	9575	11349	12522	156.257	203.502	273.316	363.996
8	51	8051	CO	Gunnison, CO	R	DN	10273	11923	14132	15593	124.929	147.349	197.814	263.368
8	53	8053	CO	Hinsdale, CO	R	DN	467	665	788	870	8.528	11.931	16.023	21.349
8	55	8055	CO	Huerfano, CO	U2	DN	6009	6620	7847	8658	67.445	71.586	96.084	127.898
8	57	8057	CO	Jackson, CO	R	DN	1605	1543	1829	2018	38.947	41.001	55.068	73.338
8	59	8059	CO	Jefferson, CO	U1	DN	438430	488338	578812	638656	3098.662	4682.892	6173.860	8142.603
8	61	8061	CO	Kiowa, CO	R	DN	1688	1669	1978	2183	40.467	43.121	57.916	77.132
8	63	8063	CO	Kit Carson, CO	R	DN	7140	7169	8497	9376	105.939	109.417	146.899	195.577
8	65	8065	CO	Lake, CO	R	DN	6007	6278	7441	8210	118.527	86.529	116.165	154.665
8	67	8067	CO	La Plata, CO	R	DN	32284	39022	46252	51034	378.698	516.165	693.013	922.725
8	69	8069	CO	Larimer, CO	U2	DN	186136	220323	261142	288142	1439.269	1779.440	2473.544	3415.574
8	71	8071	CO	Las Animas, CO	U2	DN	13765	14385	17050	18813	146.856	138.648	186.053	247.654
8	73	8073	CO	Lincoln, CO	R	DN	4529	5456	6467	7136	97.481	115.699	155.392	206.947
8	75	8075	CO	Logan, CO	U2	DN	17567	18026	21365	23574	220.023	191.441	256.921	342.003
8	77	8077	CO	Mesa, CO	U2	DN	93145	108176	128217	141474	842.460	997.717	1305.775	1697.810
8	79	8079	CO	Mineral, CO	R	DN	558	661	783	864	16.808	14.254	19.146	25.489
8	81	8081	CO	Moffat, CO	U2	DN	11357	12158	14410	15900	136.034	89.274	119.747	159.360
8	83	8083	CO	Montezuma, CO	R	DN	18672	21755	25786	28452	224.310	296.178	397.651	529.456
8	85	8085	CO	Montrose, CO	R	DN	24423	29442	34896	38504	360.522	404.119	542.595	722.466
8	87	8087	CO	Morgan, CO	U2	DN	21939	24690	29265	32291	251.790	232.056	311.417	414.526
8	89	8089	CO	Otero, CO	U2	DN	20185	20762	24608	27153	247.947	222.671	298.841	397.800
8	91	8091	CO	Ouray, CO	R	DN	2295	3071	3640	4016	40.243	58.630	78.742	104.864
8	93	8093	CO	Park, CO	R	DN	7174	11936	14148	15610	111.482	183.267	246.143	327.802
8	95	8095	CO	Phillips, CO	R	DN	4189	4312	5110	5639	94.943	107.013	143.726	191.411
8	97	8097	CO	Pitkin, CO	R	DN	12661	13446	15937	17585	153.466	198.101	265.970	354.129
8	99	8099	CO	Prowers, CO	U2	DN	13347	13608	16130	17797	141.872	133.853	179.618	239.075
8	101	8101	CO	Pueblo, CO	U2	DN	123051	131494	155856	171970	917.453	1005.416	1192.359	1436.978
8	103	8103	CO	Rio Blanco, CO	R	DN	6051	6253	7412	8178	130.753	152.562	204.903	272.874
8	105	8105	CO	Rio Grande, CO	R	DN	10770	11313	13408	14795	153.275	167.793	225.275	299.943
8	107	8107	CO	Routt, CO	R	DN	14088	16781	19890	21947	193.379	193.695	260.018	346.193
8	109	8109	CO	Saguache, CO	R	DN	4619	5722	6782	7484	82.256	117.999	158.482	211.050
8	111	8111	CO	San Juan, CO	R	DN	745	584	692	764	17.411	19.033	25.562	34.034
8	113	8113	CO	San Miguel, CO	R	DN	3653	5084	6025	6648	66.727	93.321	125.336	166.914
8	115	8115	CO	Sedgwick, CO	R	DN	2690	2616	3101	3422	68.271	68.720	92.294	122.917
8	117	8117	CO	Summit, CO	R	DN	12881	17670	20944	23109	184.954	329.061	441.952	588.576
8	119	8119	CO	Teller, CO	R	DN	12468	18744	22217	24514	123.088	204.069	273.994	364.816
8	121	8121	CO	Washington, CO	R	DN	4812	4653	5516	6086	110.874	122.928	165.103	219.873
8	123	8123	CO	Weld, CO	U2	DN	131821	152188	180383	199033	1505.523	1768.892	2347.382	3088.859
8	125	8125	CO	Yuma, CO	R	DN	8954	9312	11038	12179	154.299	161.220	216.476	288.256
9	1	9001	CT	Fairfield, CT	U1	NY	827645	832505	852322	920334	6906.317	7232.493	8791.108	10938.557
9	3	9003	CT	Hartford, CT	U1	PA	851783	828947	848679	916400	7231.961	7679.935	9433.033	11794.603
9	5	9005	CT	Litchfield, CT	U1	NY	174092	180083	184370	199082	915.068	1174.496	1454.348	1824.232

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9	7	9007	CT	Middlesex, CT	U1	PA	143196	148179	151707	163812	1256.860	1298.312	1607.094	2018.804
9	9	9009	CT	New Haven, CT	U1	NY	804219	793917	812815	877675	6055.841	6274.963	7628.494	9492.894
9	11	9011	CT	New London, CT	U1	PA	254957	253244	259272	279961	2155.069	2586.898	3183.042	3988.774
9	13	9013	CT	Tolland, CT	U1	PA	128699	130691	133802	144479	1049.663	1103.598	1370.178	1724.276
9	15	9015	CT	Windham, CT	U1	PA	102525	104757	107251	115809	734.241	707.749	880.502	1107.576
10	1	10001	DE	Kent, DE	U2	PA	110993	121035	134217	140892	1205.669	1371.140	1742.709	2226.366
10	3	10003	DE	New Castle, DE	U1	PA	441946	470139	521342	547267	3898.965	4687.206	5898.284	7478.722
10	5	10005	DE	Sussex, DE	R	PA	113229	131062	145336	152563	1902.655	1585.696	2035.803	2614.127
11	1	11001	DC	District of Columbia, DC	U1	PA	606900	540098	534379	615719	3136.300	3306.832	4271.816	5562.260
12	1	12001	FL	Alachua, FL	U2	FL	181596	195936	227865	267120	1906.976	2141.480	2847.656	3804.797
12	3	12003	FL	Baker, FL	R	FL	18486	20436	23766	27860	253.167	248.600	341.670	466.973
12	5	12005	FL	Bay, FL	U2	FL	126994	143476	166856	195601	1163.195	1588.128	2104.890	2799.107
12	7	12007	FL	Bradford, FL	R	FL	22515	24342	28308	33185	189.281	296.267	407.175	556.501
12	9	12009	FL	Brevard, FL	U1	FL	398978	452120	525795	616377	3123.533	4007.588	5525.583	7589.852
12	11	12011	FL	Broward, FL	U1	FL	1255531	1440011	1674669	1963174	8190.810	12332.745	16503.497	22271.491
12	13	12013	FL	Calhoun, FL	R	FL	11011	12148	14127	16561	95.097	186.975	257.015	351.305
12	15	12015	FL	Charlotte, FL	U2	FL	110975	130437	151693	177826	809.223	1103.229	1681.786	2512.292
12	17	12017	FL	Citrus, FL	R	FL	93513	109748	127632	149620	449.842	1110.602	1526.233	2085.823
12	19	12019	FL	Clay, FL	U1	FL	105986	131009	152357	178605	447.098	1278.653	1704.042	2283.216
12	21	12021	FL	Collier, FL	U2	FL	152099	189498	220378	258343	1166.625	1430.794	2147.864	3168.782
12	23	12023	FL	Columbia, FL	R	FL	42613	51393	59767	70064	771.526	505.136	694.178	948.699
12	25	12025	FL	Dade, FL	U1	FL	1937194	2029256	2359934	2766494	11679.388	14589.632	18325.694	23050.577
12	27	12027	FL	DeSoto, FL	R	FL	23865	25917	30140	35333	198.593	230.156	316.225	432.113
12	29	12029	FL	Dixie, FL	R	FL	10585	12280	14282	16742	83.134	179.741	247.072	337.709
12	31	12031	FL	Duval, FL	U1	FL	672971	724100	842096	987169	5914.323	7550.319	9970.077	13284.924
12	33	12033	FL	Escambia, FL	U1	FL	262798	279775	325365	381418	2180.633	3209.330	4105.979	5291.247
12	35	12035	FL	Flagler, FL	U2	FL	28701	43638	50750	59492	397.787	189.252	266.664	370.583
12	37	12037	FL	Franklin, FL	R	FL	8967	9966	11591	13587	71.743	107.691	147.995	202.253
12	39	12039	FL	Gadsden, FL	R	FL	41116	44823	52127	61108	506.438	503.258	698.336	964.320
12	41	12041	FL	Gilchrist, FL	R	FL	9667	12838	14931	17503	69.728	164.152	225.646	308.415
12	43	12043	FL	Glades, FL	R	FL	7591	9397	10928	12811	77.753	128.900	177.186	242.193
12	45	12045	FL	Gulf, FL	R	FL	11504	13580	15793	18514	78.686	128.758	176.931	241.796
12	47	12047	FL	Hamilton, FL	R	FL	10930	12294	14297	16760	351.194	185.600	255.124	348.717
12	49	12049	FL	Hardee, FL	R	FL	19499	21740	25282	29638	124.898	277.541	381.463	521.374
12	51	12051	FL	Hendry, FL	R	FL	25773	30797	35815	41985	142.373	247.735	340.377	465.116
12	53	12053	FL	Hernando, FL	U1	FL	101115	122048	141937	166389	754.294	1006.215	1352.641	1814.540
12	55	12055	FL	Highlands, FL	R	FL	68432	75651	87979	103135	416.323	883.048	1213.603	1658.634
12	57	12057	FL	Hillsborough, FL	U1	FL	834054	898674	1045118	1225166	6480.339	7660.187	10204.083	13612.342
12	59	12059	FL	Holmes, FL	R	FL	15778	18010	20945	24553	207.785	224.170	308.108	421.109
12	61	12061	FL	Indian River, FL	U2	FL	90208	97928	113886	133506	799.427	896.952	1215.820	1648.021
12	63	12063	FL	Jackson, FL	R	FL	41375	45087	52434	61468	643.132	554.921	762.672	1042.369
12	65	12065	FL	Jefferson, FL	R	FL	11296	12955	15067	17662	245.777	150.253	206.501	282.230
12	67	12067	FL	Lafayette, FL	R	FL	5578	6187	7196	8435	52.340	94.718	130.199	177.972
12	69	12069	FL	Lake, FL	R	FL	152104	189913	220860	258909	1080.672	1501.160	2210.250	3206.377

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12	71	12071	FL	Lee, FL	U1	FL	335113	379666	441534	517600	2500.721	3250.893	4611.456	6505.879
12	73	12073	FL	Leon, FL	U2	FL	192493	211930	246466	288926	1503.178	2194.260	3001.484	4109.545
12	75	12075	FL	Levy, FL	R	FL	25912	31348	36456	42737	202.871	440.191	605.088	827.062
12	77	12077	FL	Liberty, FL	R	FL	5569	6541	7607	8917	68.641	94.566	129.990	177.684
12	79	12079	FL	Madison, FL	R	FL	16569	17417	20255	23744	314.569	226.025	310.648	424.580
12	81	12081	FL	Manatee, FL	U2	FL	211707	233506	271557	318340	1442.705	1842.233	2606.779	3672.758
12	83	12083	FL	Marion, FL	R	FL	194835	231240	268922	315251	1956.260	2883.286	4138.499	5874.712
12	85	12085	FL	Martin, FL	U1	FL	100900	113917	132481	155304	1098.275	984.433	1434.146	2053.707
12	87	12087	FL	Monroe, FL	U2	FL	78024	81363	94621	110922	669.873	384.184	527.309	720.122
12	89	12089	FL	Nassau, FL	U1	FL	43941	52645	61224	71772	561.407	421.362	567.037	764.190
12	91	12091	FL	Okaloosa, FL	U2	FL	143777	164180	190934	223827	1220.432	1605.571	2184.213	2973.044
12	93	12093	FL	Okeechobee, FL	R	FL	29627	32606	37919	44451	183.392	356.486	489.902	669.535
12	95	12095	FL	Orange, FL	U1	FL	677491	768762	894036	1048057	5476.736	7952.857	11508.377	16521.077
12	97	12097	FL	Osceola, FL	U1	FL	107728	137214	159573	187064	1335.519	651.412	958.474	1389.896
12	99	12099	FL	Palm Beach, FL	U1	FL	863503	996378	1158743	1358367	5748.220	7919.972	10855.736	14873.902
12	101	12101	FL	Pasco, FL	U1	FL	281131	314664	365940	428983	1626.295	3023.376	4052.602	5426.939
12	103	12103	FL	Pinellas, FL	U1	FL	851659	868894	1010484	1184566	5214.478	7508.295	9963.782	13260.606
12	105	12105	FL	Polk, FL	U1	FL	405382	442465	514568	603215	3543.012	4930.908	6458.764	8483.898
12	107	12107	FL	Putnam, FL	R	FL	65070	69664	81016	94974	356.359	936.960	1287.804	1760.142
12	109	12109	FL	St. Johns, FL	U1	FL	83829	108582	126276	148030	766.041	790.194	1059.113	1423.944
12	111	12111	FL	St. Lucie, FL	U1	FL	150171	175361	203937	239070	2096.173	1969.599	2858.585	4084.193
12	113	12113	FL	Santa Rosa, FL	U1	FL	81608	109785	127675	149670	1882.635	1105.353	1428.263	1851.628
12	115	12115	FL	Sarasota, FL	U1	FL	277776	298234	346833	406584	1005.581	2190.230	3094.564	4356.064
12	117	12117	FL	Seminole, FL	U1	FL	287521	336556	391400	458829	1463.368	3425.590	4957.423	7117.020
12	119	12119	FL	Sumter, FL	R	FL	31577	38306	44549	52223	606.010	435.639	598.745	818.335
12	121	12121	FL	Suwannee, FL	R	FL	26780	32177	37421	43868	418.322	350.478	481.678	658.325
12	123	12123	FL	Taylor, FL	R	FL	17111	18488	21501	25205	185.201	172.804	237.437	324.469
12	125	12125	FL	Union, FL	R	FL	10252	12058	14023	16439	68.036	174.085	239.300	327.084
12	127	12127	FL	Volusia, FL	U1	FL	370737	412788	480055	562756	3171.235	3685.421	5124.205	7064.837
12	129	12129	FL	Wakulla, FL	R	FL	14202	18462	21470	25169	109.632	241.160	331.499	453.111
12	131	12131	FL	Walton, FL	R	FL	27759	36463	42405	49711	481.420	382.984	526.184	719.004
12	133	12133	FL	Washington, FL	R	FL	16919	19749	22968	26924	243.268	223.637	307.358	420.073
13	1	13001	GA	Appling, GA	R	SE	15744	16300	19044	21186	155.479	191.944	251.262	327.833
13	3	13003	GA	Atkinson, GA	R	SE	6213	6958	8129	9043	85.823	95.943	125.699	164.089
13	5	13005	GA	Bacon, GA	R	SE	9566	10234	11956	13301	76.330	98.911	129.388	168.755
13	7	13007	GA	Baker, GA	R	SE	3615	3716	4342	4830	45.733	55.825	73.137	95.473
13	9	13009	GA	Baldwin, GA	U2	SE	39530	41595	48595	54062	277.031	308.794	403.330	525.558
13	11	13011	GA	Banks, GA	R	SE	10308	12129	14170	15764	142.330	159.178	208.546	272.246
13	13	13013	GA	Barrow, GA	U1	AT	29721	37645	43981	48928	245.559	318.742	435.103	588.198
13	15	13015	GA	Bartow, GA	R	AT	55915	67286	78610	87453	1017.341	708.305	966.641	1306.562
13	17	13017	GA	Ben Hill, GA	U2	SE	16245	17182	20074	22332	119.325	136.106	177.847	231.804
13	19	13019	GA	Berrien, GA	R	SE	14153	15709	18352	20417	118.880	154.833	202.593	264.267
13	21	13021	GA	Bibb, GA	U1	SE	150137	155141	181251	201640	1542.745	2129.876	2614.384	3250.489
13	23	13023	GA	Bleckley, GA	R	SE	10430	11045	12903	14355	96.156	102.566	134.136	174.924

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13	25	13025	GA	Brantley, GA	R	SE	11077	13051	15247	16963	100.718	171.055	224.104	292.552
13	27	13027	GA	Brooks, GA	R	SE	15398	16487	19261	21428	156.119	167.265	218.850	285.467
13	29	13029	GA	Bryan, GA	R	SE	15438	21999	25702	28593	302.696	198.582	254.358	325.611
13	31	13031	GA	Bulloch, GA	R	SE	43125	48902	57132	63559	416.616	454.693	594.847	775.856
13	33	13033	GA	Burke, GA	R	SE	20579	22418	26191	29138	209.329	241.820	316.506	412.934
13	35	13035	GA	Butts, GA	U1	SE	15326	16937	19787	22013	190.469	182.355	238.688	311.420
13	37	13037	GA	Calhoun, GA	R	SE	5013	5063	5915	6580	51.818	77.412	101.421	132.392
13	39	13039	GA	Camden, GA	U2	SE	30167	43012	50251	55904	512.190	253.232	330.901	431.291
13	43	13043	GA	Candler, GA	R	SE	7744	8743	10214	11363	114.544	70.189	91.756	119.624
13	45	13045	GA	Carroll, GA	R	AT	71422	79976	93436	103947	705.870	803.038	1096.431	1482.397
13	47	13047	GA	Catoosa, GA	U1	SE	42464	48552	56724	63104	543.010	594.352	747.017	946.041
13	49	13049	GA	Charlton, GA	R	SE	8496	9161	10703	11907	118.688	131.199	171.887	224.382
13	51	13051	GA	Chatham, GA	U2	SE	216774	224625	262429	291951	1943.630	2633.090	3313.140	4195.546
13	53	13053	GA	Chattahoochee, GA	U2	SE	16934	16408	19169	21325	54.908	170.892	205.878	251.205
13	55	13055	GA	Chattooga, GA	R	SE	22242	22825	26666	29666	151.715	276.510	361.990	472.349
13	57	13057	GA	Cherokee, GA	U1	AT	90204	121605	142070	158052	644.016	1389.374	1883.586	2535.947
13	59	13059	GA	Clarke, GA	U2	SE	87594	90549	105789	117689	702.801	1294.514	1650.366	2124.017
13	61	13061	GA	Clay, GA	R	SE	3364	3447	4027	4480	27.216	51.949	68.059	88.852
13	63	13063	GA	Clayton, GA	U1	AT	181436	200945	234764	261173	1751.812	3129.365	4197.315	5614.821
13	65	13065	GA	Clinch, GA	R	SE	6160	6572	7678	8542	78.184	61.106	79.918	104.216
13	67	13067	GA	Cobb, GA	U1	AT	447745	536300	626558	697041	3875.894	7682.065	10306.289	13788.967
13	69	13069	GA	Coffee, GA	R	SE	29592	33288	38890	43265	258.469	317.535	415.444	541.886
13	71	13071	GA	Colquitt, GA	R	SE	36645	39192	45787	50938	266.751	367.871	481.153	627.480
13	73	13073	GA	Columbia, GA	U1	SE	66031	85558	99957	111201	515.429	819.585	1053.752	1361.947
13	75	13075	GA	Cook, GA	R	SE	13456	14460	16893	18794	298.957	139.740	182.802	238.413
13	77	13077	GA	Coweta, GA	U1	AT	53853	76829	89759	99856	678.366	659.827	901.215	1218.708
13	79	13079	GA	Crawford, GA	R	SE	8991	10751	12560	13973	92.523	138.843	181.902	237.456
13	81	13081	GA	Crisp, GA	U2	SE	20011	20569	24031	26734	342.242	171.487	224.110	292.122
13	83	13083	GA	Dade, GA	U1	SE	13147	14447	16879	18777	201.832	201.848	256.147	326.266
13	85	13085	GA	Dawson, GA	R	SE	9429	13240	15468	17208	81.992	145.604	190.763	249.021
13	87	13087	GA	Decatur, GA	R	SE	25517	26457	30910	34387	243.491	251.209	328.537	428.423
13	89	13089	GA	DeKalb, GA	R	AT	546171	581793	679708	756169	5295.297	9397.459	12600.254	16852.121
13	91	13091	GA	Dodge, GA	R	SE	17607	18112	21160	23540	144.545	203.229	265.976	346.993
13	93	13093	GA	Dooly, GA	R	SE	9901	10340	12080	13439	289.334	116.810	152.889	199.470
13	95	13095	GA	Dougherty, GA	U2	SE	96321	95874	112010	124610	784.803	1128.595	1385.966	1725.368
13	97	13097	GA	Douglas, GA	U1	AT	71120	84434	98644	109741	785.442	1190.830	1603.791	2150.732
13	99	13099	GA	Early, GA	R	SE	11854	12109	14147	15739	135.909	108.499	141.845	184.932
13	101	13101	GA	Echols, GA	R	SE	2334	2409	2815	3132	27.877	36.043	47.221	61.638
13	103	13103	GA	Effingham, GA	R	SE	25687	33724	39399	43831	209.492	359.517	460.629	589.793
13	105	13105	GA	Elbert, GA	R	SE	18949	19108	22323	24835	156.056	216.903	283.863	370.323
13	107	13107	GA	Emanuel, GA	R	SE	20546	20942	24466	27219	226.476	219.190	286.771	374.042
13	109	13109	GA	Evans, GA	R	SE	8724	9600	11216	12477	75.597	134.719	176.499	230.409
13	111	13111	GA	Fannin, GA	R	SE	15992	17790	20784	23122	118.612	246.953	323.542	422.360
13	113	13113	GA	Fayette, GA	U1	AT	62415	81814	95583	106335	416.662	597.140	814.189	1099.905

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13	115	13115	GA	Floyd, GA	U2	SE	81251	84156	98319	109379	796.350	1222.696	1582.162	2050.071
13	117	13117	GA	Forsyth, GA	U1	AT	44083	71225	83212	92573	440.107	643.461	879.413	1189.667
13	119	13119	GA	Franklin, GA	R	SE	16650	18247	21318	23716	322.270	228.680	299.482	390.869
13	121	13121	GA	Fulton, GA	U1	AT	648779	712003	831831	925406	7425.434	11119.089	14913.176	19949.178
13	123	13123	GA	Gilmer, GA	R	SE	13368	17245	20147	22414	155.443	206.433	270.456	353.051
13	125	13125	GA	Glascock, GA	R	SE	2357	2471	2887	3212	19.172	36.397	47.686	62.253
13	127	13127	GA	Glynn, GA	U2	SE	62496	66057	77174	85855	684.247	821.124	1059.764	1370.989
13	129	13129	GA	Gordon, GA	R	SE	35067	39544	46199	51396	548.042	446.517	584.609	762.862
13	131	13131	GA	Grady, GA	R	SE	20279	21334	24925	27728	188.784	192.761	252.052	328.656
13	133	13133	GA	Greene, GA	R	SE	11793	13171	15388	17119	197.193	144.002	188.505	245.963
13	135	13135	GA	Gwinnett, GA	U1	AT	352910	479687	560417	623459	3086.164	5799.866	7792.801	10435.548
13	137	13137	GA	Habersham, GA	R	SE	27622	30686	35851	39884	256.772	384.160	503.125	656.657
13	139	13139	GA	Hall, GA	R	SE	95434	113102	132137	147002	868.835	1233.004	1614.417	2106.735
13	141	13141	GA	Hancock, GA	R	SE	8908	8978	10489	11669	70.506	137.560	180.222	235.267
13	143	13143	GA	Haralson, GA	R	SE	21966	23841	27854	30987	226.830	244.810	320.350	417.894
13	145	13145	GA	Harris, GA	R	SE	17788	21593	25227	28065	235.705	264.827	324.018	399.079
13	147	13147	GA	Hart, GA	R	SE	19712	21229	24802	27592	164.011	235.508	308.264	402.208
13	149	13149	GA	Heard, GA	R	SE	8628	9777	11423	12708	70.664	133.236	174.557	227.875
13	151	13151	GA	Henry, GA	U1	AT	58741	92480	108044	120198	819.573	846.749	1153.251	1556.934
13	153	13153	GA	Houston, GA	U1	SE	89208	101495	118577	131915	813.416	924.768	1138.214	1417.466
13	155	13155	GA	Irwin, GA	R	SE	8649	8922	10424	11597	89.170	91.414	119.592	155.972
13	157	13157	GA	Jackson, GA	R	SE	30005	35552	41536	46208	487.625	375.333	491.378	641.183
13	159	13159	GA	Jasper, GA	R	SE	8453	9670	11298	12568	74.257	130.533	171.017	223.258
13	161	13161	GA	Jeff Davis, GA	R	SE	12032	12533	14642	16289	117.830	129.809	169.839	221.533
13	163	13163	GA	Jefferson, GA	R	SE	17408	17783	20775	23112	172.554	268.821	352.190	459.764
13	165	13165	GA	Jenkins, GA	R	SE	8247	8389	9801	10904	74.055	76.610	100.163	130.595
13	167	13167	GA	Johnson, GA	R	SE	8329	8341	9745	10841	79.310	128.618	168.507	219.983
13	169	13169	GA	Jones, GA	U1	SE	20739	22363	26127	29066	181.621	314.746	391.406	490.463
13	171	13171	GA	Lamar, GA	R	SE	13038	14438	16868	18765	148.274	138.084	180.648	235.626
13	173	13173	GA	Lanier, GA	R	SE	5531	6634	7751	8623	48.270	85.413	111.899	146.085
13	175	13175	GA	Laurens, GA	R	SE	39988	43000	50237	55888	480.607	366.515	479.159	624.710
13	177	13177	GA	Lee, GA	R	SE	16250	21071	24617	27386	126.040	237.489	295.680	371.149
13	179	13179	GA	Liberty, GA	U2	SE	52745	58978	68904	76655	396.275	342.873	447.287	582.406
13	181	13181	GA	Lincoln, GA	R	SE	7442	8002	9348	10400	60.970	114.922	150.562	196.553
13	183	13183	GA	Long, GA	R	SE	6202	8037	9390	10446	67.263	95.773	125.477	163.789
13	185	13185	GA	Lowndes, GA	U2	SE	75981	82837	96779	107665	807.182	642.768	839.947	1094.812
13	187	13187	GA	Lumpkin, GA	R	SE	14573	17614	20579	22893	129.315	183.547	240.301	313.566
13	189	13189	GA	McDuffie, GA	U1	SE	20119	21378	24976	27786	241.103	219.247	284.974	370.726
13	191	13191	GA	McIntosh, GA	R	SE	8634	9749	11390	12671	309.862	133.328	174.678	228.045
13	193	13193	GA	Macon, GA	R	SE	13114	13233	15460	17199	96.527	142.466	186.407	243.146
13	195	13195	GA	Madison, GA	R	SE	21050	23935	27963	31109	179.365	325.061	421.136	547.252
13	197	13197	GA	Marion, GA	R	SE	5590	6394	7470	8310	52.392	86.322	113.093	147.640
13	199	13199	GA	Meriwether, GA	R	SE	22411	22837	26680	29682	201.854	293.137	383.832	500.901
13	201	13201	GA	Miller, GA	R	SE	6280	6280	7337	8162	58.398	96.978	127.053	165.856

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
13	205	13205	GA	Mitchell, GA	R	SE	20275	20967	24495	27251	175.663	194.805	254.739	332.172
13	207	13207	GA	Monroe, GA	R	SE	17113	18961	22152	24644	556.620	207.393	271.480	354.212
13	209	13209	GA	Montgomery, GA	R	SE	7379	7694	8989	10001	67.480	109.241	143.114	186.819
13	211	13211	GA	Morgan, GA	R	SE	12883	14321	16732	18614	286.204	152.533	199.648	260.470
13	213	13213	GA	Murray, GA	R	SE	26147	31116	36353	40442	208.228	365.448	478.627	624.695
13	215	13215	GA	Muscogee, GA	U2	SE	179280	182271	212946	236901	1167.879	1692.824	2033.026	2476.007
13	217	13217	GA	Newton, GA	U1	AT	41808	53242	62203	69200	385.688	512.015	699.325	945.698
13	219	13219	GA	Oconee, GA	R	SE	17618	22287	26038	28967	141.412	271.396	351.294	456.260
13	221	13221	GA	Oglethorpe, GA	R	SE	9763	11032	12888	14338	87.402	150.763	197.520	257.842
13	223	13223	GA	Paulding, GA	U1	AT	41611	65055	76003	84553	268.252	607.633	830.448	1123.434
13	225	13225	GA	Peach, GA	U1	SE	21189	23644	27623	30730	319.525	217.914	271.450	340.488
13	227	13227	GA	Pickens, GA	R	AT	14432	17982	21009	23372	150.787	222.864	304.641	412.166
13	229	13229	GA	Pierce, GA	R	SE	13328	15175	17729	19723	119.284	160.402	209.964	273.953
13	231	13231	GA	Pike, GA	R	SE	10224	12067	14098	15684	91.253	157.882	206.847	270.016
13	233	13233	GA	Polk, GA	R	SE	33815	35526	41505	46174	269.753	371.155	485.646	633.493
13	235	13235	GA	Pulaski, GA	R	SE	8108	8304	9702	10793	70.856	78.208	102.273	133.350
13	237	13237	GA	Putnam, GA	R	SE	14137	16472	19244	21409	133.912	155.186	203.058	264.871
13	239	13239	GA	Quitman, GA	R	SE	2210	2411	2816	3133	25.940	34.111	44.693	58.336
13	241	13241	GA	Rabun, GA	R	SE	11648	13018	15209	16919	104.497	179.872	235.657	307.625
13	243	13243	GA	Randolph, GA	R	SE	8023	7916	9248	10288	67.186	74.189	96.997	126.462
13	245	13245	GA	Richmond, GA	U1	SE	189719	192615	225032	250346	1537.066	2182.698	2792.526	3598.578
13	247	13247	GA	Rockdale, GA	U1	AT	54091	65199	76172	84740	419.913	874.237	1184.870	1594.966
13	249	13249	GA	Schley, GA	R	SE	3590	3800	4440	4939	31.067	55.407	72.592	94.760
13	251	13251	GA	Screven, GA	R	SE	13842	14322	16732	18615	129.000	175.523	229.803	299.865
13	253	13253	GA	Seminole, GA	R	SE	9010	9708	11342	12617	74.516	102.345	133.933	174.733
13	255	13255	GA	Spalding, GA	U1	AT	54457	56613	66141	73581	399.168	504.002	687.508	929.025
13	257	13257	GA	Stephens, GA	R	SE	23436	24981	29186	32469	176.458	248.996	325.767	424.923
13	259	13259	GA	Stewart, GA	R	SE	5654	5454	6372	7089	77.655	87.312	114.388	149.334
13	261	13261	GA	Sumter, GA	U2	SE	30232	31477	36775	40912	220.876	246.765	322.397	420.168
13	263	13263	GA	Talbot, GA	R	SE	6524	6842	7993	8893	76.403	98.919	129.591	169.174
13	265	13265	GA	Taliaferro, GA	R	SE	1915	1865	2179	2424	81.207	29.571	38.743	50.583
13	267	13267	GA	Tattnall, GA	R	SE	17722	18865	22040	24520	138.266	224.686	294.167	383.869
13	269	13269	GA	Taylor, GA	R	SE	7642	8133	9502	10571	79.608	118.010	154.609	201.837
13	271	13271	GA	Telfair, GA	R	SE	11000	11399	13317	14815	101.524	129.691	169.748	221.466
13	273	13273	GA	Terrell, GA	R	SE	10653	11034	12890	14341	107.272	93.950	122.799	160.086
13	275	13275	GA	Thomas, GA	R	SE	38943	42043	49119	54645	324.018	369.416	483.036	629.834
13	277	13277	GA	Tift, GA	R	SE	34998	36621	42785	47598	453.522	312.404	408.361	532.352
13	279	13279	GA	Toombs, GA	U2	SE	24072	25394	29667	33005	201.051	165.588	216.101	281.452
13	281	13281	GA	Towns, GA	R	SE	6754	7965	9306	10352	55.946	104.297	136.644	178.377
13	283	13283	GA	Treutlen, GA	R	SE	5994	5964	6968	7752	111.748	55.292	72.286	94.251
13	285	13285	GA	Troup, GA	U2	SE	55532	58116	67897	75535	651.325	442.832	578.478	753.846
13	287	13287	GA	Turner, GA	U2	SE	8703	9086	10615	11809	231.467	70.074	91.546	119.288
13	289	13289	GA	Twiggs, GA	R	SE	9806	9863	11522	12819	201.290	151.427	188.924	237.194
13	291	13291	GA	Union, GA	R	SE	11993	15149	17699	19689	109.260	185.200	242.636	316.746

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13	293	13293	GA	Upson, GA	R	SE	26300	27098	31659	35220	181.729	284.513	372.256	485.566
13	295	13295	GA	Walker, GA	U1	SE	58340	61347	71671	79734	400.269	706.195	889.158	1127.262
13	297	13297	GA	Walton, GA	U1	AT	38586	49689	58051	64581	324.458	396.432	541.052	731.340
13	299	13299	GA	Ware, GA	R	SE	35471	35768	41787	46488	305.891	331.433	433.339	565.013
13	301	13301	GA	Warren, GA	R	SE	6078	6044	7061	7855	136.373	93.858	122.968	160.515
13	303	13303	GA	Washington, GA	R	SE	19112	19872	23217	25828	160.659	211.318	276.515	360.707
13	305	13305	GA	Wayne, GA	R	SE	22356	24681	28834	32078	206.499	225.861	295.423	385.277
13	307	13307	GA	Webster, GA	R	SE	2263	2256	2636	2932	39.056	34.945	45.783	59.773
13	309	13309	GA	Wheeler, GA	R	SE	4903	4947	5779	6429	57.550	75.714	99.194	129.498
13	311	13311	GA	White, GA	R	SE	13006	16282	19022	21162	115.282	200.843	263.131	343.494
13	313	13313	GA	Whitfield, GA	R	SE	72462	80052	93525	104045	857.192	829.012	1084.933	1415.384
13	315	13315	GA	Wilcox, GA	R	SE	7008	7265	8488	9443	58.778	108.221	141.782	185.083
13	317	13317	GA	Wilkes, GA	R	SE	10597	10556	12332	13720	126.848	106.623	139.459	181.873
13	319	13319	GA	Wilkinson, GA	R	SE	10228	10769	12581	13997	107.221	157.944	206.929	270.122
13	321	13321	GA	Worth, GA	R	SE	19744	21987	25688	28577	221.202	228.928	299.617	390.883
15	1	15001	HI	Hawaii, HI	U2	FL	120317	138438	159555	193940	1303.243	913.323	1193.196	1559.040
15	3	15003	HI	Honolulu, HI	U1	FL	836231	865053	997008	1211867	5399.338	6172.309	7687.797	9657.241
15	5	15005	HI	Kalawao, HI	R	FL	130	88	101	123	3.113	2.284	2.990	3.909
15	7	15007	HI	Kauai, HI	U2	FL	51177	55674	64166	77994	545.380	435.595	569.273	743.968
15	9	15009	HI	Maui, HI	U2	FL	100374	116153	133871	162721	814.333	482.966	629.798	821.997
16	1	16001	ID	Ada, ID	U2	ID	205775	258398	324860	361925	1557.533	2767.099	3712.992	4907.852
16	3	16003	ID	Adams, ID	R	ID	3254	3773	4743	5284	52.656	65.718	85.444	109.490
16	5	16005	ID	Bannock, ID	U2	ID	66026	72732	91440	101872	482.934	769.324	986.222	1253.193
16	7	16007	ID	Bear Lake, ID	R	ID	6084	6507	8180	9113	76.310	80.688	104.705	134.008
16	9	16009	ID	Benewah, ID	R	SP	7937	8820	11088	12354	101.015	160.297	208.411	267.059
16	11	16011	ID	Bingham, ID	R	ID	37583	41044	51601	57488	433.246	510.689	662.777	848.392
16	13	16013	ID	Blaine, ID	R	ID	13552	16690	20983	23377	154.829	168.319	218.335	279.389
16	15	16015	ID	Boise, ID	R	ID	3509	4809	6046	6736	47.183	70.868	92.140	118.072
16	17	16017	ID	Bonner, ID	R	SP	26622	33607	42251	47071	333.157	448.913	583.230	747.037
16	19	16019	ID	Bonneville, ID	U2	ID	72207	79139	99494	110846	571.698	851.333	1093.302	1390.752
16	21	16021	ID	Boundary, ID	R	SP	8332	9661	12145	13531	114.678	168.271	218.783	280.348
16	23	16023	ID	Butte, ID	R	ID	2918	3109	3909	4355	52.579	58.931	76.621	98.184
16	25	16025	ID	Camas, ID	R	ID	727	826	1039	1158	12.869	14.681	19.090	24.462
16	27	16027	ID	Canyon, ID	U2	ID	90076	112875	141908	158099	866.620	1025.631	1394.586	1858.214
16	29	16029	ID	Caribou, ID	R	ID	6963	7320	9203	10253	94.116	87.835	113.945	145.813
16	31	16031	ID	Cassia, ID	R	ID	19532	21168	26613	29649	215.818	251.592	326.418	417.766
16	33	16033	ID	Clark, ID	R	ID	762	826	1039	1157	12.556	15.388	20.008	25.648
16	35	16035	ID	Clearwater, ID	R	ID	8505	9319	11716	13053	124.362	123.100	159.815	204.615
16	37	16037	ID	Custer, ID	R	ID	4133	4226	5314	5920	53.260	83.471	108.526	139.060
16	39	16039	ID	Elmore, ID	U2	ID	21205	24355	30619	34113	192.361	193.256	250.128	319.654
16	41	16041	ID	Franklin, ID	R	ID	9232	10590	13313	14832	100.331	123.529	160.304	205.191
16	43	16043	ID	Fremont, ID	R	ID	10937	11692	14699	16377	136.277	169.741	220.442	282.297
16	45	16045	ID	Gem, ID	R	ID	11844	14081	17703	19723	139.830	161.128	209.114	267.680
16	47	16047	ID	Gooding, ID	R	ID	11633	13290	16708	18614	155.737	187.089	243.014	311.230

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16	49	16049	ID	Idaho, ID	R	ID	13768	14894	18725	20862	193.727	223.621	290.479	372.029
16	51	16051	ID	Jefferson, ID	R	ID	16543	18599	23383	26051	213.124	288.608	375.019	480.398
16	53	16053	ID	Jerome, ID	R	ID	15138	17304	21755	24237	160.870	194.937	252.917	323.675
16	55	16055	ID	Kootenai, ID	U2	SP	69795	94628	118967	132541	641.356	804.491	1043.042	1334.360
16	57	16057	ID	Latah, ID	U2	SP	30617	32258	40556	45183	278.310	304.097	393.856	503.535
16	59	16059	ID	Lemhi, ID	R	ID	6899	7912	9947	11082	82.512	89.426	116.029	148.506
16	61	16061	ID	Lewis, ID	R	ID	3516	3988	5014	5586	64.787	71.010	92.322	118.312
16	63	16063	ID	Lincoln, ID	R	ID	3308	3735	4695	5231	54.057	66.808	86.861	111.303
16	65	16065	ID	Madison, ID	U2	ID	23674	23532	29584	32960	184.680	235.433	304.927	389.844
16	67	16067	ID	Minidoka, ID	R	ID	19361	20470	25735	28672	219.594	247.613	321.242	411.118
16	69	16069	ID	Nez Perce, ID	U2	ID	33754	36381	45739	50957	227.761	205.179	264.460	337.143
16	71	16071	ID	Oneida, ID	R	ID	3492	3938	4951	5515	51.261	70.525	91.692	117.505
16	73	16073	ID	Owyhee, ID	R	ID	8392	9965	12528	13957	130.138	169.485	220.360	282.369
16	75	16075	ID	Payette, ID	R	ID	16434	19679	24741	27564	189.951	237.012	307.693	393.948
16	77	16077	ID	Power, ID	U2	ID	7086	8121	10210	11375	69.466	78.937	102.311	130.872
16	79	16079	ID	Shoshone, ID	R	SP	13931	13975	17569	19574	266.476	237.385	308.427	395.065
16	81	16081	ID	Teton, ID	R	ID	3439	5043	6340	7063	45.578	69.452	90.302	115.713
16	83	16083	ID	Twin Falls, ID	U2	ID	53580	60195	75678	84313	518.290	554.254	718.067	918.212
16	85	16085	ID	Valley, ID	R	ID	6109	7815	9825	10946	88.167	123.377	160.411	205.557
16	87	16087	ID	Washington, ID	U2	ID	8550	9870	12409	13824	88.220	95.112	123.285	157.695
17	1	17001	IL	Adams, IL	U2	ND	66090	67599	70447	74714	412.074	442.377	547.015	680.208
17	3	17003	IL	Alexander, IL	R	ND	10626	10114	10540	11179	108.480	94.834	117.309	145.913
17	5	17005	IL	Bond, IL	R	ND	14991	16773	17480	18538	225.654	165.173	204.366	254.226
17	7	17007	IL	Boone, IL	U1	MI	30806	36905	38460	40790	356.025	245.429	307.023	384.319
17	9	17009	IL	Brown, IL	R	ND	5836	6272	6537	6932	34.319	93.218	115.371	143.539
17	11	17011	IL	Bureau, IL	R	MI	35688	35618	37118	39367	434.132	377.732	467.347	581.342
17	13	17013	IL	Calhoun, IL	R	ND	5322	5012	5223	5539	26.135	85.006	105.209	130.906
17	15	17015	IL	Carroll, IL	R	MI	16805	16922	17634	18703	106.483	209.402	259.119	322.351
17	17	17017	IL	Cass, IL	R	ND	13437	13254	13812	14649	72.686	133.179	164.764	204.951
17	19	17019	IL	Champaign, IL	U2	MI	173025	169123	176248	186924	1377.467	1226.262	1514.505	1886.114
17	21	17021	IL	Christian, IL	R	ND	34418	34581	36038	38221	215.611	288.117	356.377	443.239
17	23	17023	IL	Clark, IL	R	ND	15921	17336	18066	19161	273.625	154.093	190.634	237.114
17	25	17025	IL	Clay, IL	R	ND	14460	14451	15060	15972	134.486	152.858	189.122	235.254
17	27	17027	IL	Clinton, IL	U1	SL	33944	35164	36645	38865	310.902	351.761	431.392	533.132
17	29	17029	IL	Coles, IL	U2	ND	51644	51359	53523	56765	436.996	224.647	277.549	344.960
17	31	17031	IL	Cook, IL	U1	CH	5105044	5080823	5294852	5615597	29914.397	43894.944	53654.249	66397.180
17	33	17033	IL	Crawford, IL	R	ND	19464	20841	21718	23034	116.759	206.729	255.774	318.175
17	35	17035	IL	Cumberland, IL	R	ND	10670	11100	11568	12269	237.778	170.431	210.934	262.434
17	37	17037	IL	DeKalb, IL	U2	MI	77932	82792	86280	91506	559.671	421.324	524.563	656.328
17	39	17039	IL	De Witt, IL	R	ND	16516	16743	17448	18505	175.685	148.871	184.156	229.050
17	41	17041	IL	Douglas, IL	R	ND	19464	19737	20568	21814	235.934	163.101	201.742	250.914
17	43	17043	IL	DuPage, IL	R	CH	781689	857708	893839	947985	6293.370	6680.001	8167.751	10109.513
17	45	17045	IL	Edgar, IL	R	ND	19595	19861	20697	21951	116.814	174.094	215.357	267.856
17	47	17047	IL	Edwards, IL	R	ND	7440	7087	7385	7833	46.258	118.837	147.081	182.992

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17	49	17049	IL	Effingham, IL	R	ND	31704	33055	34447	36534	498.425	323.757	400.550	498.249
17	51	17051	IL	Fayette, IL	R	ND	20893	21502	22408	23766	351.436	239.229	296.005	368.229
17	53	17053	IL	Ford, IL	U2	MI	14275	14081	14674	15563	137.206	109.242	135.106	168.025
17	55	17055	IL	Franklin, IL	R	ND	40319	40628	42339	44904	408.230	357.893	442.714	550.647
17	57	17057	IL	Fulton, IL	R	MI	38080	38359	39974	42396	207.838	312.995	387.141	481.499
17	59	17059	IL	Gallatin, IL	R	ND	6909	6705	6987	7411	45.264	110.356	136.584	169.928
17	61	17061	IL	Greene, IL	R	ND	15317	15593	16250	17234	79.947	162.421	200.954	249.964
17	63	17063	IL	Grundy, IL	U1	CH	32337	35694	37197	39450	471.133	270.503	337.014	421.848
17	65	17065	IL	Hamilton, IL	R	ND	8499	8604	8966	9509	56.150	94.379	116.776	145.274
17	67	17067	IL	Hancock, IL	R	MI	21373	21178	22071	23408	136.752	249.616	308.864	384.231
17	69	17069	IL	Hardin, IL	R	ND	5189	4996	5207	5522	25.146	82.882	102.581	127.631
17	71	17071	IL	Henderson, IL	R	MI	8096	8560	8920	9461	65.928	129.318	160.050	199.122
17	73	17073	IL	Henry, IL	U1	MI	51159	51411	53577	56822	593.844	437.702	520.795	627.943
17	75	17075	IL	Iroquois, IL	R	MI	30787	31312	32631	34608	443.360	407.927	504.807	628.018
17	77	17077	IL	Jackson, IL	U2	ND	61067	60751	63310	67145	297.027	415.805	514.170	639.378
17	79	17079	IL	Jasper, IL	R	ND	10609	10566	11011	11678	89.866	120.711	149.358	185.811
17	81	17081	IL	Jefferson, IL	R	ND	37020	38688	40318	42760	528.555	328.765	406.686	505.835
17	83	17083	IL	Jersey, IL	U1	SL	20539	21147	22038	23372	124.415	213.977	262.418	324.312
17	85	17085	IL	Jo Daviess, IL	R	MI	21821	21698	22612	23982	146.413	278.595	344.081	427.558
17	87	17087	IL	Johnson, IL	R	ND	11347	12827	13368	14177	181.231	181.243	224.318	279.088
17	89	17089	IL	Kane, IL	U1	CH	317471	371754	387414	410882	2147.935	878.824	1092.140	1364.984
17	91	17091	IL	Kankakee, IL	U2	MI	96255	101166	105427	111814	730.504	911.002	1115.555	1371.745
17	93	17093	IL	Kendall, IL	U1	CH	39413	48364	50401	53455	248.545	237.770	296.091	370.510
17	95	17095	IL	Knox, IL	U2	MI	56393	55678	58024	61538	475.552	276.918	342.223	425.416
17	97	17097	IL	Lake, IL	U1	CH	516418	583602	608186	645028	4643.096	3903.907	4784.327	5929.930
17	99	17099	IL	La Salle, IL	U2	MI	106913	109167	113766	120658	1077.555	688.345	851.103	1058.318
17	101	17101	IL	Lawrence, IL	R	ND	15972	15672	16332	17322	109.266	179.435	222.017	276.185
17	103	17103	IL	Lee, IL	R	MI	34392	35579	37078	39324	435.532	315.288	390.029	485.121
17	105	17105	IL	Livingston, IL	R	MI	39301	40171	41863	44399	467.932	328.819	406.721	505.854
17	107	17107	IL	Logan, IL	U2	ND	30798	31243	32559	34531	407.431	253.647	313.734	390.203
17	109	17109	IL	McDonough, IL	U2	MI	35244	34251	35694	37857	180.709	203.773	251.910	313.208
17	111	17111	IL	McHenry, IL	U1	CH	183241	229279	238937	253411	1387.117	782.568	973.822	1218.055
17	113	17113	IL	McLean, IL	U2	MI	129180	139137	144999	153782	1255.740	1232.918	1541.479	1938.160
17	115	17115	IL	Macon, IL	U2	ND	117206	114685	119516	126756	890.225	1037.445	1238.938	1498.411
17	117	17117	IL	Macoupin, IL	R	ND	47679	48995	51059	54152	334.514	491.494	608.081	756.399
17	119	17119	IL	Madison, IL	U1	SL	249238	257298	268136	284379	2217.085	2657.327	3211.968	3935.218
17	121	17121	IL	Marion, IL	R	ND	41561	41967	43735	46384	406.872	370.867	458.768	570.612
17	123	17123	IL	Marshall, IL	R	MI	12846	12856	13398	14209	123.714	165.144	204.358	254.239
17	125	17125	IL	Mason, IL	R	ND	16269	16797	17505	18565	80.640	204.070	252.523	314.146
17	127	17127	IL	Massac, IL	R	ND	14752	15325	15970	16938	159.257	131.557	162.738	202.420
17	129	17129	IL	Menard, IL	R	ND	11164	12176	12689	13458	53.094	178.320	224.292	282.785
17	131	17131	IL	Mercer, IL	R	MI	17290	17508	18245	19350	84.892	219.281	271.348	337.567
17	133	17133	IL	Monroe, IL	U1	SL	22422	25430	26501	28106	210.505	252.188	307.833	379.367
17	135	17135	IL	Montgomery, IL	R	ND	30728	30954	32258	34212	387.444	277.459	343.224	426.903

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17	137	17137	IL	Morgan, IL	U2	ND	36397	36105	37626	39905	296.298	233.457	288.658	358.931
17	139	17139	IL	Moultrie, IL	R	ND	13930	14361	14966	15873	97.759	155.211	192.042	238.902
17	141	17141	IL	Ogle, IL	R	MI	45957	49593	51682	54813	484.684	454.438	568.631	711.878
17	143	17143	IL	Peoria, IL	U1	MI	182827	182681	190377	201909	1385.330	1682.140	2004.843	2425.519
17	145	17145	IL	Perry, IL	R	ND	21412	21374	22275	23624	124.234	187.090	231.428	287.843
17	147	17147	IL	Piatt, IL	R	ND	15548	16362	17052	18084	193.304	178.041	220.297	274.050
17	149	17149	IL	Pike, IL	R	ND	17577	17328	18058	19152	220.301	215.366	266.493	331.533
17	151	17151	IL	Pope, IL	R	ND	4373	4637	4832	5125	26.105	69.850	86.449	107.564
17	153	17153	IL	Pulaski, IL	R	ND	7523	7254	7559	8017	99.774	120.164	148.721	185.033
17	155	17155	IL	Putnam, IL	R	MI	5730	5836	6082	6451	60.678	91.525	113.277	140.926
17	157	17157	IL	Randolph, IL	R	ND	34583	34154	35592	37748	179.811	305.651	378.090	470.261
17	159	17159	IL	Richland, IL	U2	ND	16545	16800	17508	18569	103.589	130.354	161.224	200.512
17	161	17161	IL	Rock Island, IL	U1	MI	148723	148341	154590	163954	1102.803	1310.165	1539.066	1841.562
17	163	17163	IL	St. Clair, IL	U1	SL	262852	263721	274830	291479	2161.703	2829.798	3416.494	4182.893
17	165	17165	IL	Saline, IL	U2	ND	26551	26386	27498	29164	159.013	210.430	260.267	323.685
17	167	17167	IL	Sangamon, IL	U2	ND	178386	189710	197701	209677	1568.412	1737.938	2158.460	2700.462
17	169	17169	IL	Schuyler, IL	R	MI	7498	7607	7927	8408	60.608	69.860	86.422	107.502
17	171	17171	IL	Scott, IL	R	ND	5644	5599	5834	6188	65.058	90.150	111.576	138.815
17	173	17173	IL	Shelby, IL	R	ND	22261	22546	23495	24919	213.425	279.178	345.463	429.777
17	175	17175	IL	Stark, IL	R	MI	6534	6371	6640	7042	39.422	104.365	129.169	160.716
17	177	17177	IL	Stephenson, IL	U2	MI	48052	49168	51239	54343	263.360	327.108	404.488	502.991
17	179	17179	IL	Tazewell, IL	U1	MI	123692	127831	133216	141286	953.838	1236.619	1476.506	1788.270
17	181	17181	IL	Union, IL	R	ND	17619	17977	18735	19869	195.701	207.164	256.338	318.891
17	183	17183	IL	Vermilion, IL	U2	MI	88257	85548	89152	94553	712.914	644.694	797.290	991.513
17	185	17185	IL	Wabash, IL	U2	ND	13111	12785	13324	14131	75.006	81.345	100.573	125.055
17	187	17187	IL	Warren, IL	R	MI	19181	18835	19628	20817	139.432	159.722	197.564	245.712
17	189	17189	IL	Washington, IL	R	ND	14965	15274	15917	16881	269.425	189.546	234.554	291.789
17	191	17191	IL	Wayne, IL	R	ND	17241	17044	17762	18838	213.961	191.329	236.730	294.483
17	193	17193	IL	White, IL	R	ND	16522	15772	16436	17432	202.798	177.911	220.124	273.824
17	195	17195	IL	Whiteside, IL	U2	MI	60186	66946	69766	73993	475.753	453.694	561.103	697.812
17	197	17197	IL	Will, IL	U1	CH	357313	432018	450217	477490	2730.352	1830.185	2259.581	2813.084
17	199	17199	IL	Williamson, IL	U2	ND	57733	60673	63229	67059	578.727	416.214	514.715	640.101
17	201	17201	IL	Winnebago, IL	U1	MI	252913	264690	275840	292550	1884.448	2450.743	3020.234	3747.024
17	203	17203	IL	Woodford, IL	U1	MI	32653	34473	35925	38101	309.489	413.641	499.939	609.968
18	1	18001	IN	Adams, IN	R	ON	31095	32588	34824	36061	208.976	353.456	439.480	547.635
18	3	18003	IN	Allen, IN	U1	ON	300836	310483	331782	343572	2275.594	3372.285	4138.506	5117.184
18	5	18005	IN	Bartholomew, IN	U2	ON	63657	68009	72674	75257	744.668	611.663	749.530	926.613
18	7	18007	IN	Benton, IN	R	ON	9441	9540	10195	10557	127.104	164.996	202.583	250.742
18	9	18009	IN	Blackford, IN	U2	ON	14067	14027	14989	15522	111.225	135.122	165.578	204.696
18	11	18011	IN	Boone, IN	U1	ON	38147	42294	45195	46801	647.756	453.424	562.214	704.482
18	13	18013	IN	Brown, IN	R	ON	14080	15375	16430	17014	113.270	246.071	302.126	373.950
18	15	18015	IN	Carroll, IN	R	ON	18809	19820	21180	21933	158.958	289.315	355.103	439.435
18	17	18017	IN	Cass, IN	R	ON	38413	38550	41195	42659	262.798	409.597	502.134	620.923
18	19	18019	IN	Clark, IN	U1	OI	87774	92435	98776	102286	850.568	1124.386	1343.381	1636.117

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18	21	18021	IN	Clay, IN	R	ON	24705	26270	28072	29070	321.248	312.817	370.932	445.835
18	23	18023	IN	Clinton, IN	R	ON	30974	32909	35167	36417	416.450	311.627	389.055	488.557
18	25	18025	IN	Crawford, IN	R	ON	9914	10415	11130	11525	166.982	173.264	212.733	263.307
18	27	18027	IN	Daviess, IN	R	ON	27533	28663	30629	31717	188.737	312.456	383.137	473.846
18	29	18029	IN	Dearborn, IN	U1	ON	38835	45470	48589	50316	383.189	428.570	526.166	649.082
18	31	18031	IN	Decatur, IN	R	ON	23645	25117	26840	27793	355.826	268.667	329.446	407.446
18	33	18033	IN	De Kalb, IN	U1	ON	35324	38237	40860	42312	400.309	347.563	431.904	538.009
18	35	18035	IN	Delaware, IN	U2	ON	119659	117916	126004	130482	885.801	1393.712	1644.312	1971.139
18	37	18037	IN	Dubois, IN	R	ON	36616	38779	41439	42911	369.562	402.164	493.083	609.766
18	39	18039	IN	Elkhart, IN	U2	ON	156198	168650	180219	186623	1193.432	2041.327	2563.745	3219.825
18	41	18041	IN	Fayette, IN	U2	ON	26015	26116	27908	28899	134.388	212.568	260.281	321.625
18	43	18043	IN	Floyd, IN	U1	OI	64404	70456	75290	77965	500.184	905.740	1084.300	1322.178
18	45	18045	IN	Fountain, IN	R	ON	17808	18174	19421	20111	234.773	214.639	263.250	325.611
18	47	18047	IN	Franklin, IN	R	ON	19580	21296	22757	23566	219.556	289.307	355.058	439.330
18	49	18049	IN	Fulton, IN	R	ON	18840	20135	21516	22281	153.704	236.332	289.897	358.601
18	51	18051	IN	Gibson, IN	R	ON	31913	31943	34134	35347	418.179	387.896	475.763	588.484
18	53	18053	IN	Grant, IN	U2	ON	74169	73011	78019	80792	623.528	590.482	722.925	893.231
18	55	18055	IN	Greene, IN	R	ON	30410	32693	34936	36178	226.816	400.597	491.469	608.015
18	57	18057	IN	Hamilton, IN	U1	ON	108936	148235	158404	164033	1011.615	1331.308	1639.329	2045.630
18	59	18059	IN	Hancock, IN	U1	ON	45527	51993	55560	57534	558.976	558.274	693.369	869.676
18	61	18061	IN	Harrison, IN	U1	ON	29890	33412	35704	36973	360.668	478.364	578.727	710.183
18	63	18063	IN	Hendricks, IN	U1	ON	75717	89923	96092	99507	711.097	952.094	1182.717	1483.624
18	65	18065	IN	Henry, IN	R	ON	48139	48763	52108	53960	538.241	564.922	692.802	856.884
18	67	18067	IN	Howard, IN	U2	ON	80827	83192	88899	92058	444.373	1042.170	1234.088	1468.785
18	69	18069	IN	Huntington, IN	R	ON	35427	36899	39430	40831	484.649	363.996	452.407	563.616
18	71	18071	IN	Jackson, IN	R	ON	37730	40433	43207	44743	479.603	372.188	456.132	563.932
18	73	18073	IN	Jasper, IN	R	ON	24960	28163	30095	31165	491.307	357.675	438.924	543.081
18	75	18075	IN	Jay, IN	R	ON	21512	21666	23153	23975	198.429	234.753	287.815	355.923
18	77	18077	IN	Jefferson, IN	U2	ON	29797	31078	33210	34391	187.107	277.637	340.170	420.493
18	79	18079	IN	Jennings, IN	R	ON	23661	26709	28541	29555	162.118	330.833	405.952	502.269
18	81	18081	IN	Johnson, IN	U1	ON	88109	104205	111354	115311	727.505	1051.574	1292.918	1611.883
18	83	18083	IN	Knox, IN	U2	ON	39884	39714	42439	43947	343.537	335.606	410.996	507.907
18	85	18085	IN	Kosciusko, IN	R	ON	65294	69639	74416	77060	372.229	865.855	1062.292	1314.196
18	87	18087	IN	Lagrange, IN	R	ON	29477	32256	34469	35693	399.241	515.158	632.514	782.850
18	89	18089	IN	Lake, IN	U1	CH	475594	478804	511649	529831	3302.394	5219.689	6014.766	7088.063
18	91	18091	IN	La Porte, IN	U2	ON	107066	108792	116255	120387	1115.550	927.825	1136.414	1404.499
18	93	18093	IN	Lawrence, IN	R	ON	42836	45153	48250	49965	280.564	460.834	564.970	698.628
18	95	18095	IN	Madison, IN	U2	ON	130669	131673	140705	145705	1052.252	1586.874	1955.387	2441.032
18	97	18097	IN	Marion, IN	U1	ON	797159	811311	866966	897775	6136.961	10320.490	12597.489	15636.574
18	99	18099	IN	Marshall, IN	R	ON	42182	44886	47965	49670	398.035	534.375	655.513	810.887
18	101	18101	IN	Martin, IN	R	ON	10369	10490	11209	11608	87.262	136.222	167.123	206.746
18	103	18103	IN	Miami, IN	R	ON	36897	33727	36041	37322	290.445	378.398	463.819	573.481
18	105	18105	IN	Monroe, IN	U2	ON	108978	115557	123484	127872	521.066	1221.149	1562.535	2012.009
18	107	18107	IN	Montgomery, IN	R	ON	34436	36021	38492	39860	398.133	390.346	478.647	591.953

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18	109	18109	IN	Morgan, IN	U1	ON	55920	63520	67878	70290	597.798	709.238	882.190	1107.511
18	111	18111	IN	Newton, IN	R	ON	13551	14521	15517	16069	219.019	236.824	290.776	359.891
18	113	18113	IN	Noble, IN	R	ON	37877	41341	44177	45747	236.047	487.348	597.855	739.589
18	115	18115	IN	Ohio, IN	R	ON	5315	5438	5811	6017	34.434	92.887	114.201	140.988
18	117	18117	IN	Orange, IN	R	ON	18409	19240	20559	21290	135.939	266.584	327.151	404.794
18	119	18119	IN	Owen, IN	R	ON	17281	19832	21192	21945	115.132	262.531	322.222	398.728
18	121	18121	IN	Parke, IN	R	ON	15410	16298	17416	18035	155.583	227.187	278.816	345.006
18	123	18123	IN	Perry, IN	R	ON	19107	19278	20600	21332	229.105	208.011	255.025	315.371
18	125	18125	IN	Pike, IN	R	ON	12509	12722	13595	14078	118.259	218.615	268.415	332.225
18	127	18127	IN	Porter, IN	U1	CH	128932	141919	151655	157044	1221.196	1420.509	1651.574	1956.617
18	129	18129	IN	Posey, IN	U1	ON	25968	26544	28365	29373	307.155	341.475	422.297	527.823
18	131	18131	IN	Pulaski, IN	R	ON	12643	13131	14031	14530	135.045	220.957	271.291	335.773
18	133	18133	IN	Putnam, IN	R	ON	30315	33222	35501	36762	441.109	389.938	478.357	591.756
18	135	18135	IN	Randolph, IN	R	ON	27148	27433	29314	30356	225.013	338.903	415.708	514.224
18	137	18137	IN	Ripley, IN	R	ON	24616	26811	28650	29668	267.007	369.971	454.073	561.878
18	139	18139	IN	Rush, IN	R	ON	18129	18221	19471	20163	167.243	230.695	282.995	350.076
18	141	18141	IN	St. Joseph, IN	U2	ON	247052	256484	274079	283818	1359.143	2607.363	3180.893	3930.437
18	143	18143	IN	Scott, IN	R	ON	20991	22557	24104	24961	206.247	216.710	261.802	320.984
18	145	18145	IN	Shelby, IN	U1	ON	40307	42745	45677	47300	508.267	465.676	579.046	726.794
18	147	18147	IN	Spencer, IN	R	ON	19490	20519	21926	22705	308.808	340.617	418.213	517.628
18	149	18149	IN	Starke, IN	R	ON	22747	23614	25234	26131	154.659	339.766	416.995	516.001
18	151	18151	IN	Steuben, IN	R	ON	27446	30580	32677	33839	484.720	388.995	477.340	590.611
18	153	18153	IN	Sullivan, IN	R	ON	18993	20096	21475	22238	200.406	259.338	318.204	393.672
18	155	18155	IN	Switzerland, IN	R	ON	7738	8508	9091	9414	42.496	135.233	166.041	205.502
18	157	18157	IN	Tippecanoe, IN	U2	ON	130598	137206	146618	151828	990.298	1351.486	1670.385	2084.848
18	159	18159	IN	Tipton, IN	R	ON	16119	16356	17478	18099	178.485	207.739	248.691	297.931
18	161	18161	IN	Union, IN	R	ON	6976	7230	7726	8000	57.455	121.916	149.691	185.268
18	163	18163	IN	Vanderburgh, IN	U1	ON	165058	166583	178010	184336	923.461	1783.072	2173.791	2694.418
18	165	18165	IN	Vermillion, IN	R	ON	16773	16965	18129	18773	276.024	214.672	254.561	305.969
18	167	18167	IN	Vigo, IN	U2	ON	106107	105107	112317	116308	841.744	1443.083	1691.071	2018.449
18	169	18169	IN	Wabash, IN	U2	ON	35069	34603	36976	38290	227.711	324.718	397.845	491.782
18	171	18171	IN	Warren, IN	R	ON	8176	8171	8731	9042	123.389	142.890	175.438	217.146
18	173	18173	IN	Warrick, IN	U1	ON	44920	49987	53416	55314	443.293	512.037	629.671	784.453
18	175	18175	IN	Washington, IN	R	ON	23717	26654	28482	29494	198.624	327.014	401.254	496.435
18	177	18177	IN	Wayne, IN	U2	ON	71951	71822	76748	79476	724.034	655.762	803.380	993.031
18	179	18179	IN	Wells, IN	R	ON	25948	26655	28484	29496	260.004	313.058	389.333	485.213
18	181	18181	IN	White, IN	R	ON	23265	24787	26488	27429	418.594	325.063	398.872	493.518
18	183	18183	IN	Whitley, IN	U1	ON	27651	29638	31671	32796	239.077	343.054	426.679	531.777
19	1	19001	IA	Adair, IA	R	ND	8409	8257	8541	8730	164.420	131.097	157.273	190.113
19	3	19003	IA	Adams, IA	R	ND	4866	4484	4638	4740	54.899	75.862	91.007	110.019
19	5	19005	IA	Allamakee, IA	R	ND	13855	13972	14451	14772	118.562	159.947	191.728	231.650
19	7	19007	IA	Appanoose, IA	R	ND	13743	13544	14009	14320	105.504	131.464	157.485	190.202
19	9	19009	IA	Audubon, IA	R	ND	7334	6888	7125	7283	63.330	78.938	94.604	114.286
19	11	19011	IA	Benton, IA	R	ND	22429	24649	25496	26060	296.352	238.972	286.380	345.964

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19	13	19013	IA	Black Hawk, IA	U2	ND	123798	121830	126014	128806	917.007	1138.103	1297.808	1520.985
19	15	19015	IA	Boone, IA	R	ND	25186	26019	26913	27509	168.043	219.819	263.231	317.873
19	17	19017	IA	Bremer, IA	R	ND	22813	23234	24032	24564	182.303	236.562	283.466	342.434
19	19	19019	IA	Buchanan, IA	R	ND	20844	21097	21821	22305	305.372	241.667	289.689	350.028
19	21	19021	IA	Buena Vista, IA	R	ND	19965	19622	20296	20746	141.105	188.954	226.343	273.374
19	23	19023	IA	Butler, IA	R	ND	15731	15700	16239	16599	169.240	245.248	294.214	355.660
19	25	19025	IA	Calhoun, IA	R	ND	11508	11438	11831	12093	129.719	179.412	215.233	260.182
19	27	19027	IA	Carroll, IA	R	ND	21423	21663	22407	22903	156.105	200.386	240.028	289.894
19	29	19029	IA	Cass, IA	R	ND	15128	14798	15306	15645	182.387	132.190	158.299	191.149
19	31	19031	IA	Cedar, IA	R	ND	17444	17894	18509	18919	278.800	229.158	274.798	332.111
19	33	19033	IA	Cerro Gordo, IA	U2	ND	46733	46423	48017	49081	304.936	210.003	250.502	301.785
19	35	19035	IA	Cherokee, IA	R	ND	14098	13515	13979	14289	109.547	135.745	162.615	196.410
19	37	19037	IA	Chickasaw, IA	R	ND	13295	13415	13876	14183	121.996	156.223	187.274	226.288
19	39	19039	IA	Clarke, IA	U2	ND	8287	8244	8527	8716	95.770	71.119	85.160	102.834
19	41	19041	IA	Clay, IA	U2	ND	17585	17598	18202	18606	110.504	119.812	143.310	172.930
19	43	19043	IA	Clayton, IA	R	ND	19054	18829	19475	19907	202.099	297.054	356.363	430.795
19	45	19045	IA	Clinton, IA	U2	ND	51040	50341	52069	53223	270.885	271.639	324.430	391.156
19	47	19047	IA	Crawford, IA	R	ND	16775	16444	17009	17386	137.533	169.417	202.989	245.197
19	49	19049	IA	Dallas, IA	U1	ND	29755	34906	36105	36905	370.010	289.989	362.121	453.212
19	51	19051	IA	Davis, IA	R	ND	8312	8399	8688	8880	68.493	93.602	112.191	135.549
19	53	19053	IA	Decatur, IA	R	ND	8338	8211	8493	8681	131.009	129.991	155.945	188.510
19	55	19055	IA	Delaware, IA	R	ND	18035	18390	19021	19443	148.614	208.782	250.267	302.399
19	57	19057	IA	Des Moines, IA	U2	ND	42614	42193	43642	44609	226.492	241.883	289.013	348.532
19	59	19059	IA	Dickinson, IA	R	ND	14909	15831	16375	16738	123.594	178.443	213.924	258.487
19	61	19061	IA	Dubuque, IA	U2	ND	86403	87844	90861	92874	522.116	755.665	893.483	1078.347
19	63	19063	IA	Emmet, IA	U2	ND	11569	11022	11401	11653	78.378	86.637	103.677	125.148
19	65	19065	IA	Fayette, IA	R	ND	21843	21973	22728	23231	176.191	249.975	299.636	362.040
19	67	19067	IA	Floyd, IA	R	ND	17058	16556	17124	17504	130.064	156.058	186.916	225.740
19	69	19069	IA	Franklin, IA	R	ND	11364	10944	11320	11571	159.787	119.522	143.226	173.027
19	71	19071	IA	Fremont, IA	R	ND	8226	7895	8166	8347	162.551	128.244	153.850	185.982
19	73	19073	IA	Greene, IA	R	ND	10045	10043	10388	10618	84.208	96.740	115.891	139.978
19	75	19075	IA	Grundy, IA	R	ND	12029	12244	12665	12945	118.692	187.532	224.976	271.968
19	77	19077	IA	Guthrie, IA	R	ND	10935	11361	11751	12012	114.787	170.477	204.516	247.226
19	79	19079	IA	Hamilton, IA	R	ND	16071	16060	16611	16979	187.360	140.449	168.189	203.095
19	81	19081	IA	Hancock, IA	R	ND	12638	12124	12540	12818	111.107	151.406	181.511	219.332
19	83	19083	IA	Hardin, IA	R	ND	19094	18595	19234	19660	147.937	179.656	215.202	259.916
19	85	19085	IA	Harrison, IA	R	ND	14730	15258	15782	16132	238.641	189.363	227.060	274.406
19	87	19087	IA	Henry, IA	R	ND	19226	19845	20526	20981	132.861	187.782	224.967	271.719
19	89	19089	IA	Howard, IA	R	ND	9809	9724	10058	10281	81.109	101.751	121.926	147.278
19	91	19091	IA	Humboldt, IA	R	ND	10756	10449	10808	11047	85.830	105.790	126.740	153.089
19	93	19093	IA	Ida, IA	R	ND	8365	7996	8271	8454	85.332	130.412	156.450	189.123
19	95	19095	IA	Iowa, IA	R	ND	14630	15348	15875	16227	266.789	228.083	273.622	330.773
19	97	19097	IA	Jackson, IA	R	ND	19950	20076	20765	21226	174.090	225.791	270.639	326.984
19	99	19099	IA	Jasper, IA	R	ND	34795	35571	36792	37608	413.095	336.305	402.884	486.616

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19	101	19101	IA	Jefferson, IA	U2	ND	16310	16919	17500	17887	94.367	118.037	141.232	170.453
19	103	19103	IA	Johnson, IA	U2	ND	96119	101432	104916	107241	749.364	875.332	1094.910	1383.651
19	105	19105	IA	Jones, IA	R	ND	19444	20161	20854	21316	138.940	182.882	219.065	264.566
19	107	19107	IA	Keokuk, IA	R	ND	11624	11513	11909	12173	123.773	181.218	217.401	262.812
19	109	19109	IA	Kossuth, IA	R	ND	18591	18006	18624	19037	168.392	205.942	246.831	298.214
19	111	19111	IA	Lee, IA	U2	ND	38687	38659	39986	40872	235.207	267.439	319.913	386.057
19	113	19113	IA	Linn, IA	U2	ND	168767	179856	186033	190155	1388.044	1689.293	2048.392	2524.009
19	115	19115	IA	Louisa, IA	R	ND	11592	11885	12293	12566	115.475	180.720	216.803	262.088
19	117	19117	IA	Lucas, IA	U2	ND	9070	9067	9379	9587	66.041	77.022	92.223	111.356
19	119	19119	IA	Lyon, IA	R	ND	11952	11959	12370	12644	105.842	150.056	179.917	217.412
19	121	19121	IA	Madison, IA	R	ND	12483	13554	14020	14331	160.836	136.088	163.100	197.042
19	123	19123	IA	Mahaska, IA	R	ND	21532	21781	22529	23028	146.880	187.244	224.220	270.753
19	125	19125	IA	Marion, IA	U2	ND	30001	31080	32148	32860	175.881	223.614	267.590	322.986
19	127	19127	IA	Marshall, IA	U2	ND	38276	38716	40045	40933	222.059	245.563	293.627	354.251
19	129	19129	IA	Mills, IA	R	ND	13202	14218	14706	15032	156.965	142.068	170.257	205.697
19	131	19131	IA	Mitchell, IA	R	ND	10928	11044	11423	11676	93.684	122.404	146.712	177.261
19	133	19133	IA	Monona, IA	R	ND	10034	10003	10347	10576	155.641	115.483	138.427	167.256
19	135	19135	IA	Monroe, IA	R	ND	8114	8055	8331	8516	60.729	72.523	86.854	104.888
19	137	19137	IA	Montgomery, IA	U2	ND	12076	11931	12341	12614	83.767	100.900	120.805	145.868
19	139	19139	IA	Muscatine, IA	U2	ND	39907	41026	42434	43375	198.950	225.580	269.526	325.033
19	141	19141	IA	O'Brien, IA	R	ND	15444	14995	15510	15853	129.819	172.906	207.242	250.396
19	143	19143	IA	Osceola, IA	R	ND	7267	7037	7279	7440	60.146	74.031	88.706	107.152
19	145	19145	IA	Page, IA	U2	ND	16870	17093	17680	18072	105.552	114.092	136.460	164.663
19	147	19147	IA	Palo Alto, IA	R	ND	10669	10159	10508	10741	91.501	111.380	133.465	161.233
19	149	19149	IA	Plymouth, IA	R	ND	23388	24469	25309	25870	182.651	246.713	295.647	357.151
19	151	19151	IA	Pocahontas, IA	R	ND	9525	8934	9240	9445	108.906	148.496	178.144	215.351
19	153	19153	IA	Polk, IA	U1	ND	327140	350362	362394	370424	2397.518	3383.383	4155.569	5148.545
19	155	19155	IA	Pottawattamie, IA	U1	ND	82628	85008	87928	89876	803.494	913.010	1136.218	1419.901
19	157	19157	IA	Poweshiek, IA	R	ND	19033	19004	19656	20092	208.135	172.570	206.681	249.603
19	159	19159	IA	Ringgold, IA	R	ND	5420	5349	5533	5655	58.547	84.498	101.369	122.540
19	161	19161	IA	Sac, IA	R	ND	12324	11952	12362	12636	115.537	192.133	230.494	278.633
19	163	19163	IA	Scott, IA	U1	ND	150973	156510	161885	165472	1285.682	1427.816	1676.365	2005.199
19	165	19165	IA	Shelby, IA	R	ND	13230	13134	13585	13886	108.912	134.457	161.105	194.602
19	167	19167	IA	Sioux, IA	R	ND	29903	30920	31982	32691	199.139	290.693	348.249	420.637
19	169	19169	IA	Story, IA	U2	ND	74252	74535	77095	78803	478.856	374.308	446.884	538.663
19	171	19171	IA	Tama, IA	R	ND	17419	17605	18210	18613	167.614	233.948	280.556	339.073
19	173	19173	IA	Taylor, IA	R	ND	7114	7141	7387	7550	80.012	110.908	133.053	160.832
19	175	19175	IA	Union, IA	U2	ND	12750	12502	12932	13218	77.379	88.438	105.790	127.664
19	177	19177	IA	Van Buren, IA	R	ND	7676	7804	8072	8251	82.625	119.670	143.564	173.545
19	179	19179	IA	Wapello, IA	U2	ND	35696	35406	36622	37434	205.633	214.825	256.778	309.721
19	181	19181	IA	Warren, IA	U1	ND	36033	39193	40539	41438	334.739	323.345	401.903	501.573
19	183	19183	IA	Washington, IA	R	ND	19612	20677	21388	21861	149.690	207.090	248.168	299.796
19	185	19185	IA	Wayne, IA	R	ND	7067	6859	7094	7251	78.538	110.175	132.171	159.789
19	187	19187	IA	Webster, IA	U2	ND	40342	38863	40197	41088	246.933	267.789	320.259	386.433

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19	189	19189	IA	Winnebago, IA	R	ND	12122	12069	12483	12760	98.881	132.177	158.410	191.388
19	191	19191	IA	Winneshiek, IA	R	ND	20847	20888	21605	22084	157.073	212.550	254.678	307.648
19	193	19193	IA	Woodbury, IA	U2	ND	98276	101547	105034	107362	713.820	893.689	1085.771	1334.870
19	195	19195	IA	Worth, IA	R	ND	7991	7796	8064	8243	156.922	124.580	149.454	180.667
19	197	19197	IA	Wright, IA	U2	ND	14269	14191	14678	15004	142.004	98.687	118.051	142.461
20	1	20001	KS	Allen, KS	R	ND	14638	14470	15651	16921	137.484	161.977	200.945	249.904
20	3	20003	KS	Anderson, KS	R	ND	7803	7990	8642	9343	81.991	89.536	111.089	138.169
20	5	20005	KS	Atchison, KS	U2	ND	16932	16407	17745	19185	131.976	132.173	163.758	203.495
20	7	20007	KS	Barber, KS	R	ND	5874	5478	5925	6406	83.894	107.493	133.520	166.175
20	9	20009	KS	Barton, KS	U2	ND	29382	28143	30439	32909	194.285	227.399	281.725	350.094
20	11	20011	KS	Bourbon, KS	U2	ND	14966	15190	16429	17762	123.723	134.447	166.672	207.188
20	13	20013	KS	Brown, KS	R	ND	11128	11050	11952	12921	119.500	143.564	178.183	221.655
20	15	20015	KS	Butler, KS	U1	ND	50580	58856	63659	68824	578.283	533.730	669.976	840.812
20	17	20017	KS	Chase, KS	R	ND	3021	2911	3149	3404	67.097	55.283	68.669	85.469
20	19	20019	KS	Chautauqua, KS	R	ND	4407	4400	4759	5145	64.260	80.646	100.174	124.675
20	21	20021	KS	Cherokee, KS	U2	ND	21374	22379	24206	26170	178.580	208.944	259.105	322.153
20	23	20023	KS	Cheyenne, KS	R	ND	3243	3213	3475	3757	47.124	59.345	73.717	91.733
20	25	20025	KS	Clark, KS	R	ND	2418	2440	2639	2854	33.299	44.249	54.964	68.403
20	27	20027	KS	Clay, KS	U2	ND	9158	9216	9968	10777	80.583	90.672	112.446	139.810
20	29	20029	KS	Cloud, KS	U2	ND	11023	10309	11150	12055	97.811	98.889	122.591	152.396
20	31	20031	KS	Coffey, KS	R	ND	8404	8693	9402	10165	142.826	108.188	134.277	167.029
20	33	20033	KS	Comanche, KS	R	ND	2313	2063	2231	2412	32.725	42.325	52.576	65.435
20	35	20035	KS	Cowley, KS	U2	ND	36915	36744	39743	42968	254.114	263.807	326.711	405.885
20	37	20037	KS	Crawford, KS	U2	ND	35582	35928	38860	42013	265.315	264.768	327.964	407.501
20	39	20039	KS	Decatur, KS	R	ND	4021	3598	3891	4207	57.765	73.584	91.400	113.759
20	41	20041	KS	Dickinson, KS	R	ND	18958	19598	21198	22917	254.580	198.080	245.688	305.513
20	43	20043	KS	Doniphan, KS	R	ND	8134	7731	8362	9040	109.665	139.816	173.407	215.616
20	45	20045	KS	Douglas, KS	U2	ND	81798	89765	97091	104968	496.790	682.950	900.179	1173.159
20	47	20047	KS	Edwards, KS	R	ND	3787	3478	3761	4067	54.721	69.301	86.080	107.146
20	49	20049	KS	Elk, KS	R	ND	3327	3355	3629	3924	50.196	60.882	75.625	94.118
20	51	20051	KS	Ellis, KS	U2	ND	26004	26294	28439	30747	264.132	179.622	222.413	276.296
20	53	20053	KS	Ellsworth, KS	R	ND	6586	6327	6843	7399	134.639	120.523	149.704	186.313
20	55	20055	KS	Finney, KS	U2	ND	33070	35503	38401	41516	139.229	203.383	251.677	312.535
20	57	20057	KS	Ford, KS	U2	ND	27463	28998	31365	33909	147.825	150.264	185.814	230.643
20	59	20059	KS	Franklin, KS	R	ND	21994	23533	25454	27519	268.213	224.624	278.594	346.403
20	61	20061	KS	Geary, KS	U2	ND	30453	26054	28180	30467	264.459	201.545	249.505	309.901
20	63	20063	KS	Gove, KS	R	ND	3231	3106	3359	3632	75.558	59.126	73.443	91.403
20	65	20065	KS	Graham, KS	R	ND	3543	3290	3559	3847	51.186	64.836	80.535	100.227
20	67	20067	KS	Grant, KS	U2	ND	7159	7791	8426	9110	47.076	38.934	48.145	59.760
20	69	20069	KS	Gray, KS	R	ND	5396	5479	5926	6407	65.827	98.745	122.655	152.653
20	71	20071	KS	Greeley, KS	R	ND	1774	1735	1876	2028	23.638	32.463	40.324	50.187
20	73	20073	KS	Greenwood, KS	R	ND	7847	8015	8669	9372	81.148	94.009	116.656	145.095
20	75	20075	KS	Hamilton, KS	R	ND	2388	2299	2486	2688	32.211	43.700	54.281	67.560
20	77	20077	KS	Harper, KS	R	ND	7124	6587	7124	7702	75.455	88.417	109.724	136.489

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20	79	20079	KS	Harvey, KS	U1	ND	31028	31513	34085	36850	304.506	239.128	299.805	375.980
20	81	20081	KS	Haskell, KS	R	ND	3886	3991	4316	4666	48.867	71.113	88.332	109.935
20	83	20083	KS	Hodgeman, KS	R	ND	2177	2222	2403	2598	29.068	39.838	49.485	61.589
20	85	20085	KS	Jackson, KS	R	ND	11525	11963	12939	13989	120.706	157.614	195.654	243.402
20	87	20087	KS	Jefferson, KS	R	ND	15905	17641	19080	20628	194.832	291.056	361.533	449.942
20	89	20089	KS	Jewell, KS	R	ND	4251	4007	4334	4685	67.149	77.791	96.628	120.255
20	91	20091	KS	Johnson, KS	U1	ND	355021	408434	441764	477607	3333.547	4339.858	5420.796	6830.404
20	93	20093	KS	Kearny, KS	R	ND	4027	4174	4515	4881	44.010	73.692	91.538	113.925
20	95	20095	KS	Kingman, KS	R	ND	8292	8481	9173	9917	82.390	98.451	122.164	151.942
20	97	20097	KS	Kiowa, KS	R	ND	3660	3471	3755	4059	51.835	66.976	83.195	103.538
20	99	20099	KS	Labette, KS	U2	ND	23693	22972	24847	26863	211.776	234.755	291.129	361.980
20	101	20101	KS	Lane, KS	R	ND	2375	2213	2394	2588	31.673	43.462	53.986	67.190
20	103	20103	KS	Leavenworth, KS	U1	ND	64371	69347	75006	81091	477.775	417.394	528.955	672.344
20	105	20105	KS	Lincoln, KS	R	ND	3653	3388	3665	3962	84.051	66.848	83.036	103.347
20	107	20107	KS	Linn, KS	R	ND	8254	8948	9679	10464	105.497	151.046	187.620	233.502
20	109	20109	KS	Logan, KS	R	ND	3081	3050	3299	3567	70.528	56.383	70.033	87.163
20	111	20111	KS	Lyon, KS	U2	ND	34732	34177	36967	39966	300.685	210.203	260.094	322.968
20	113	20113	KS	McPherson, KS	U2	ND	27268	27549	29797	32215	302.119	240.586	298.229	370.709
20	115	20115	KS	Marion, KS	R	ND	12888	12910	13964	15097	148.541	192.278	238.733	297.044
20	117	20117	KS	Marshall, KS	R	ND	11705	11226	12142	13127	130.451	158.192	196.362	244.279
20	119	20119	KS	Meade, KS	R	ND	4247	4375	4732	5116	61.343	77.720	96.539	120.137
20	121	20121	KS	Miami, KS	U1	ND	23466	25801	27906	30171	291.734	274.554	348.773	443.959
20	123	20123	KS	Mitchell, KS	U2	ND	7203	7031	7604	8221	64.285	64.018	79.358	98.644
20	125	20125	KS	Montgomery, KS	U2	ND	38816	37383	40434	43714	282.064	328.008	406.524	505.282
20	127	20127	KS	Morris, KS	R	ND	6198	6197	6703	7247	82.242	113.422	140.887	175.329
20	129	20129	KS	Morton, KS	R	ND	3480	3389	3666	3963	44.250	63.683	79.103	98.451
20	131	20131	KS	Nemaha, KS	R	ND	10446	10281	11120	12023	143.639	191.159	237.445	295.511
20	133	20133	KS	Neosho, KS	U2	ND	17035	16963	18347	19836	147.468	153.535	190.336	236.607
20	135	20135	KS	Ness, KS	R	ND	4033	3694	3996	4320	57.626	73.803	91.673	114.093
20	137	20137	KS	Norton, KS	U2	ND	5947	5834	6310	6822	54.785	58.524	72.573	90.244
20	139	20139	KS	Osage, KS	R	ND	15248	16820	18193	19669	267.271	234.198	290.801	361.833
20	141	20141	KS	Osborne, KS	R	ND	4867	4559	4931	5331	76.348	89.064	110.629	137.688
20	143	20143	KS	Ottawa, KS	R	ND	5634	5798	6271	6780	76.502	103.100	128.065	159.390
20	145	20145	KS	Pawnee, KS	U2	ND	7555	7285	7879	8519	59.574	63.389	78.560	97.653
20	147	20147	KS	Phillips, KS	R	ND	6590	6137	6638	7177	65.523	73.442	91.112	113.313
20	149	20149	KS	Pottawatomie, KS	R	ND	16128	17909	19371	20942	159.188	230.960	286.732	356.743
20	151	20151	KS	Pratt, KS	U2	ND	9702	9705	10497	11348	69.034	66.045	81.775	101.569
20	153	20153	KS	Rawlins, KS	R	ND	3404	3239	3503	3787	52.592	62.292	77.375	96.298
20	155	20155	KS	Reno, KS	U2	ND	62389	62844	67973	73487	466.236	486.288	602.482	748.684
20	157	20157	KS	Republic, KS	R	ND	6482	6189	6694	7237	71.468	76.368	94.759	117.862
20	159	20159	KS	Rice, KS	R	ND	10610	10079	10902	11786	114.706	132.666	164.645	204.799
20	161	20161	KS	Riley, KS	U2	ND	67139	63751	68953	74548	524.840	399.369	494.107	613.516
20	163	20163	KS	Rooks, KS	R	ND	6039	5769	6240	6746	89.759	110.513	137.272	170.837
20	165	20165	KS	Rush, KS	R	ND	3842	3489	3774	4080	57.857	70.307	87.331	108.689

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20	167	20167	KS	Russell, KS	U2	ND	7835	7659	8284	8956	91.568	63.661	78.886	98.044
20	169	20169	KS	Saline, KS	U2	ND	49301	51289	55474	59975	311.221	197.526	243.684	302.057
20	171	20171	KS	Scott, KS	U2	ND	5289	5034	5444	5886	36.305	34.360	42.533	52.826
20	173	20173	KS	Sedgwick, KS	U1	ND	403662	433677	469067	507125	3231.894	4002.782	4952.589	6163.013
20	175	20175	KS	Seward, KS	U2	ND	18743	19952	21581	23332	83.117	66.658	82.142	101.755
20	177	20177	KS	Shawnee, KS	U2	ND	160976	164367	177780	192204	1622.495	1852.981	2279.216	2822.068
20	179	20179	KS	Sheridan, KS	R	ND	3043	2789	3017	3262	45.406	55.686	69.169	86.097
20	181	20181	KS	Sherman, KS	U2	ND	6926	6647	7189	7772	64.516	43.659	54.033	67.097
20	183	20183	KS	Smith, KS	R	ND	5078	4719	5104	5518	76.192	92.925	115.426	143.655
20	185	20185	KS	Stafford, KS	R	ND	5365	5139	5558	6009	72.952	98.177	121.950	151.774
20	187	20187	KS	Stanton, KS	R	ND	2333	2330	2521	2725	29.968	42.692	53.030	66.003
20	189	20189	KS	Stevens, KS	U2	ND	5048	5354	5791	6261	31.897	38.237	47.368	58.856
20	191	20191	KS	Sumner, KS	R	ND	25841	26820	29009	31362	351.445	312.498	387.785	482.334
20	193	20193	KS	Thomas, KS	U2	ND	8258	8194	8862	9581	81.209	61.148	75.741	94.104
20	195	20195	KS	Trego, KS	R	ND	3694	3383	3659	3956	84.457	67.599	83.966	104.508
20	197	20197	KS	Wabaunsee, KS	R	ND	6603	6690	7235	7823	139.245	120.833	150.090	186.804
20	199	20199	KS	Wallace, KS	R	ND	1821	1803	1950	2108	26.197	33.324	41.393	51.520
20	201	20201	KS	Washington, KS	R	ND	7073	6666	7210	7795	109.453	129.432	160.776	200.079
20	203	20203	KS	Wichita, KS	R	ND	2758	2711	2932	3170	38.960	50.470	62.690	78.032
20	205	20205	KS	Wilson, KS	U2	ND	10289	10292	11131	12035	96.633	97.646	121.075	150.538
20	207	20207	KS	Woodson, KS	R	ND	4116	3993	4319	4670	58.933	75.321	93.559	116.446
20	209	20209	KS	Wyandotte, KS	U1	ND	162026	153970	166535	180046	1235.525	1837.003	2291.262	2884.562
21	1	21001	KY	Adair, KY	R	ON	15360	16332	17330	17952	116.705	163.017	200.290	248.638
21	3	21003	KY	Allen, KY	R	ON	14628	16004	16982	17591	105.367	148.638	182.575	226.606
21	5	21005	KY	Anderson, KY	R	ON	14571	17538	18610	19277	89.053	130.360	159.990	198.480
21	7	21007	KY	Ballard, KY	R	ON	7902	8283	8789	9104	74.758	105.087	129.267	160.577
21	9	21009	KY	Barren, KY	R	ON	34001	36374	38598	39982	404.820	319.663	392.457	486.946
21	11	21011	KY	Bath, KY	R	ON	9692	10260	10887	11278	157.822	128.892	158.549	196.956
21	13	21013	KY	Bell, KY	R	ON	31506	30030	31866	33008	240.758	297.459	365.204	453.143
21	15	21015	KY	Boone, KY	U1	OR	57589	73518	78012	80809	593.094	784.638	952.946	1167.736
21	17	21017	KY	Bourbon, KY	U1	ON	19236	19333	20515	21250	137.660	162.156	208.593	268.701
21	19	21019	KY	Boyd, KY	U1	ON	51150	50049	53108	55012	482.683	549.432	654.550	787.293
21	21	21021	KY	Boyle, KY	R	ON	25641	26865	28507	29529	168.593	207.746	254.781	315.928
21	23	21023	KY	Bracken, KY	R	ON	7766	8216	8718	9031	65.745	103.279	127.042	157.815
21	25	21025	KY	Breathitt, KY	R	ON	15703	15651	16607	17203	135.396	208.830	256.880	319.109
21	27	21027	KY	Breckinridge, KY	R	ON	16312	17158	18207	18860	143.266	216.930	266.844	331.472
21	29	21029	KY	Bullitt, KY	U1	OR	47567	56514	59968	62119	516.333	533.884	641.351	783.704
21	31	21031	KY	Butler, KY	R	ON	11245	11684	12398	12843	94.008	149.544	183.954	228.509
21	33	21033	KY	Caldwell, KY	U2	ON	13232	13325	14140	14647	140.828	101.513	124.442	154.271
21	35	21035	KY	Calloway, KY	R	ON	30735	32738	34739	35985	206.300	253.830	311.343	386.096
21	37	21037	KY	Campbell, KY	U1	OR	83866	86914	92227	95534	823.392	1152.131	1393.520	1703.254
21	39	21039	KY	Carlisle, KY	R	ON	5238	5361	5688	5892	46.620	69.659	85.687	106.449
21	41	21041	KY	Carroll, KY	R	ON	9292	9543	10126	10490	105.962	83.760	102.801	127.544
21	43	21043	KY	Carter, KY	U1	ON	24340	26269	27875	28875	334.450	286.035	345.094	418.223

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21	45	21045	KY	Casey, KY	R	ON	14211	14485	15371	15922	125.904	188.986	232.473	288.789
21	47	21047	KY	Christian, KY	U2	ON	68941	72616	77055	79818	588.705	511.776	641.372	805.138
21	49	21049	KY	Clark, KY	U1	ON	29496	31367	33285	34478	292.532	222.762	286.309	368.626
21	51	21051	KY	Clay, KY	R	ON	21746	22430	23801	24655	193.324	289.195	355.737	441.901
21	53	21053	KY	Clinton, KY	R	ON	9135	9286	9853	10207	79.199	121.484	149.437	185.632
21	55	21055	KY	Crittenden, KY	R	ON	9196	9439	10016	10376	66.615	86.676	106.416	132.047
21	57	21057	KY	Cumberland, KY	R	ON	6784	6863	7282	7543	61.930	90.219	110.978	137.855
21	59	21059	KY	Daviess, KY	U2	ON	87189	90465	95995	99437	657.020	996.481	1214.509	1494.419
21	61	21061	KY	Edmonson, KY	R	ON	10357	11024	11698	12117	156.834	137.735	169.429	210.462
21	63	21063	KY	Elliott, KY	R	ON	6455	6528	6927	7175	58.694	85.844	105.596	131.172
21	65	21065	KY	Estill, KY	R	ON	14614	15362	16301	16886	113.246	164.136	201.730	250.463
21	67	21067	KY	Fayette, KY	U1	ON	225366	237801	252337	261386	1683.226	3063.553	3876.308	4944.058
21	69	21069	KY	Fleming, KY	R	ON	12292	13070	13869	14367	94.990	130.521	160.364	199.061
21	71	21071	KY	Floyd, KY	R	ON	43586	43378	46029	47680	400.582	541.468	665.836	826.962
21	73	21073	KY	Franklin, KY	U2	ON	44143	45928	48736	50483	396.774	303.639	371.899	460.796
21	75	21075	KY	Fulton, KY	U2	ON	8271	7722	8194	8487	55.533	47.115	57.594	71.276
21	77	21077	KY	Gallatin, KY	R	ON	5393	6574	6976	7226	76.224	71.720	88.174	108.876
21	79	21079	KY	Garrard, KY	R	ON	11579	13371	14189	14697	80.691	117.284	144.059	178.799
21	81	21081	KY	Grant, KY	R	ON	15737	19244	20420	21152	184.305	176.669	217.015	267.796
21	83	21083	KY	Graves, KY	R	ON	33550	35300	37458	38801	252.589	339.586	417.110	517.691
21	85	21085	KY	Grayson, KY	R	ON	21050	22961	24364	25238	161.643	226.672	278.523	345.750
21	87	21087	KY	Green, KY	R	ON	10371	10542	11186	11587	93.832	137.922	169.656	210.750
21	89	21089	KY	Greenup, KY	U1	ON	36742	37070	39336	40747	291.827	424.977	508.791	613.795
21	91	21091	KY	Hancock, KY	R	ON	7864	8706	9238	9569	65.780	104.581	128.646	159.795
21	93	21093	KY	Hardin, KY	U2	ON	89240	89892	95387	98808	813.085	575.993	705.008	873.189
21	95	21095	KY	Harlan, KY	R	ON	36574	35535	37707	39059	332.823	423.123	520.117	645.831
21	97	21097	KY	Harrison, KY	R	ON	16248	17194	18245	18900	108.687	146.375	179.655	222.872
21	99	21099	KY	Hart, KY	R	ON	14890	16317	17315	17935	242.485	198.018	243.581	302.585
21	101	21101	KY	Henderson, KY	U1	ON	43044	44396	47109	48799	391.150	608.162	743.287	922.675
21	103	21103	KY	Henry, KY	R	ON	12823	14441	15324	15874	200.573	170.530	209.767	260.580
21	105	21105	KY	Hickman, KY	R	ON	5566	5229	5549	5748	51.531	74.021	91.054	113.103
21	107	21107	KY	Hopkins, KY	R	ON	46126	46261	49088	50849	322.878	406.051	498.285	618.100
21	109	21109	KY	Jackson, KY	R	ON	11955	12704	13481	13964	101.927	158.987	195.568	242.939
21	111	21111	KY	Jefferson, KY	U1	OR	665123	669836	710781	736269	6160.086	9301.165	11042.312	13396.335
21	113	21113	KY	Jessamine, KY	U1	ON	30508	35248	37403	38744	173.498	215.126	275.659	354.283
21	115	21115	KY	Johnson, KY	R	ON	23248	23971	25436	26348	194.509	262.458	322.579	400.518
21	117	21117	KY	Kenton, KY	U1	OR	142031	145625	154527	160068	1307.584	1958.625	2364.339	2886.322
21	119	21119	KY	Knott, KY	R	ON	17906	18003	19103	19788	152.434	238.126	292.919	363.866
21	121	21121	KY	Knox, KY	R	ON	29676	31220	33128	34316	240.918	340.946	419.088	520.370
21	123	21123	KY	Larue, KY	R	ON	11679	12715	13493	13976	162.184	125.749	154.511	191.819
21	125	21125	KY	Laurel, KY	R	ON	43438	49121	52123	53993	573.379	515.907	634.260	787.625
21	127	21127	KY	Lawrence, KY	R	ON	13998	15229	16160	16739	119.987	186.157	228.989	284.461
21	129	21129	KY	Lee, KY	R	ON	7422	7893	8376	8676	65.883	98.704	121.415	150.825
21	131	21131	KY	Leslie, KY	R	ON	13642	13553	14381	14897	126.450	181.420	223.167	277.219

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21	133	21133	KY	Letcher, KY	R	ON	27000	26677	28308	29323	249.522	329.551	405.210	503.238
21	135	21135	KY	Lewis, KY	R	ON	13029	13491	14316	14829	123.591	173.270	213.138	264.767
21	137	21137	KY	Lincoln, KY	R	ON	20045	21761	23091	23919	152.413	239.721	294.725	365.998
21	139	21139	KY	Livingston, KY	R	ON	9062	9292	9860	10213	145.136	120.514	148.243	184.151
21	141	21141	KY	Logan, KY	R	ON	24416	25913	27497	28483	179.305	244.734	300.584	373.052
21	143	21143	KY	Lyon, KY	R	ON	6624	7814	8291	8589	102.170	88.092	108.359	134.615
21	145	21145	KY	McCracken, KY	U2	ON	62879	64471	68412	70865	584.592	366.889	448.605	555.278
21	147	21147	KY	McCreary, KY	R	ON	15603	16421	17424	18049	132.840	207.501	255.246	317.064
21	149	21149	KY	McLean, KY	R	ON	9628	9691	10283	10652	85.734	128.040	157.501	195.653
21	151	21151	KY	Madison, KY	U2	ON	57508	64224	68150	70593	538.281	439.918	565.472	728.096
21	153	21153	KY	Magoffin, KY	R	ON	13077	13721	14559	15081	114.834	173.908	213.923	265.740
21	155	21155	KY	Marion, KY	R	ON	16499	16910	17944	18588	129.586	158.318	194.395	241.212
21	157	21157	KY	Marshall, KY	R	ON	27205	29457	31257	32378	366.326	292.927	359.932	446.828
21	159	21159	KY	Martin, KY	R	ON	12526	12273	13023	13490	118.319	166.579	204.910	254.539
21	161	21161	KY	Mason, KY	R	ON	16666	16869	17900	18542	123.565	144.724	177.583	220.269
21	163	21163	KY	Meade, KY	R	ON	24170	27573	29258	30307	172.517	256.118	314.671	390.614
21	165	21165	KY	Menifee, KY	R	ON	5092	5545	5883	6094	43.476	67.717	83.299	103.471
21	167	21167	KY	Mercer, KY	R	ON	19148	20261	21500	22271	136.616	175.951	215.984	267.964
21	169	21169	KY	Metcalfe, KY	R	ON	8963	9398	9972	10330	80.585	119.197	146.623	182.144
21	171	21171	KY	Monroe, KY	R	ON	11401	11248	11936	12364	89.982	120.925	148.573	184.428
21	173	21173	KY	Montgomery, KY	R	ON	19561	20604	21864	22648	256.938	202.611	248.901	308.936
21	175	21175	KY	Morgan, KY	R	ON	11648	13218	14026	14529	102.837	154.904	190.546	236.710
21	177	21177	KY	Muhlenberg, KY	R	ON	31318	31866	33814	35026	240.150	312.767	384.137	476.746
21	179	21179	KY	Nelson, KY	R	ON	29710	34375	36476	37784	213.263	322.143	395.846	491.411
21	181	21181	KY	Nicholas, KY	R	ON	6725	6992	7419	7685	60.810	89.434	110.012	136.658
21	183	21183	KY	Ohio, KY	R	ON	21105	21835	23170	24001	165.391	222.425	273.270	339.209
21	185	21185	KY	Oldham, KY	U1	OR	33263	41822	44378	45969	407.647	401.020	485.027	595.112
21	187	21187	KY	Owen, KY	R	ON	9035	9937	10544	10922	75.826	120.154	147.801	183.600
21	189	21189	KY	Owsley, KY	R	ON	5036	5332	5658	5860	48.505	66.972	82.383	102.333
21	191	21191	KY	Pendleton, KY	R	ON	12036	13599	14430	14947	93.366	160.063	196.789	242.966
21	193	21193	KY	Perry, KY	R	ON	30283	30992	32886	34066	268.454	344.621	423.582	525.938
21	195	21195	KY	Pike, KY	R	ON	72584	72564	77000	79761	672.976	897.416	1103.518	1370.522
21	197	21197	KY	Powell, KY	R	ON	11686	12481	13244	13719	85.094	126.047	154.878	192.276
21	199	21199	KY	Pulaski, KY	R	ON	49489	54741	58087	60170	352.646	542.995	667.272	828.405
21	201	21201	KY	Robertson, KY	R	ON	2124	2166	2298	2381	19.248	28.247	34.746	43.163
21	203	21203	KY	Rockcastle, KY	R	ON	14803	15610	16564	17158	219.981	168.387	206.970	256.981
21	205	21205	KY	Rowan, KY	R	ON	20353	21783	23114	23943	221.392	181.002	222.133	275.562
21	207	21207	KY	Russell, KY	R	ON	14716	16089	17073	17685	116.470	195.704	240.736	299.046
21	209	21209	KY	Scott, KY	U1	ON	23867	28649	30400	31490	232.827	194.947	250.716	322.921
21	211	21211	KY	Shelby, KY	U1	ON	24824	28263	29990	31066	313.554	263.205	323.380	401.436
21	213	21213	KY	Simpson, KY	U2	ON	15145	16028	17008	17617	153.017	119.800	146.892	182.132
21	215	21215	KY	Spencer, KY	R	ON	6801	8820	9360	9695	50.376	90.444	111.256	138.204
21	217	21217	KY	Taylor, KY	R	ON	21146	22660	24045	24907	150.057	178.472	218.943	271.547
21	219	21219	KY	Todd, KY	R	ON	10940	11161	11843	12268	100.889	145.488	178.964	222.317

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21	221	21221	KY	Trigg, KY	R	ON	10361	11828	12551	13001	147.738	137.788	169.493	210.545
21	223	21223	KY	Trimble, KY	R	ON	6090	7122	7557	7828	98.445	80.988	99.626	123.749
21	225	21225	KY	Union, KY	R	ON	16557	16540	17551	18180	127.168	179.677	220.787	274.085
21	227	21227	KY	Warren, KY	U2	ON	77720	85267	90479	93724	723.138	583.643	715.426	886.865
21	229	21229	KY	Washington, KY	R	ON	10441	10713	11368	11775	80.559	107.976	132.644	164.642
21	231	21231	KY	Wayne, KY	R	ON	17468	18521	19654	20358	125.161	174.831	214.727	266.492
21	233	21233	KY	Webster, KY	R	ON	13955	13590	14421	14938	110.816	141.352	173.621	215.483
21	235	21235	KY	Whitley, KY	R	ON	33326	35261	37416	38758	401.807	321.972	395.361	490.609
21	237	21237	KY	Wolfe, KY	R	ON	6503	7208	7648	7922	56.910	86.483	106.381	132.151
21	239	21239	KY	Woodford, KY	U1	ON	19955	22003	23348	24185	215.111	187.392	241.240	310.897
22	1	22001	LA	Acadia Parish, LA	R	SE	55882	57433	60561	65706	510.471	459.540	569.493	706.490
22	3	22003	LA	Allen Parish, LA	R	SE	21226	23525	24806	26914	128.325	226.338	277.637	342.683
22	5	22005	LA	Ascension Parish, LA	U1	AT	58214	68297	72017	78136	581.653	675.529	871.022	1118.892
22	7	22007	LA	Assumption Parish, LA	R	SE	22753	22847	24092	26139	153.773	303.914	372.914	460.388
22	9	22009	LA	Avoyelles Parish, LA	R	SE	39159	40558	42767	46401	218.504	409.375	502.137	619.790
22	11	22011	LA	Beauregard Parish, LA	R	SE	30083	31554	33273	36100	235.689	323.270	396.541	489.455
22	13	22013	LA	Bienville Parish, LA	R	SE	16201	15880	16745	18168	203.487	200.259	245.705	303.319
22	15	22015	LA	Bossier Parish, LA	U1	SE	86088	91798	96798	105023	654.671	884.248	1057.184	1284.177
22	17	22017	LA	Caddo Parish, LA	U1	SE	248253	244086	257380	279249	1137.438	2553.901	3042.722	3688.379
22	19	22019	LA	Calcasieu Parish, LA	U2	AT	168134	177340	186999	202887	1083.058	1523.678	1882.566	2332.811
22	21	22021	LA	Caldwell Parish, LA	R	SE	9806	10273	10833	11753	95.231	150.299	184.454	227.749
22	23	22023	LA	Cameron Parish, LA	R	SE	9260	9047	9540	10351	115.424	141.873	174.113	214.970
22	25	22025	LA	Catahoula Parish, LA	R	SE	11065	11063	11666	12657	95.235	130.167	159.692	197.127
22	27	22027	LA	Claiborne Parish, LA	R	SE	17405	16962	17886	19405	123.924	165.280	202.698	250.151
22	29	22029	LA	Concordia Parish, LA	R	SE	20828	20753	21884	23743	164.288	187.986	230.523	284.479
22	31	22031	LA	De Soto Parish, LA	R	SE	25699	25178	26549	28805	225.979	310.343	380.759	470.037
22	33	22033	LA	East Baton Rouge Paris	U1	AT	380105	392228	413592	448733	2025.685	3825.220	4851.280	6170.870
22	35	22035	LA	East Carroll Parish, LA	U2	SE	9709	9094	9589	10404	59.362	70.900	86.902	107.212
22	37	22037	LA	East Feliciana Parish, L.	R	SE	19211	20594	21716	23561	146.718	238.024	292.038	360.517
22	39	22039	LA	Evangeline Parish, LA	R	SE	33274	33989	35840	38885	187.277	329.602	404.249	498.928
22	41	22041	LA	Franklin Parish, LA	R	SE	22387	22114	23318	25299	158.805	259.711	318.615	393.301
22	43	22043	LA	Grant Parish, LA	R	SE	17526	18468	19474	21129	298.495	268.516	329.536	406.872
22	45	22045	LA	Iberia Parish, LA	U2	SE	68297	71550	75447	81857	445.992	496.015	607.957	750.064
22	47	22047	LA	Iberville Parish, LA	R	AT	31049	31118	32812	35600	283.073	371.716	456.041	562.961
22	49	22049	LA	Jackson Parish, LA	R	SE	15924	15603	16453	17851	124.361	178.321	218.755	270.032
22	51	22051	LA	Jefferson Parish, LA	U1	SE	448306	450821	475376	515766	1660.465	2706.882	3235.604	3922.906
22	53	22053	LA	Jefferson Davis Parish,	U2	SE	30722	31539	33257	36082	317.967	213.085	261.145	322.167
22	55	22055	LA	Lafayette Parish, LA	U2	SE	164762	181339	191216	207463	1020.473	1837.218	2247.462	2766.321
22	57	22057	LA	Lafourche Parish, LA	U2	SE	85860	87726	92504	100364	689.486	693.790	853.110	1053.331
22	59	22059	LA	La Salle Parish, LA	R	SE	13662	13738	14487	15717	114.145	169.766	208.291	257.128
22	61	22061	LA	Lincoln Parish, LA	U2	SE	41745	41922	44206	47962	370.482	270.414	331.344	408.717
22	63	22063	LA	Livingston Parish, LA	U1	AT	70523	83335	87874	95340	602.808	941.977	1211.441	1553.810
22	65	22065	LA	Madison Parish, LA	U2	SE	12463	12912	13615	14772	237.219	67.641	82.838	102.147
22	67	22067	LA	Morehouse Parish, LA	R	SE	31938	31763	33493	36339	190.293	287.946	353.100	435.754

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22	69	22069	LA	Natchitoches Parish, LA	R	SE	37199	37273	39303	42642	317.584	321.768	394.550	486.901
22	71	22071	LA	Orleans Parish, LA	U1	SE	496938	473067	498834	541218	2091.093	2932.876	3503.173	4245.472
22	73	22073	LA	Ouachita Parish, LA	U2	SE	142191	146360	154332	167445	852.645	1370.624	1706.700	2131.205
22	75	22075	LA	Plaquemines Parish, LA	U2	SE	25575	25816	27222	29535	215.737	129.070	155.788	189.969
22	77	22077	LA	Pointe Coupee Parsish,	R	AT	22540	23479	24758	26862	198.548	268.596	329.528	406.783
22	79	22079	LA	Rapides Parish, LA	U2	SE	131556	127215	134144	145541	812.500	1365.475	1631.112	1972.654
22	81	22081	LA	Red River Parish, LA	R	SE	9518	9671	10197	11064	115.633	143.818	176.501	217.918
22	83	22083	LA	Richland Parish, LA	R	SE	20629	20828	21962	23828	278.524	206.367	253.111	312.404
22	85	22085	LA	Sabine Parish, LA	R	SE	22646	23603	24888	27003	192.016	301.723	370.228	457.067
22	87	22087	LA	St. Bernard Parish, LA	U1	SE	66631	66319	69931	75873	327.731	420.977	503.910	611.461
22	89	22089	LA	St. Charles Parish, LA	U1	SE	42437	46952	49509	53715	454.633	253.079	303.971	369.595
22	91	22091	LA	St. Helena Parish, LA	R	SE	9874	9795	10329	11206	79.446	151.278	185.658	229.235
22	93	22093	LA	St. James Parish, LA	R	SE	20879	20975	22117	23997	197.473	212.817	259.122	317.583
22	95	22095	LA	St. John the Baptist Pari	U1	SE	39996	41732	44005	47744	384.850	49.796	59.878	72.855
22	97	22097	LA	St. Landry Parish, LA	R	SE	80312	83015	87536	94974	585.315	809.927	1004.116	1245.949
22	99	22099	LA	St. Martin Parish, LA	R	SE	44097	46387	48914	53070	381.163	476.232	590.484	732.759
22	101	22101	LA	St. Mary Parish, LA	U2	SE	58086	57112	60223	65340	423.676	346.142	424.036	522.986
22	103	22103	LA	St. Tammany Parish, LA	U1	SE	144500	178863	188605	204630	1065.051	1561.154	1889.943	2308.610
22	105	22105	LA	Tangipahoa Parish, LA	R	SE	85709	93890	99004	107416	796.407	943.680	1157.613	1428.903
22	107	22107	LA	Tensas Parish, LA	R	SE	7103	6798	7168	7777	62.273	108.824	133.556	164.898
22	109	22109	LA	Terrebonne Parish, LA	U2	SE	96982	102303	107875	117041	601.857	788.556	960.858	1180.010
22	111	22111	LA	Union Parish, LA	R	SE	20796	21646	22825	24765	145.572	268.746	329.751	407.078
22	113	22113	LA	Vermilion Parish, LA	R	SE	50055	51459	54262	58872	315.451	539.384	661.639	816.679
22	115	22115	LA	Vernon Parish, LA	R	SE	61961	53279	56181	60954	355.529	582.009	713.752	880.880
22	117	22117	LA	Washington Parish, LA	R	SE	43185	43101	45449	49310	726.000	397.011	486.859	600.846
22	119	22119	LA	Webster Parish, LA	R	SE	41989	42510	44826	48634	279.113	363.609	439.325	536.976
22	121	22121	LA	West Baton Rouge Paris	U1	AT	19419	20318	21425	23245	351.995	258.573	331.910	425.240
22	123	22123	LA	West Carroll Parish, LA	R	SE	12093	12181	12845	13936	89.414	185.276	227.381	280.736
22	125	22125	LA	West Feliciana Parish, L	R	SE	12915	13224	13944	15129	62.473	197.870	242.836	299.828
22	127	22127	LA	Winn Parish, LA	R	SE	16496	17587	18545	20121	153.122	160.436	196.771	242.847
23	1	23001	ME	Androscoggin, ME	U2	NR	105259	101647	106204	113726	943.589	1095.505	1320.538	1629.480
23	3	23003	ME	Aroostook, ME	R	NN	86936	78500	82019	87828	956.407	780.029	970.427	1222.380
23	5	23005	ME	Cumberland, ME	U2	NR	243135	250252	261472	279990	2539.849	2788.563	3519.695	4514.134
23	7	23007	ME	Franklin, ME	R	NN	29008	29014	30315	32462	291.907	352.925	439.737	554.408
23	9	23009	ME	Hancock, ME	R	NN	46948	49254	51462	55107	406.225	540.350	673.102	848.499
23	11	23011	ME	Kennebec, ME	U2	NR	115904	115888	121083	129659	999.957	912.771	1134.651	1428.560
23	13	23013	ME	Knox, ME	R	NR	36310	37367	39042	41807	293.143	365.139	454.549	572.765
23	15	23015	ME	Lincoln, ME	R	NR	30357	31423	32832	35157	305.441	420.387	524.066	660.920
23	17	23017	ME	Oxford, ME	R	NN	52602	53608	56012	59979	479.847	630.629	785.704	990.536
23	19	23019	ME	Penobscot, ME	U2	NN	146601	143772	150217	160856	1517.716	1638.876	2011.580	2506.819
23	21	23021	ME	Piscataquis, ME	R	NN	18653	18363	19187	20545	184.533	222.544	277.263	349.538
23	23	23023	ME	Sagadahoc, ME	R	NR	33535	35359	36944	39561	276.080	278.753	346.633	436.525
23	25	23025	ME	Somerset, ME	R	NN	49767	51870	54195	58033	528.578	502.978	626.155	789.029
23	27	23027	ME	Waldo, ME	R	NN	33018	35591	37187	39821	378.711	385.626	480.400	605.600

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23	29	23029	ME	Washington, ME	R	NN	35308	35889	37498	40154	379.681	451.895	563.171	710.109
23	31	23031	ME	York, ME	R	NR	164587	172237	179959	192705	1389.092	1414.709	1757.072	2211.068
24	1	24001	MD	Allegany, MD	U2	PA	74946	72669	79201	86655	758.693	787.527	894.137	1044.983
24	3	24003	MD	Anne Arundel, MD	U1	PA	427239	463915	505615	553205	3260.051	3976.245	4896.204	6066.133
24	5	24005	MD	Baltimore, MD	U1	PA	692134	716587	780999	854508	5528.619	6463.586	7956.911	9856.594
24	9	24009	MD	Calvert, MD	U1	PA	51372	66836	72843	79700	458.642	706.706	931.040	1226.728
24	11	24011	MD	Caroline, MD	R	PA	27035	29171	31793	34786	306.436	370.107	473.172	604.566
24	13	24013	MD	Carroll, MD	U1	PA	123372	143570	156475	171202	1538.872	1326.701	1660.410	2077.254
24	15	24015	MD	Cecil, MD	U1	PA	71347	79422	86561	94708	1010.398	1035.276	1322.249	1691.292
24	17	24017	MD	Charles, MD	U1	PA	101154	113086	123251	134852	713.257	662.070	871.297	1147.263
24	19	24019	MD	Dorchester, MD	R	PA	30236	29942	32633	35705	315.741	294.072	375.813	480.046
24	21	24021	MD	Frederick, MD	U1	PA	150208	178500	194545	212855	1578.353	1577.636	2063.042	2706.181
24	23	24023	MD	Garrett, MD	R	PA	28138	29315	31950	34957	490.925	430.583	550.546	703.467
24	25	24025	MD	Harford, MD	U1	PA	182132	208213	226929	248288	1660.185	1671.799	2072.818	2578.766
24	27	24027	MD	Howard, MD	U1	PA	187328	222873	242906	265769	1204.193	1847.285	2278.580	2825.959
24	29	24029	MD	Kent, MD	R	PA	17842	18892	20590	22528	195.761	214.377	274.037	350.107
24	31	24031	MD	Montgomery, MD	U1	PA	762207	817543	891030	974895	5363.245	7020.783	9082.963	11837.415
24	33	24033	MD	Prince George's, MD	U1	PA	723373	763882	832545	910905	6128.590	6652.736	8601.300	11205.312
24	35	24035	MD	Queen Anne's, MD	U1	PA	33953	38359	41807	45742	337.756	519.567	650.497	813.987
24	37	24037	MD	St. Mary's, MD	R	PA	75974	84297	91874	100521	669.383	862.194	1102.067	1407.930
24	39	24039	MD	Somerset, MD	R	PA	23440	24326	26513	29008	231.654	316.516	404.651	517.006
24	41	24041	MD	Talbot, MD	R	PA	30549	32696	35635	38989	281.256	330.230	422.079	539.201
24	43	24043	MD	Washington, MD	U2	PA	121393	127189	138622	151669	1485.598	1423.194	1822.513	2342.306
24	45	24045	MD	Wicomico, MD	R	PA	74339	78607	85672	93736	707.943	784.601	1002.797	1281.037
24	47	24047	MD	Worcester, MD	R	PA	35028	41103	44797	49014	343.809	303.127	387.317	494.703
24	510	24510	MD	Baltimore City, MD	U1	PA	736014	668507	728597	797174	5963.897	6482.614	7957.461	9840.185
25	1	25001	MA	Barnstable, MA	U2	PA	186605	202482	211240	223696	1279.227	2150.411	2772.015	3579.599
25	3	25003	MA	Berkshire, MA	U2	PA	139352	134974	140812	149115	1633.616	847.920	996.500	1193.659
25	5	25005	MA	Bristol, MA	U1	PA	506325	514190	536430	568062	3550.746	4998.519	6124.914	7618.656
25	7	25007	MA	Dukes, MA	R	PA	11639	13301	13876	14695	75.723	101.599	125.901	157.786
25	9	25009	MA	Essex, MA	U1	PA	670080	688354	718128	760474	4754.978	5979.293	7319.570	9099.182
25	11	25011	MA	Franklin, MA	R	PA	70092	71163	74241	78618	1091.623	420.603	521.074	652.952
25	13	25013	MA	Hampden, MA	U1	PA	456310	443165	462333	489596	3228.568	3761.102	4529.748	5558.825
25	15	25015	MA	Hampshire, MA	U1	PA	146568	149626	156098	165303	1254.365	956.022	1159.165	1428.105
25	17	25017	MA	Middlesex, MA	U1	PA	1398468	1415097	1476304	1563358	9283.863	11542.630	14126.545	17558.533
25	19	25019	MA	Nantucket, MA	U2	PA	6012	7294	7610	8059	32.464	25.972	32.165	40.299
25	21	25021	MA	Norfolk, MA	U1	PA	616087	635935	663441	702563	4993.525	4878.203	5968.563	7417.310
25	23	25023	MA	Plymouth, MA	U1	PA	435276	458319	478142	506337	2882.564	3369.436	4152.915	5184.304
25	25	25025	MA	Suffolk, MA	U1	PA	663906	645901	673838	713573	2286.075	5193.250	6345.321	7878.847
25	27	25027	MA	Worcester, MA	U1	PA	709705	723278	754562	799057	5716.818	5592.893	6876.761	8571.921
26	1	26001	MI	Alcona, MI	R	MI	10145	10861	11109	11340	95.889	127.002	152.623	184.854
26	3	26003	MI	Alger, MI	R	MI	8972	9817	10041	10250	77.631	79.552	95.553	115.692
26	5	26005	MI	Allegan, MI	R	MI	90509	99146	101411	103520	772.292	930.389	1178.673	1498.564
26	7	26007	MI	Alpena, MI	R	MI	30605	30633	31333	31985	265.888	249.458	299.586	362.703

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26	9	26009	MI	Antrim, MI	R	MI	18185	20576	21047	21484	235.379	227.651	273.580	331.353
26	11	26011	MI	Arenac, MI	R	MI	14906	16196	16566	16911	185.692	186.917	224.626	272.060
26	13	26013	MI	Baraga, MI	R	MI	7954	8377	8569	8747	72.841	99.574	119.662	144.934
26	15	26015	MI	Barry, MI	R	MI	50057	53036	54248	55377	314.459	549.542	660.296	799.637
26	17	26017	MI	Bay, MI	U1	MI	111723	110609	113136	115489	1043.345	1067.398	1260.289	1504.092
26	19	26019	MI	Benzie, MI	R	MI	12200	13991	14311	14609	134.583	152.728	183.540	222.302
26	21	26021	MI	Berrien, MI	U2	MI	161378	160808	164483	167904	1573.748	1752.649	2050.037	2413.174
26	23	26023	MI	Branch, MI	R	MI	41502	43324	44314	45236	333.159	406.442	488.272	591.253
26	25	26025	MI	Calhoun, MI	U2	MI	135982	140987	144209	147208	1410.654	1240.666	1513.308	1855.869
26	27	26027	MI	Cass, MI	R	MI	49477	49897	51037	52099	341.836	530.963	637.511	771.728
26	29	26029	MI	Charlevoix, MI	R	MI	21468	23321	23854	24350	167.560	191.116	229.556	277.956
26	31	26031	MI	Cheboygan, MI	R	MI	21398	23230	23761	24255	225.964	209.018	251.099	304.065
26	33	26033	MI	Chippewa, MI	R	MI	34604	37429	38284	39081	268.185	260.254	312.504	378.312
26	35	26035	MI	Clare, MI	R	MI	24952	28431	29081	29686	220.432	276.892	332.703	402.918
26	37	26037	MI	Clinton, MI	U1	MI	57893	62345	63770	65096	606.908	576.437	712.988	886.384
26	39	26039	MI	Crawford, MI	R	MI	12260	13649	13960	14251	119.513	153.479	184.442	223.390
26	41	26041	MI	Delta, MI	R	MI	37780	38655	39538	40361	302.637	258.394	310.207	375.474
26	43	26043	MI	Dickinson, MI	U2	MI	26831	27029	27647	28222	178.680	138.481	166.126	200.999
26	45	26045	MI	Eaton, MI	U1	MI	92879	99131	101396	103505	794.886	824.596	1015.328	1258.886
26	47	26047	MI	Emmet, MI	R	MI	25040	27868	28505	29097	248.803	242.166	290.918	352.270
26	49	26049	MI	Genesee, MI	U1	MI	430459	434688	444621	453869	4488.457	4707.840	5377.994	6273.679
26	51	26051	MI	Gladwin, MI	R	MI	21896	24453	25012	25532	196.476	242.532	291.415	352.925
26	53	26053	MI	Gogebic, MI	R	MI	18052	17527	17927	18300	138.685	145.349	174.555	211.326
26	55	26055	MI	Grand Traverse, MI	R	MI	64273	71891	73534	75064	532.433	626.644	752.801	911.586
26	57	26057	MI	Gratiot, MI	R	MI	38982	39875	40786	41635	326.730	301.144	361.622	437.786
26	59	26059	MI	Hillsdale, MI	R	MI	43431	45839	46886	47861	382.394	447.509	537.649	651.073
26	61	26061	MI	Houghton, MI	R	MI	35446	35758	36575	37336	307.347	301.925	362.627	439.046
26	63	26063	MI	Huron, MI	R	MI	34951	35224	36029	36779	345.321	396.521	476.458	577.017
26	65	26065	MI	Ingham, MI	U1	MI	281912	283778	290263	296300	2091.450	2567.928	3130.787	3858.971
26	67	26067	MI	Ionia, MI	R	MI	57024	60528	61911	63199	563.364	527.927	634.155	767.873
26	69	26069	MI	Iosco, MI	R	MI	30209	25855	26446	26996	245.945	284.378	341.610	413.646
26	71	26071	MI	Iron, MI	R	MI	13175	13082	13381	13660	134.239	164.932	198.209	240.060
26	73	26073	MI	Isabella, MI	R	MI	54624	57195	58502	59718	431.130	409.627	491.860	595.437
26	75	26075	MI	Jackson, MI	U2	MI	149756	154547	158079	161367	1589.524	1689.932	2024.021	2441.573
26	77	26077	MI	Kalamazoo, MI	U2	MI	223411	228366	233585	238443	1808.398	2314.901	2818.400	3452.470
26	79	26079	MI	Kalkaska, MI	R	MI	13497	15172	15519	15841	165.025	168.964	203.052	245.930
26	81	26081	MI	Kent, MI	U1	MI	500631	533883	546083	557441	5008.125	5100.277	6371.118	8032.766
26	83	26083	MI	Keweenaw, MI	R	MI	1701	2024	2070	2113	19.325	21.295	25.590	30.990
26	85	26085	MI	Lake, MI	R	MI	8583	9929	10156	10367	120.335	107.449	129.125	156.394
26	87	26087	MI	Lapeer, MI	U1	MI	74768	85161	87107	88919	842.194	810.255	944.541	1111.905
26	89	26089	MI	Leelanau, MI	R	MI	16527	18437	18858	19250	189.415	206.414	248.056	300.443
26	91	26091	MI	Lenawee, MI	R	MI	91476	97066	99284	101349	739.412	729.424	930.542	1190.716
26	93	26093	MI	Livingston, MI	U1	MI	115645	138161	141318	144258	1178.949	1234.113	1575.158	2016.163
26	95	26095	MI	Luce, MI	R	MI	5763	6467	6614	6752	65.556	72.145	86.701	105.003

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26	97	26097	MI	Mackinac, MI	R	MI	10674	11050	11303	11538	110.595	103.390	124.203	150.396
26	99	26099	MI	Macomb, MI	U1	OI	717400	774015	791702	808169	5389.995	6721.796	7693.040	8958.108
26	101	26101	MI	Manistee, MI	R	MI	21265	22906	23429	23916	175.361	186.927	224.520	271.850
26	103	26103	MI	Marquette, MI	U2	MI	70887	63091	64533	65875	544.034	412.057	494.480	598.387
26	105	26105	MI	Mason, MI	R	MI	25537	27523	28152	28737	187.187	219.533	263.673	319.245
26	107	26107	MI	Mecosta, MI	R	MI	37308	38911	39800	40628	257.466	318.666	382.733	463.400
26	109	26109	MI	Menominee, MI	R	MI	24920	24511	25071	25593	214.750	201.317	241.768	292.709
26	111	26111	MI	Midland, MI	U1	MI	75651	80448	82287	83998	566.021	501.790	598.361	718.303
26	113	26113	MI	Missaukee, MI	R	MI	12147	13463	13770	14057	108.939	152.064	182.744	221.327
26	115	26115	MI	Monroe, MI	U1	MI	133600	141058	144281	147282	1418.493	1130.328	1313.330	1543.058
26	117	26117	MI	Montcalm, MI	R	MI	53059	58706	60047	61296	444.569	568.849	683.472	827.700
26	119	26119	MI	Montmorency, MI	R	MI	8936	9831	10056	10265	73.758	111.866	134.436	162.831
26	121	26121	MI	Muskegon, MI	U2	MI	158983	164896	168665	172173	1006.285	1449.957	1817.959	2297.174
26	123	26123	MI	Newaygo, MI	R	MI	38206	44080	45087	46025	272.739	432.615	519.826	629.548
26	125	26125	MI	Oakland, MI	U1	OI	1083592	1154666	1181052	1205616	8085.274	10262.520	11763.747	13711.035
26	127	26127	MI	Oceana, MI	R	MI	22455	24293	24848	25365	174.240	281.094	337.804	409.137
26	129	26129	MI	Ogemaw, MI	R	MI	18681	20630	21102	21540	207.538	203.616	244.648	296.281
26	131	26131	MI	Ontonagon, MI	R	MI	8854	8222	8410	8585	97.083	110.840	133.202	161.330
26	133	26133	MI	Osceola, MI	R	MI	20146	21759	22256	22719	238.979	252.201	303.081	367.086
26	135	26135	MI	Oscoda, MI	R	MI	7842	8701	8900	9085	67.519	98.171	117.978	142.885
26	137	26137	MI	Otsego, MI	R	MI	17957	21251	21737	22189	168.810	186.463	224.025	271.293
26	139	26139	MI	Ottawa, MI	U1	MI	187768	215741	220671	225260	1226.850	1756.518	2207.114	2792.536
26	141	26141	MI	Presque Isle, MI	R	MI	13743	14299	14626	14930	123.677	129.166	155.160	187.878
26	143	26143	MI	Roscommon, MI	R	MI	19776	22689	23207	23690	206.754	208.092	250.016	302.763
26	145	26145	MI	Saginaw, MI	U1	MI	211946	211373	216204	220700	1909.806	1976.126	2331.866	2781.978
26	147	26147	MI	St. Clair, MI	U1	MI	145607	155976	159540	162858	1430.347	1550.192	1790.548	2096.408
26	149	26149	MI	St. Joseph, MI	R	MI	58913	60902	62294	63590	438.197	530.970	637.783	772.242
26	151	26151	MI	Sanilac, MI	R	MI	39928	42335	43302	44203	401.567	499.845	600.687	727.529
26	153	26153	MI	Schoolcraft, MI	R	MI	8302	8684	8883	9067	67.469	63.241	75.940	91.934
26	155	26155	MI	Shiawassee, MI	R	MI	69770	71884	73526	75056	735.493	594.444	713.955	864.414
26	157	26157	MI	Tuscola, MI	R	MI	55498	57717	59036	60264	530.650	616.904	741.243	897.697
26	159	26159	MI	Van Buren, MI	R	MI	70060	74882	76593	78186	759.507	774.274	955.245	1179.635
26	161	26161	MI	Washtenaw, MI	U1	MI	282937	297136	303926	310248	2351.844	3053.640	3842.971	4877.764
26	163	26163	MI	Wayne, MI	U1	OI	2111687	2124887	2173443	2218648	17748.700	19784.628	22623.254	26329.493
26	165	26165	MI	Wexford, MI	R	MI	26360	28749	29406	30017	270.806	211.033	253.431	306.827
27	1	27001	MN	Aitkin, MN	R	MI	12425	13662	14855	15841	156.206	198.634	249.036	311.417
27	3	27003	MN	Anoka, MN	U1	MN	243641	280526	305034	325281	1827.986	2454.878	3096.664	3911.273
27	5	27005	MN	Becker, MN	R	MI	27881	29046	31583	33680	287.009	344.949	432.351	540.557
27	7	27007	MN	Beltrami, MN	R	MI	34384	38091	41419	44168	276.507	378.895	474.818	593.600
27	9	27009	MN	Benton, MN	U2	MI	30185	33173	36071	38465	237.276	326.480	407.925	510.373
27	11	27011	MN	Big Stone, MN	R	MI	6285	5774	6279	6695	70.232	100.475	125.972	157.531
27	13	27013	MN	Blue Earth, MN	U2	MI	54044	54038	58759	62659	388.474	386.048	483.389	604.025
27	15	27015	MN	Brown, MN	U2	MI	26984	27188	29563	31526	199.951	175.832	220.118	275.014
27	17	27017	MN	Carlton, MN	R	MI	29259	30485	33148	35348	359.288	315.250	395.047	493.859

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27	19	27019	MN	Carver, MN	U1	MN	47915	61015	66345	70749	313.157	457.894	583.807	742.188
27	21	27021	MN	Cass, MN	R	MI	21791	25181	27381	29198	245.312	348.363	436.759	546.174
27	23	27023	MN	Chippewa, MN	R	MI	13228	13049	14189	15131	122.929	116.760	146.264	182.813
27	25	27025	MN	Chisago, MN	U1	MN	30521	38165	41499	44254	430.305	487.925	626.155	799.160
27	27	27027	MN	Clay, MN	U2	MI	50422	51617	56126	59852	434.479	431.659	542.298	678.440
27	29	27029	MN	Clearwater, MN	R	MI	8309	8216	8934	9527	102.100	132.833	166.538	208.263
27	31	27031	MN	Cook, MN	R	MI	3868	4615	5019	5352	47.687	61.835	77.526	96.949
27	33	27033	MN	Cottonwood, MN	R	MI	12694	12319	13396	14285	137.079	137.884	172.788	216.011
27	35	27035	MN	Crow Wing, MN	R	MI	44249	50126	54505	58123	377.229	465.296	583.051	728.876
27	37	27037	MN	Dakota, MN	U1	MN	275189	326100	354590	378126	1754.615	2680.056	3378.264	4265.039
27	39	27039	MN	Dodge, MN	R	MI	15731	16820	18290	19504	150.335	198.114	248.317	310.472
27	41	27041	MN	Douglas, MN	R	MI	28674	30434	33093	35289	369.124	339.354	425.314	531.741
27	43	27043	MN	Faribault, MN	R	MI	16937	16504	17946	19137	242.048	213.886	268.086	335.186
27	45	27045	MN	Fillmore, MN	R	MI	20777	20702	22510	24004	235.366	332.152	416.437	520.750
27	47	27047	MN	Freeborn, MN	U2	MI	33060	31776	34552	36846	363.834	250.428	313.613	391.900
27	49	27049	MN	Goodhue, MN	R	MI	40690	42418	46124	49185	321.385	369.988	463.511	579.348
27	51	27051	MN	Grant, MN	R	MI	6246	6156	6694	7138	119.983	99.852	125.189	156.550
27	53	27053	MN	Hennepin, MN	U1	MN	1032431	1050214	1141967	1217765	8361.116	10237.863	12885.489	16252.769
27	55	27055	MN	Houston, MN	R	MI	18497	19124	20794	22175	173.415	205.384	261.877	333.918
27	57	27057	MN	Hubbard, MN	R	MI	14939	16498	17940	19130	141.320	195.339	244.852	306.137
27	59	27059	MN	Isanti, MN	U1	MN	25921	29038	31574	33670	250.545	337.022	432.396	551.784
27	61	27061	MN	Itasca, MN	R	MI	40863	43170	46942	50058	440.650	532.653	667.657	834.781
27	63	27063	MN	Jackson, MN	R	MI	11677	11697	12719	13563	180.808	132.622	166.205	207.783
27	65	27065	MN	Kanabec, MN	R	MI	12802	13865	15076	16077	119.409	160.539	201.219	251.583
27	67	27067	MN	Kandiyohi, MN	R	MI	38761	40757	44318	47260	305.683	353.399	442.728	553.365
27	69	27069	MN	Kittson, MN	R	MI	5767	5416	5890	6281	77.756	92.194	115.588	144.557
27	71	27071	MN	Koochiching, MN	U2	MI	16299	15770	17148	18286	139.774	134.126	167.998	209.963
27	73	27073	MN	Lac qui Parle, MN	R	MI	8924	8219	8937	9530	123.435	142.666	178.865	223.667
27	75	27075	MN	Lake, MN	R	MI	10415	10673	11605	12376	98.291	111.048	139.156	173.959
27	77	27077	MN	Lake of the Woods, MN	R	MI	4076	4473	4864	5186	43.866	65.162	81.695	102.163
27	79	27079	MN	Le Sueur, MN	R	MI	23239	24650	26803	28582	235.915	296.682	371.867	464.945
27	81	27081	MN	Lincoln, MN	R	MI	6890	6600	7177	7653	95.645	110.148	138.097	172.692
27	83	27083	MN	Lyon, MN	R	MI	24789	24557	26702	28474	207.571	213.687	267.674	334.556
27	85	27085	MN	McLeod, MN	U2	MI	32030	33451	36374	38788	240.287	266.447	333.742	417.105
27	87	27087	MN	Mahnomen, MN	R	MI	5044	5083	5527	5893	64.503	80.636	101.098	126.421
27	89	27089	MN	Marshall, MN	R	MI	10993	10592	11517	12282	151.815	175.739	220.335	275.524
27	91	27091	MN	Martin, MN	R	MI	22914	22339	24291	25903	266.825	195.224	244.543	305.634
27	93	27093	MN	Meeker, MN	R	MI	20846	21425	23297	24844	194.405	241.507	302.669	378.404
27	95	27095	MN	Mille Lacs, MN	R	MI	18670	20384	22165	23636	190.496	242.015	303.354	379.295
27	97	27097	MN	Morrison, MN	R	MI	29604	30373	33026	35219	285.596	363.428	455.507	569.494
27	99	27099	MN	Mower, MN	U2	MI	37385	37168	40415	43098	383.224	264.937	331.737	414.507
27	101	27101	MN	Murray, MN	R	MI	9660	9546	10380	11069	134.099	154.430	193.616	242.121
27	103	27103	MN	Nicollet, MN	U2	MI	28076	29755	32355	34502	173.208	151.280	189.282	236.411
27	105	27105	MN	Nobles, MN	R	MI	20098	19783	21511	22939	235.256	169.769	212.652	265.778

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27	107	27107	MN	Norman, MN	R	MI	7975	7754	8431	8991	109.298	127.494	159.844	199.885
27	109	27109	MN	Olmsted, MN	U2	MI	106470	113455	123367	131555	911.688	1004.812	1283.355	1633.276
27	111	27111	MN	Otter Tail, MN	R	MI	50714	53721	58414	62291	709.908	622.473	780.185	975.430
27	113	27113	MN	Pennington, MN	U2	MI	13306	13513	14693	15668	107.507	91.062	114.014	142.447
27	115	27115	MN	Pine, MN	R	MI	21264	23244	25275	26952	332.483	300.253	376.391	470.635
27	117	27117	MN	Pipestone, MN	R	MI	10491	10141	11027	11759	98.513	98.550	123.467	154.331
27	119	27119	MN	Polk, MN	U2	MI	32589	32162	34972	37293	273.800	295.383	355.746	430.177
27	121	27121	MN	Pope, MN	R	MI	10745	10880	11830	12615	116.368	132.576	166.166	207.755
27	123	27123	MN	Ramsey, MN	U1	MN	485783	484558	526892	561865	4076.615	4821.518	6066.854	7651.040
27	125	27125	MN	Red Lake, MN	R	MI	4525	4370	4752	5067	63.754	72.340	90.696	113.414
27	127	27127	MN	Redwood, MN	R	MI	17254	16741	18204	19412	185.169	202.034	253.205	316.559
27	129	27129	MN	Renville, MN	R	MI	17673	17153	18651	19889	216.109	242.693	304.225	380.394
27	131	27131	MN	Rice, MN	U2	MI	49183	52960	57587	61410	405.216	306.347	383.462	479.053
27	133	27133	MN	Rock, MN	R	MI	9806	9877	10740	11453	121.028	90.211	113.016	141.265
27	135	27135	MN	Roseau, MN	R	MI	15026	16120	17528	18691	146.535	240.215	301.168	376.607
27	137	27137	MN	St. Louis, MN	U2	MI	198213	195450	212525	226632	1935.209	1792.290	2109.427	2503.590
27	139	27139	MN	Scott, MN	U1	MN	57846	73473	79892	85195	389.309	505.226	642.652	815.841
27	141	27141	MN	Sherburne, MN	R	MN	41945	55592	60449	64462	274.877	418.966	536.565	683.979
27	143	27143	MN	Sibley, MN	R	MI	14366	14545	15816	16866	180.029	229.664	287.940	360.060
27	145	27145	MN	Stearns, MN	U2	MI	119324	126366	137406	146527	1306.396	1244.460	1556.044	1947.679
27	147	27147	MN	Steele, MN	U2	MI	30729	31416	34161	36429	274.667	196.820	246.383	307.819
27	149	27149	MN	Stevens, MN	U2	MI	10634	10209	11101	11838	90.503	84.754	106.148	132.656
27	151	27151	MN	Swift, MN	R	MI	10724	10811	11756	12536	122.346	122.307	153.280	191.624
27	153	27153	MN	Todd, MN	R	MI	23363	23881	25967	27691	348.487	295.383	370.235	462.907
27	155	27155	MN	Traverse, MN	R	MI	4463	4305	4681	4992	64.587	71.349	89.453	111.869
27	157	27157	MN	Wabasha, MN	R	MI	19744	20605	22405	23892	194.168	214.580	268.898	336.160
27	159	27159	MN	Wadena, MN	R	MI	13154	12983	14118	15055	127.079	141.851	177.758	222.214
27	161	27161	MN	Waseca, MN	R	MI	18079	18155	19741	21052	151.540	161.670	202.532	253.129
27	163	27163	MN	Washington, MN	U1	MN	145858	185021	201185	214539	1074.792	1349.005	1709.918	2166.108
27	165	27165	MN	Watonwan, MN	R	MI	11682	11733	12759	13605	110.490	120.475	150.960	188.723
27	167	27167	MN	Wilkin, MN	R	MI	7516	7388	8034	8567	91.777	63.838	79.964	99.945
27	169	27169	MN	Winona, MN	U2	MI	47828	48200	52411	55890	422.637	295.013	369.267	461.312
27	171	27171	MN	Wright, MN	U1	MN	68710	81092	88177	94030	888.360	805.629	1033.479	1318.726
27	173	27173	MN	Yellow Medicine, MN	R	MI	11684	11589	12601	13438	138.519	151.156	189.467	236.885
28	1	28001	MS	Adams, MS	U2	SE	35356	34648	37355	39330	258.290	307.161	372.986	456.405
28	3	28003	MS	Alcorn, MS	R	SE	31722	32595	35141	37000	271.074	341.558	415.557	509.082
28	5	28005	MS	Amite, MS	R	SE	13328	13643	14709	15486	141.324	201.594	245.839	301.581
28	7	28007	MS	Attala, MS	R	SE	18481	18405	19843	20892	168.123	197.892	240.756	294.929
28	9	28009	MS	Benton, MS	R	SE	8046	7983	8606	9061	86.185	121.701	148.412	182.056
28	11	28011	MS	Bolivar, MS	R	SE	41875	40750	43935	46258	357.284	390.268	474.223	580.517
28	13	28013	MS	Calhoun, MS	R	SE	14908	15019	16193	17049	165.583	225.492	274.984	337.332
28	15	28015	MS	Carroll, MS	R	SE	9237	9957	10735	11303	151.398	139.714	170.380	209.017
28	17	28017	MS	Chickasaw, MS	R	SE	18085	18247	19673	20713	148.314	189.681	230.725	282.612
28	19	28019	MS	Choctaw, MS	R	SE	9071	9277	10002	10530	95.099	137.203	167.318	205.250

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28	21	28021	MS	Claiborne, MS	R	SE	11370	11679	12592	13258	129.803	171.978	209.722	257.287
28	23	28023	MS	Clarke, MS	R	SE	17313	17900	19299	20319	235.880	230.370	280.712	344.197
28	25	28025	MS	Clay, MS	R	SE	21120	21507	23187	24413	173.098	220.159	267.784	328.003
28	27	28027	MS	Coahoma, MS	U2	SE	31665	31381	33833	35622	270.896	248.326	301.217	368.350
28	29	28029	MS	Copiah, MS	R	SE	27592	28710	30953	32590	316.270	301.969	367.439	450.157
28	31	28031	MS	Covington, MS	R	SE	16527	17367	18724	19714	168.364	220.259	268.394	329.098
28	33	28033	MS	DeSoto, MS	R	SE	67910	88575	95496	100545	659.905	882.184	1109.247	1399.208
28	35	28035	MS	Forrest, MS	U2	SE	68314	72981	78684	82844	589.582	842.102	1012.787	1232.199
28	37	28037	MS	Franklin, MS	R	SE	8377	8276	8923	9394	86.767	126.707	154.517	189.555
28	39	28039	MS	George, MS	R	SE	16673	18587	20039	21099	161.705	221.555	269.967	331.023
28	41	28041	MS	Greene, MS	R	SE	10220	11615	12523	13185	103.883	154.583	188.510	231.261
28	43	28043	MS	Grenada, MS	U2	SE	21555	22341	24087	25360	198.418	198.959	241.738	295.908
28	45	28045	MS	Hancock, MS	U2	SE	31760	38189	41174	43351	272.095	380.401	470.694	586.915
28	47	28047	MS	Harrison, MS	U2	SE	165365	174147	187755	197682	1199.271	2121.758	2608.825	3240.562
28	49	28049	MS	Hinds, MS	U1	SE	254441	248485	267901	282066	2501.994	3450.357	4294.001	5378.920
28	51	28051	MS	Holmes, MS	R	SE	21604	21450	23126	24349	300.101	293.542	357.736	438.689
28	53	28053	MS	Humphreys, MS	R	SE	12134	11426	12319	12970	130.422	153.870	187.434	229.790
28	55	28055	MS	Issaquena, MS	R	SE	1909	1676	1807	1902	26.562	28.875	35.212	43.202
28	57	28057	MS	Itawamba, MS	R	SE	20017	20903	22537	23728	198.614	263.152	320.631	393.131
28	59	28059	MS	Jackson, MS	U2	SE	115243	126650	136546	143766	970.488	1393.992	1716.058	2133.160
28	61	28061	MS	Jasper, MS	R	SE	17114	17543	18914	19914	267.380	258.859	315.673	387.265
28	63	28063	MS	Jefferson, MS	R	SE	8653	8506	9171	9656	97.053	130.880	159.607	195.799
28	65	28065	MS	Jefferson Davis, MS	R	SE	14051	13977	15069	15866	146.364	212.530	259.175	317.944
28	67	28067	MS	Jones, MS	R	SE	62031	63221	68161	71765	691.092	675.533	821.965	1007.001
28	69	28069	MS	Kemper, MS	R	SE	10356	10410	11223	11817	107.275	156.640	191.019	234.333
28	71	28071	MS	Lafayette, MS	R	SE	31826	34022	36680	38620	272.213	364.606	443.815	543.850
28	73	28073	MS	Lamar, MS	R	SE	30424	35053	37792	39791	334.362	430.383	522.640	639.543
28	75	28075	MS	Lauderdale, MS	U2	SE	75555	76565	82547	86912	689.849	633.548	769.041	940.831
28	77	28077	MS	Lawrence, MS	R	SE	12458	12876	13882	14616	132.330	188.434	229.792	281.893
28	79	28079	MS	Leake, MS	R	SE	18436	19255	20760	21858	179.133	234.161	285.244	349.691
28	81	28081	MS	Lee, MS	U2	SE	65579	72748	78433	82580	459.698	584.413	709.830	868.724
28	83	28083	MS	Leflore, MS	U2	SE	37341	37202	40109	42230	308.963	343.666	417.549	511.099
28	85	28085	MS	Lincoln, MS	R	SE	30278	31499	33961	35756	358.416	338.162	411.546	504.252
28	87	28087	MS	Lowndes, MS	R	SE	59308	60931	65693	69166	430.507	584.859	711.041	870.682
28	89	28089	MS	Madison, MS	U1	SE	53794	68446	73794	77696	481.226	657.878	824.761	1037.704
28	91	28091	MS	Marion, MS	R	SE	25544	26300	28355	29854	228.096	306.655	373.402	457.668
28	93	28093	MS	Marshall, MS	R	SE	30361	32110	34619	36450	268.558	374.298	455.855	558.788
28	95	28095	MS	Monroe, MS	R	SE	36582	37919	40882	43044	302.996	390.389	474.933	581.791
28	97	28097	MS	Montgomery, MS	R	SE	12387	12389	13357	14063	144.718	120.645	146.658	179.579
28	99	28099	MS	Neshoba, MS	R	SE	24800	26804	28898	30426	215.139	296.067	360.497	441.836
28	101	28101	MS	Newton, MS	R	SE	20291	21224	22882	24092	271.488	263.623	321.181	393.788
28	103	28103	MS	Noxubee, MS	R	SE	12604	12403	13372	14079	139.661	190.642	232.486	285.197
28	105	28105	MS	Oktibbeha, MS	R	SE	38375	39058	42110	44337	295.085	364.547	443.047	542.407
28	107	28107	MS	Panola, MS	R	SE	29996	32444	34979	36829	388.867	378.811	461.433	565.668

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
28	109	28109	MS	Pearl River, MS	R	SE	38714	44609	48095	50638	393.060	429.911	523.181	641.011
28	111	28111	MS	Perry, MS	R	SE	10865	11658	12569	13233	104.272	164.339	200.409	245.853
28	113	28113	MS	Pike, MS	R	SE	36882	37833	40790	42946	435.865	422.284	514.020	629.878
28	115	28115	MS	Pontotoc, MS	R	SE	22237	24394	26301	27691	194.454	282.893	344.610	422.467
28	117	28117	MS	Prentiss, MS	R	SE	23278	24073	25954	27327	208.104	238.963	290.620	355.933
28	119	28119	MS	Quitman, MS	R	SE	10490	9919	10694	11260	133.576	158.667	193.491	237.363
28	121	28121	MS	Rankin, MS	U1	SE	87161	104168	112308	118246	826.766	1232.427	1544.072	1942.015
28	123	28123	MS	Scott, MS	R	SE	24137	24980	26932	28356	294.266	268.330	326.549	400.097
28	125	28125	MS	Sharkey, MS	R	SE	7066	6679	7201	7582	69.563	106.878	130.335	159.888
28	127	28127	MS	Simpson, MS	R	SE	23953	25027	26983	28409	213.752	320.113	390.077	478.307
28	129	28129	MS	Smith, MS	R	SE	14798	15091	16270	17131	159.382	223.829	272.955	334.838
28	131	28131	MS	Stone, MS	R	SE	10750	12571	13554	14270	84.610	125.345	152.597	187.006
28	133	28133	MS	Sunflower, MS	R	SE	35129	34944	37674	39666	288.819	321.341	390.641	478.330
28	135	28135	MS	Tallahatchie, MS	R	SE	15210	15086	16264	17124	165.115	230.059	280.554	344.164
28	137	28137	MS	Tate, MS	R	SE	21432	23265	25082	26409	261.019	268.355	326.863	400.694
28	139	28139	MS	Tippah, MS	R	SE	19523	20702	22320	23500	173.980	232.472	283.059	346.912
28	141	28141	MS	Tishomingo, MS	R	SE	17683	18437	19878	20929	178.802	230.948	281.383	344.993
28	143	28143	MS	Tunica, MS	R	SE	8164	8102	8735	9197	102.033	123.486	150.588	184.734
28	145	28145	MS	Union, MS	R	SE	22085	23399	25227	26561	189.885	254.802	310.174	380.097
28	147	28147	MS	Walthall, MS	R	SE	14352	14335	15455	16272	145.469	217.083	264.727	324.753
28	149	28149	MS	Warren, MS	R	SE	47880	49027	52858	55653	543.062	479.656	583.222	714.227
28	151	28151	MS	Washington, MS	U2	SE	67935	66115	71281	75050	473.259	382.269	461.660	563.081
28	153	28153	MS	Wayne, MS	R	SE	19517	20027	21592	22734	172.083	235.049	286.218	350.805
28	155	28155	MS	Webster, MS	R	SE	10222	10385	11196	11788	108.882	154.614	188.549	231.300
28	157	28157	MS	Wilkinson, MS	R	SE	9678	9265	9989	10517	105.932	146.386	178.514	218.989
28	159	28159	MS	Winston, MS	R	SE	19433	19291	20798	21898	164.524	210.081	255.604	313.140
28	161	28161	MS	Yalobusha, MS	R	SE	12033	12287	13247	13947	161.671	139.782	170.164	208.536
28	163	28163	MS	Yazoo, MS	R	SE	25506	25407	27392	28840	298.243	240.402	292.149	357.657
29	1	29001	MO	Adair, MO	U2	ND	24577	24339	26190	27786	155.128	149.355	185.557	231.709
29	3	29003	MO	Andrew, MO	R	ND	14632	15226	16384	17383	211.934	166.128	200.620	242.579
29	5	29005	MO	Atchison, MO	R	ND	7457	7183	7729	8200	190.736	127.934	159.402	199.401
29	7	29007	MO	Audrain, MO	U2	ND	23599	23572	25365	26912	190.522	182.806	227.335	284.042
29	9	29009	MO	Barry, MO	R	ND	27547	31952	34382	36478	265.161	401.546	500.176	625.560
29	11	29011	MO	Barton, MO	R	ND	11312	11858	12760	13538	104.289	127.903	159.234	199.088
29	13	29013	MO	Bates, MO	R	ND	15025	15731	16928	17960	160.971	192.700	239.972	300.083
29	15	29015	MO	Benton, MO	R	ND	13859	16148	17376	18435	152.068	237.769	296.255	370.578
29	17	29017	MO	Bollinger, MO	R	ND	10619	11384	12250	12997	128.576	182.182	226.995	283.951
29	19	29019	MO	Boone, MO	U2	ND	112379	126033	135619	143887	1273.866	1342.764	1737.986	2258.708
29	21	29021	MO	Buchanan, MO	U2	ND	83083	81971	88206	93583	667.045	777.224	926.723	1112.066
29	23	29023	MO	Butler, MO	R	ND	38765	40173	43229	45864	315.442	395.243	491.935	614.959
29	25	29025	MO	Caldwell, MO	R	ND	8380	8647	9304	9871	108.093	143.771	179.133	224.078
29	27	29027	MO	Callaway, MO	R	ND	32809	36343	39107	41491	463.405	398.537	496.246	620.507
29	29	29029	MO	Camden, MO	R	ND	27495	32428	34894	37021	249.853	391.112	487.157	609.273
29	31	29031	MO	Cape Girardeau, MO	U2	ND	61633	65385	70358	74647	524.662	363.730	451.838	564.173

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
29	33	29033	MO	Carroll, MO	R	ND	10748	10263	11043	11717	108.920	114.449	142.462	178.102
29	35	29035	MO	Carter, MO	R	ND	5515	6226	6700	7108	67.753	94.617	117.891	147.463
29	37	29037	MO	Cass, MO	U1	ND	63808	75883	81655	86633	427.850	790.282	997.212	1264.265
29	39	29039	MO	Cedar, MO	R	ND	12093	12895	13876	14722	113.476	146.668	182.626	228.353
29	41	29041	MO	Chariton, MO	R	ND	9202	8852	9526	10106	130.925	157.871	196.706	246.053
29	43	29043	MO	Christian, MO	R	ND	32644	44915	48331	51277	228.591	417.965	556.207	741.857
29	45	29045	MO	Clark, MO	R	ND	7547	7510	8081	8574	106.013	129.479	161.327	201.798
29	47	29047	MO	Clay, MO	U1	ND	153411	171089	184101	195325	1336.204	1806.547	2258.835	2847.985
29	49	29049	MO	Clinton, MO	R	ND	16595	18331	19725	20927	282.050	224.526	285.405	363.431
29	51	29051	MO	Cole, MO	U2	ND	63579	68066	73243	77708	403.372	532.360	662.212	827.527
29	53	29053	MO	Cooper, MO	R	ND	14835	15914	17124	18168	196.010	141.878	176.554	220.687
29	55	29055	MO	Crawford, MO	R	ND	19173	21606	23249	24666	386.700	271.135	337.714	422.358
29	57	29057	MO	Dade, MO	R	ND	7449	7873	8472	8989	92.153	127.797	159.232	199.179
29	59	29059	MO	Dallas, MO	R	ND	12646	14781	15905	16875	150.987	216.958	270.325	338.147
29	61	29061	MO	Daviess, MO	R	ND	7865	7800	8393	8905	197.384	134.934	168.124	210.308
29	63	29063	MO	DeKalb, MO	R	ND	9967	10936	11767	12485	169.498	154.264	192.177	240.363
29	65	29065	MO	Dent, MO	R	ND	13702	14025	15092	16012	140.915	163.858	204.023	255.107
29	67	29067	MO	Douglas, MO	R	ND	11876	12239	13169	13972	119.742	157.106	195.659	244.684
29	69	29069	MO	Dunklin, MO	R	ND	33112	32850	35348	37503	306.480	313.057	389.558	486.922
29	71	29071	MO	Franklin, MO	U1	SL	80603	89512	96320	102192	846.171	876.293	1074.067	1326.927
29	73	29073	MO	Gasconade, MO	R	ND	14006	14655	15769	16731	140.146	196.569	244.836	306.193
29	75	29075	MO	Gentry, MO	R	ND	6854	6856	7377	7827	98.447	117.486	146.385	183.112
29	77	29077	MO	Greene, MO	U2	ND	207949	223059	240023	254656	2183.926	2406.862	3160.757	4182.242
29	79	29079	MO	Grundy, MO	U2	ND	10536	10285	11067	11742	87.673	83.458	103.796	129.687
29	81	29081	MO	Harrison, MO	R	ND	8469	8406	9045	9596	162.032	97.592	121.504	151.902
29	83	29083	MO	Henry, MO	U2	ND	20044	20920	22511	23883	143.271	158.916	197.641	246.962
29	85	29085	MO	Hickory, MO	R	ND	7335	8450	9093	9647	79.473	125.842	156.796	196.128
29	87	29087	MO	Holt, MO	R	ND	6034	5687	6119	6492	152.542	103.521	128.985	161.347
29	89	29089	MO	Howard, MO	R	ND	9631	9753	10494	11134	97.939	119.385	148.658	185.890
29	91	29091	MO	Howell, MO	R	ND	31447	34978	37638	39932	289.546	398.015	495.641	619.782
29	93	29093	MO	Iron, MO	R	ND	10726	10975	11810	12530	138.349	184.019	229.284	286.797
29	95	29095	MO	Jackson, MO	U1	ND	633234	645867	694989	737359	5572.851	7751.196	9673.856	12183.331
29	97	29097	MO	Jasper, MO	U2	ND	90465	97620	105044	111448	927.533	1119.267	1434.040	1837.010
29	99	29099	MO	Jefferson, MO	U1	SL	171380	190091	204549	217019	1264.798	2218.531	2700.530	3322.609
29	101	29101	MO	Johnson, MO	R	ND	42514	46664	50213	53275	323.690	421.112	524.091	655.115
29	103	29103	MO	Knox, MO	R	ND	4482	4384	4718	5005	68.751	76.894	95.809	119.844
29	105	29105	MO	Laclede, MO	R	ND	27158	29949	32227	34191	363.476	307.445	382.758	478.554
29	107	29107	MO	Lafayette, MO	U1	ND	31107	32322	34780	36900	427.806	323.362	410.795	522.921
29	109	29109	MO	Lawrence, MO	R	ND	30236	32477	34947	37077	428.633	324.468	403.899	504.949
29	111	29111	MO	Lewis, MO	R	ND	10233	10170	10943	11610	136.067	133.918	166.777	208.564
29	113	29113	MO	Lincoln, MO	R	ND	28892	34283	36890	39139	253.279	435.145	533.725	659.647
29	115	29115	MO	Linn, MO	U2	ND	13885	13954	15016	15931	116.581	118.735	147.707	184.590
29	117	29117	MO	Livingston, MO	U2	ND	14592	14386	15480	16424	114.229	110.576	137.501	171.795
29	119	29119	MO	McDonald, MO	R	ND	16938	19338	20809	22077	186.195	290.592	362.072	452.912

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29	121	29121	MO	Macon, MO	R	ND	15345	15282	16445	17447	152.239	174.821	217.649	272.121
29	123	29123	MO	Madison, MO	R	ND	11127	11516	12392	13147	97.355	127.951	159.303	199.171
29	125	29125	MO	Maries, MO	R	ND	7976	8280	8910	9453	94.254	136.838	170.498	213.272
29	127	29127	MO	Marion, MO	U2	ND	27682	27803	29917	31741	154.118	133.184	165.274	206.240
29	129	29129	MO	Mercer, MO	R	ND	3723	3957	4258	4518	58.471	63.872	79.584	99.548
29	131	29131	MO	Miller, MO	R	ND	20700	22322	24019	25484	192.039	283.504	353.100	441.582
29	133	29133	MO	Mississippi, MO	U2	ND	14442	13625	14661	15555	183.346	112.814	140.297	175.301
29	135	29135	MO	Moniteau, MO	R	ND	12298	13072	14066	14924	120.052	155.980	194.239	242.884
29	137	29137	MO	Monroe, MO	R	ND	9104	9040	9727	10320	101.497	120.565	150.152	187.778
29	139	29139	MO	Montgomery, MO	R	ND	11355	11776	12671	13444	255.725	194.809	242.728	303.632
29	141	29141	MO	Morgan, MO	R	ND	15574	17719	19067	20230	172.341	267.192	332.915	416.435
29	143	29143	MO	New Madrid, MO	R	ND	20928	20582	22147	23497	372.937	240.236	299.094	373.957
29	145	29145	MO	Newton, MO	R	ND	44445	47762	51395	54528	654.643	589.933	762.647	982.297
29	147	29147	MO	Nodaway, MO	R	ND	21709	21025	22624	24003	188.093	203.166	252.809	315.976
29	149	29149	MO	Oregon, MO	R	ND	9470	9887	10639	11288	127.796	162.470	202.433	253.223
29	151	29151	MO	Osage, MO	R	ND	12018	12456	13403	14220	149.960	206.183	256.901	321.351
29	153	29153	MO	Ozark, MO	R	ND	8598	9468	10188	10809	99.369	147.509	183.794	229.902
29	155	29155	MO	Pemiscot, MO	R	ND	21921	21577	23218	24634	333.575	206.819	257.359	321.676
29	157	29157	MO	Perry, MO	R	ND	16648	17359	18680	19819	236.356	175.554	218.518	273.181
29	159	29159	MO	Pettis, MO	U2	ND	35437	36595	39378	41779	263.696	292.507	363.836	454.653
29	161	29161	MO	Phelps, MO	R	ND	35248	38005	40895	43388	438.210	329.349	409.820	512.232
29	163	29163	MO	Pike, MO	R	ND	15969	16116	17342	18399	153.415	163.412	203.389	254.255
29	165	29165	MO	Platte, MO	U1	ND	57867	67135	72241	76645	606.570	744.812	934.770	1181.241
29	167	29167	MO	Polk, MO	R	ND	21826	24936	26832	28468	181.389	265.785	330.948	413.817
29	169	29169	MO	Pulaski, MO	R	ND	41307	38623	41561	44095	485.154	405.929	505.184	631.481
29	171	29171	MO	Putnam, MO	R	ND	5079	4960	5337	5662	76.042	87.136	108.570	135.806
29	173	29173	MO	Ralls, MO	R	ND	8476	8781	9449	10025	109.671	141.986	176.905	221.292
29	175	29175	MO	Randolph, MO	U2	ND	24370	23957	25779	27351	196.407	214.274	266.580	333.152
29	177	29177	MO	Ray, MO	U1	ND	21968	23038	24790	26301	215.682	283.133	359.869	458.225
29	179	29179	MO	Reynolds, MO	R	ND	6661	6696	7205	7645	90.245	114.278	142.388	178.112
29	181	29181	MO	Ripley, MO	R	ND	12303	13663	14702	15599	155.500	211.073	262.993	328.970
29	183	29183	MO	St. Charles, MO	U1	SL	212751	256914	276454	293308	1450.798	2619.167	3162.867	3872.884
29	185	29185	MO	St. Clair, MO	R	ND	8457	8994	9678	10268	107.621	145.090	180.779	226.135
29	187	29187	MO	St. Francios, MO	R	ND	48904	53785	57875	61404	350.899	451.189	561.410	701.684
29	189	29189	MO	St. Louis, MO	U1	SL	993508	1002154	1078372	1144116	7405.957	11768.326	14162.742	17306.259
29	193	29193	MO	Ste. Genevieve, MO	R	ND	16037	17046	18342	19461	253.681	205.108	255.424	319.392
29	195	29195	MO	Saline, MO	U2	ND	23523	22980	24728	26236	316.191	201.775	251.009	313.691
29	197	29197	MO	Schuyler, MO	R	ND	4236	4354	4685	4971	62.147	72.673	90.551	113.262
29	199	29199	MO	Scotland, MO	R	ND	4822	4828	5195	5512	67.588	82.728	103.077	128.927
29	201	29201	MO	Scott, MO	U2	ND	39376	40178	43234	45870	448.919	290.455	361.144	451.177
29	203	29203	MO	Shannon, MO	R	ND	7613	8079	8694	9224	98.421	130.609	162.737	203.568
29	205	29205	MO	Shelby, MO	R	ND	6942	6836	7356	7804	97.685	119.099	148.394	185.622
29	207	29207	MO	Stoddard, MO	R	ND	28895	29471	31712	33646	298.386	375.728	467.913	585.129
29	209	29209	MO	Stone, MO	R	ND	19078	25428	27362	29030	194.558	327.309	407.817	510.139

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29	211	29211	MO	Sullivan, MO	R	ND	6326	6611	7113	7547	92.798	108.530	135.227	169.149
29	213	29213	MO	Taney, MO	R	ND	25561	32762	35254	37403	232.402	337.976	420.912	526.376
29	215	29215	MO	Texas, MO	R	ND	21476	22304	24000	25464	262.996	368.447	459.077	574.250
29	217	29217	MO	Vernon, MO	R	ND	19041	19146	20602	21858	165.402	190.192	236.707	295.882
29	219	29219	MO	Warren, MO	R	ND	19534	23041	24794	26305	270.798	278.549	341.620	422.190
29	221	29221	MO	Washington, MO	R	ND	20380	22357	24057	25524	201.596	307.130	382.595	478.513
29	223	29223	MO	Wayne, MO	R	ND	11543	12671	13635	14466	140.760	198.035	246.747	308.653
29	225	29225	MO	Webster, MO	R	ND	23753	27773	29885	31707	380.967	338.073	449.988	600.268
29	227	29227	MO	Worth, MO	R	ND	2440	2348	2527	2681	37.548	41.861	52.157	65.251
29	229	29229	MO	Wright, MO	R	ND	16758	19081	20532	21784	166.105	221.225	275.510	344.540
29	510	29510	MO	St. Louis City, MO	U1	ND	396685	349700	376296	399237	2479.762	4681.566	5631.206	6878.968
30	1	30001	MT	Beaverhead, MT	R	ID	8424	8928	10264	11034	86.747	92.338	119.481	153.666
30	3	30003	MT	Big Horn, MT	R	ID	11337	12434	14295	15367	145.884	163.947	212.386	273.358
30	5	30005	MT	Blaine, MT	R	ID	6728	7031	8083	8689	120.210	125.771	163.068	209.977
30	7	30007	MT	Broadwater, MT	R	ID	3318	3974	4568	4911	56.112	62.026	80.420	103.546
30	9	30009	MT	Carbon, MT	R	ID	8080	9233	10615	11411	139.101	151.045	195.838	252.166
30	11	30011	MT	Carter, MT	R	ID	1503	1503	1728	1858	30.898	28.097	36.429	46.906
30	13	30013	MT	Cascade, MT	U2	ID	77691	78928	90740	97546	550.593	741.736	868.065	1026.068
30	15	30015	MT	Chouteau, MT	R	ID	5452	5267	6055	6509	104.633	101.917	132.141	170.156
30	17	30017	MT	Custer, MT	U2	ID	11697	12055	13859	14899	95.117	80.565	103.951	133.458
30	19	30019	MT	Daniels, MT	R	ID	2266	2087	2399	2579	48.691	42.360	54.922	70.719
30	21	30021	MT	Dawson, MT	U2	ID	9505	9113	10477	11263	121.793	99.309	128.470	165.202
30	23	30023	MT	Deer Lodge, MT	U2	ID	10356	10047	11550	12416	45.473	69.447	89.591	115.006
30	25	30025	MT	Fallon, MT	R	ID	3103	3045	3500	3763	64.632	58.006	75.209	96.838
30	27	30027	MT	Fergus, MT	U2	ID	12083	12439	14300	15373	128.376	127.116	164.449	211.471
30	29	30029	MT	Flathead, MT	R	ID	59218	69923	80388	86417	605.305	723.586	936.751	1205.124
30	31	30031	MT	Gallatin, MT	U2	ID	50463	59590	68508	73647	443.090	517.830	669.826	861.293
30	33	30033	MT	Garfield, MT	R	ID	1589	1465	1684	1810	28.444	29.704	38.513	49.588
30	35	30035	MT	Glacier, MT	R	ID	12121	12606	14493	15580	132.594	172.252	223.133	287.175
30	37	30037	MT	Golden Valley, MT	R	ID	912	1031	1185	1274	17.621	17.049	22.103	28.472
30	39	30039	MT	Granite, MT	R	ID	2548	2620	3012	3238	46.371	47.632	61.757	79.526
30	41	30041	MT	Hill, MT	U2	ID	17654	17555	20182	21696	161.402	161.551	208.839	268.435
30	43	30043	MT	Jefferson, MT	R	ID	7939	9601	11038	11866	120.723	148.408	192.420	247.767
30	45	30045	MT	Judith Basin, MT	R	ID	2282	2311	2657	2856	45.444	42.659	55.311	71.207
30	47	30047	MT	Lake, MT	R	ID	21041	24727	28427	30560	289.404	340.224	440.923	567.602
30	49	30049	MT	Lewis and Clark, MT	U2	ID	47495	52429	60275	64796	415.026	312.143	402.591	516.762
30	51	30051	MT	Liberty, MT	R	ID	2295	2377	2733	2938	39.999	42.902	55.625	71.628
30	53	30053	MT	Lincoln, MT	R	ID	17481	18588	21369	22972	267.678	283.631	367.584	473.186
30	55	30055	MT	McCone, MT	R	ID	2276	2069	2379	2558	46.408	42.546	55.165	71.023
30	57	30057	MT	Madison, MT	R	ID	5989	6769	7782	8366	93.570	111.956	145.158	186.903
30	59	30059	MT	Meagher, MT	R	ID	1819	1807	2077	2233	36.995	34.005	44.088	56.776
30	61	30061	MT	Mineral, MT	R	ID	3315	3666	4215	4531	63.120	61.970	80.346	103.463
30	63	30063	MT	Missoula, MT	U2	ID	78687	87371	100447	107981	651.560	877.146	1124.013	1437.137
30	65	30065	MT	Musselshell, MT	R	ID	4106	4534	5212	5603	76.054	76.756	99.519	128.137

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	Population 1996	Population 2007	Population 2020	Annual VMT (Millions) 1990	Annual VMT (Millions) 1996	Annual VMT (Millions) 2007	Annual VMT (Millions) 2020
30	67	30067	MT	Park, MT	R	ID	14484	15706	18057	19411	122.721	162.850	210.740	271.049
30	69	30069	MT	Petroleum, MT	R	ID	519	518	596	640	11.251	9.702	12.578	16.210
30	71	30071	MT	Phillips, MT	R	ID	5163	4941	5680	6107	92.176	96.516	125.137	161.138
30	73	30073	MT	Pondera, MT	R	ID	6433	6431	7394	7948	73.974	73.742	95.439	122.748
30	75	30075	MT	Powder River, MT	R	ID	2090	1935	2224	2391	43.284	39.070	50.655	65.228
30	77	30077	MT	Powell, MT	U2	ID	6620	7007	8056	8660	65.022	69.174	89.487	115.068
30	79	30079	MT	Prairie, MT	R	ID	1383	1342	1543	1658	31.533	25.854	33.519	43.164
30	81	30081	MT	Ravalli, MT	R	ID	25010	33191	38158	41020	350.283	422.858	548.091	705.626
30	83	30083	MT	Richland, MT	R	ID	10716	10266	11802	12688	132.729	115.172	149.016	191.630
30	85	30085	MT	Roosevelt, MT	R	ID	10999	11104	12765	13723	138.144	158.606	205.469	264.441
30	87	30087	MT	Rosebud, MT	R	ID	10505	10251	11786	12669	135.441	144.395	187.024	240.669
30	89	30089	MT	Sanders, MT	R	ID	8669	10027	11527	12392	148.997	162.056	210.114	270.541
30	91	30091	MT	Sheridan, MT	R	ID	4732	4397	5055	5434	92.986	88.457	114.690	147.681
30	93	30093	MT	Silver Bow, MT	U2	ID	33941	34370	39513	42477	150.394	121.753	155.972	199.380
30	95	30095	MT	Stillwater, MT	R	ID	6536	7649	8794	9454	96.148	122.182	158.415	203.989
30	97	30097	MT	Sweet Grass, MT	R	ID	3154	3365	3868	4159	55.233	58.959	76.445	98.438
30	99	30099	MT	Teton, MT	R	ID	6271	6330	7278	7823	111.485	117.228	151.993	195.710
30	101	30101	MT	Toole, MT	U2	ID	5046	4851	5577	5995	52.929	49.235	63.667	81.854
30	103	30103	MT	Treasure, MT	R	ID	874	844	970	1043	16.848	16.339	21.184	27.274
30	105	30105	MT	Valley, MT	R	ID	8239	8287	9527	10242	115.712	95.686	123.845	159.310
30	107	30107	MT	Wheatland, MT	R	ID	2246	2321	2668	2868	40.516	41.988	54.437	70.101
30	109	30109	MT	Wibaux, MT	R	ID	1191	1118	1285	1382	25.350	22.264	28.867	37.167
30	111	30111	MT	Yellowstone, MT	U2	ID	113419	124006	142565	153259	904.172	1216.675	1619.329	2133.243
30	113	30113	MT	Yellowstone National Pa	R	ID	52	41	47	50	4.726	0.971	1.260	1.618
31	1	31001	NE	Adams, NE	U2	ND	29625	29728	32037	34040	166.248	153.867	189.018	232.465
31	3	31003	NE	Antelope, NE	R	ND	7965	7448	8027	8528	102.461	146.971	181.204	223.350
31	5	31005	NE	Arthur, NE	R	ND	462	433	466	496	6.060	8.525	10.510	12.959
31	7	31007	NE	Banner, NE	R	ND	852	864	931	989	10.846	15.720	19.383	23.891
31	9	31009	NE	Blaine, NE	R	ND	675	643	693	737	10.239	12.455	15.356	18.929
31	11	31011	NE	Boone, NE	R	ND	6667	6420	6919	7351	87.295	123.019	151.674	186.953
31	13	31013	NE	Box Butte, NE	U2	ND	13130	12950	13956	14828	77.900	74.327	91.344	112.378
31	15	31015	NE	Boyd, NE	R	ND	2835	2664	2871	3051	39.343	52.311	64.498	79.493
31	17	31017	NE	Brown, NE	R	ND	3657	3617	3898	4141	51.698	67.479	83.197	102.545
31	19	31019	NE	Buffalo, NE	U2	ND	37447	39807	42898	45580	399.927	271.385	333.863	410.959
31	21	31021	NE	Burt, NE	R	ND	7868	7885	8498	9029	104.092	145.180	178.997	220.626
31	23	31023	NE	Butler, NE	R	ND	8601	8591	9258	9837	88.831	115.313	142.097	175.086
31	25	31025	NE	Cass, NE	R	ND	21318	23619	25453	27044	358.989	283.079	356.356	448.357
31	27	31027	NE	Cedar, NE	R	ND	10131	9863	10629	11293	134.355	186.937	230.482	284.073
31	29	31029	NE	Chase, NE	R	ND	4381	4266	4597	4885	56.200	80.838	99.667	122.851
31	31	31031	NE	Cherry, NE	R	ND	6307	6391	6887	7318	55.781	67.771	83.473	102.826
31	33	31033	NE	Cheyenne, NE	U2	ND	9494	9537	10278	10920	117.781	72.693	89.448	110.116
31	35	31035	NE	Clay, NE	R	ND	7123	7149	7704	8186	95.745	131.433	162.048	199.733
31	37	31037	NE	Colfax, NE	R	ND	9139	10345	11148	11845	81.538	98.942	121.868	150.106
31	39	31039	NE	Cuming, NE	R	ND	10117	9994	10770	11443	107.099	130.782	161.146	198.558

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	Population 1996	Population 2007	Population 2020	Annual VMT (Millions) 1990	Annual VMT (Millions) 1996	Annual VMT (Millions) 2007	Annual VMT (Millions) 2020
31	41	31041	NE	Custer, NE	R	ND	12270	12112	13053	13869	130.086	161.429	198.917	245.084
31	43	31043	NE	Dakota, NE	U2	ND	16742	18447	19880	21122	201.344	169.288	207.197	255.872
31	45	31045	NE	Dawes, NE	U2	ND	9021	9036	9737	10346	63.083	70.347	86.565	106.576
31	47	31047	NE	Dawson, NE	U2	ND	19940	22678	24439	25967	227.037	133.063	163.646	201.397
31	49	31049	NE	Deuel, NE	R	ND	2237	2055	2215	2353	59.424	41.277	50.892	62.733
31	51	31051	NE	Dixon, NE	R	ND	6143	6378	6873	7303	84.290	113.350	139.755	172.260
31	53	31053	NE	Dodge, NE	U2	ND	34500	35036	37757	40117	219.621	229.321	282.023	347.082
31	55	31055	NE	Douglas, NE	U1	ND	416444	437497	471477	500951	2930.811	3832.871	4741.342	5904.044
31	57	31057	NE	Dundy, NE	R	ND	2582	2351	2533	2691	33.792	47.644	58.741	72.401
31	59	31059	NE	Fillmore, NE	R	ND	7103	6921	7459	7925	93.543	131.065	161.594	199.176
31	61	31061	NE	Franklin, NE	R	ND	3938	3837	4135	4393	51.698	72.665	89.589	110.427
31	63	31063	NE	Frontier, NE	R	ND	3101	3169	3415	3628	43.072	57.219	70.550	86.940
31	65	31065	NE	Furnas, NE	R	ND	5553	5443	5866	6233	76.605	102.462	126.330	155.714
31	67	31067	NE	Gage, NE	U2	ND	22794	22865	24641	26181	179.320	208.116	256.224	315.539
31	69	31069	NE	Garden, NE	R	ND	2460	2258	2433	2585	33.092	45.392	55.965	68.981
31	71	31071	NE	Garfield, NE	R	ND	2141	2089	2251	2392	27.911	39.507	48.709	60.027
31	73	31073	NE	Gosper, NE	R	ND	1928	2237	2410	2561	25.273	35.576	43.862	54.067
31	75	31075	NE	Grant, NE	R	ND	769	740	797	847	10.357	14.190	17.494	21.570
31	77	31077	NE	Greeley, NE	R	ND	3006	2946	3175	3373	40.888	55.467	68.386	84.298
31	79	31079	NE	Hall, NE	U2	ND	48925	51282	55265	58720	461.134	225.362	276.671	340.129
31	81	31081	NE	Hamilton, NE	R	ND	8862	9346	10072	10702	147.215	97.993	120.705	148.691
31	83	31083	NE	Harlan, NE	R	ND	3810	3778	4072	4326	50.694	70.301	86.678	106.834
31	85	31085	NE	Hayes, NE	R	ND	1222	1105	1190	1265	16.019	22.549	27.800	34.263
31	87	31087	NE	Hitchcock, NE	R	ND	3750	3465	3734	3967	48.174	69.194	85.313	105.154
31	89	31089	NE	Holt, NE	R	ND	12599	12270	13223	14049	125.662	166.224	204.829	252.374
31	91	31091	NE	Hooker, NE	R	ND	793	728	784	833	11.695	14.632	18.042	22.230
31	93	31093	NE	Howard, NE	R	ND	6057	6423	6922	7355	80.003	111.728	137.751	169.791
31	95	31095	NE	Jefferson, NE	R	ND	8759	8445	9101	9670	74.438	87.063	107.211	132.051
31	97	31097	NE	Johnson, NE	R	ND	4673	4587	4944	5253	62.420	86.226	106.311	131.041
31	99	31099	NE	Kearney, NE	R	ND	6629	6672	7190	7640	58.341	75.037	92.434	113.874
31	101	31101	NE	Keith, NE	U2	ND	8584	8617	9286	9866	108.773	70.762	87.092	107.230
31	103	31103	NE	Keya Paha, NE	R	ND	1029	987	1064	1130	15.367	18.987	23.410	28.853
31	105	31105	NE	Kimball, NE	U2	ND	4108	4041	4355	4627	52.956	31.531	38.797	47.766
31	107	31107	NE	Knox, NE	R	ND	9564	9402	10132	10766	135.318	175.920	216.899	267.336
31	109	31109	NE	Lancaster, NE	U2	ND	213641	230508	248411	263940	1482.293	1933.705	2439.687	3076.298
31	111	31111	NE	Lincoln, NE	U2	ND	32508	33376	35969	38217	370.884	211.053	259.534	319.376
31	113	31113	NE	Logan, NE	R	ND	878	897	967	1027	11.615	16.200	19.975	24.619
31	115	31115	NE	Loup, NE	R	ND	683	677	730	775	10.145	12.602	15.539	19.144
31	117	31117	NE	McPherson, NE	R	ND	546	555	598	635	7.008	10.075	12.423	15.304
31	119	31119	NE	Madison, NE	U2	ND	32655	34545	37228	39555	205.380	233.183	286.852	353.080
31	121	31121	NE	Merrick, NE	R	ND	8049	8160	8793	9343	79.451	99.064	122.052	150.373
31	123	31123	NE	Morrill, NE	R	ND	5423	5423	5844	6210	71.871	100.065	123.373	152.076
31	125	31125	NE	Nance, NE	R	ND	4275	4234	4563	4848	55.985	78.882	97.257	119.871
31	127	31127	NE	Nemaha, NE	R	ND	7980	7839	8448	8976	69.236	88.029	108.432	133.565

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
31	129	31129	NE	Nuckolls, NE	R	ND	5786	5426	5847	6213	58.178	106.764	131.633	162.238
31	131	31131	NE	Otoe, NE	R	ND	14252	14535	15664	16643	118.764	150.375	185.205	228.139
31	133	31133	NE	Pawnee, NE	R	ND	3317	3193	3441	3656	46.501	61.206	75.462	93.009
31	135	31135	NE	Perkins, NE	R	ND	3367	3299	3556	3778	42.955	62.128	76.601	94.406
31	137	31137	NE	Phelps, NE	U2	ND	9715	9883	10651	11316	67.600	81.726	100.591	123.859
31	139	31139	NE	Pierce, NE	R	ND	7827	7898	8512	9044	100.172	144.423	178.065	219.478
31	141	31141	NE	Platte, NE	U2	ND	29820	30413	32775	34824	193.521	215.200	264.741	325.878
31	143	31143	NE	Polk, NE	R	ND	5668	5634	6071	6451	74.645	104.715	129.107	159.130
31	145	31145	NE	Red Willow, NE	U2	ND	11705	11432	12319	13090	77.580	76.463	94.029	115.708
31	147	31147	NE	Richardson, NE	R	ND	9937	9611	10358	11005	87.978	101.335	124.795	153.715
31	149	31149	NE	Rock, NE	R	ND	2019	1776	1913	2033	28.147	37.255	45.934	56.614
31	151	31151	NE	Saline, NE	R	ND	12715	12982	13990	14864	113.689	151.355	186.466	229.722
31	153	31153	NE	Sarpy, NE	U1	ND	102583	116287	125319	133153	796.762	1042.218	1293.444	1613.748
31	155	31155	NE	Saunders, NE	R	ND	18285	19028	20506	21788	190.845	274.084	337.819	416.294
31	157	31157	NE	Scotts Bluff, NE	U2	ND	36025	36244	39059	41501	266.642	292.253	359.676	442.841
31	159	31159	NE	Seward, NE	R	ND	15450	16163	17419	18507	262.312	188.183	231.849	285.638
31	161	31161	NE	Sheridan, NE	R	ND	6750	6639	7154	7601	89.100	124.551	153.563	189.273
31	163	31163	NE	Sherman, NE	R	ND	3718	3600	3879	4122	49.912	68.605	84.584	104.256
31	165	31165	NE	Sioux, NE	R	ND	1549	1518	1636	1738	21.794	28.582	35.240	43.433
31	167	31167	NE	Stanton, NE	R	ND	6244	6205	6687	7105	77.353	115.214	142.051	175.082
31	169	31169	NE	Thayer, NE	R	ND	6635	6325	6816	7242	89.551	122.428	150.947	186.046
31	171	31171	NE	Thomas, NE	R	ND	851	806	869	923	11.492	15.703	19.360	23.863
31	173	31173	NE	Thurston, NE	R	ND	6936	7155	7711	8193	84.877	127.982	157.795	194.493
31	175	31175	NE	Valley, NE	R	ND	5169	4834	5209	5535	43.943	95.378	117.595	144.943
31	177	31177	NE	Washington, NE	U1	ND	16607	18204	19618	20844	128.638	188.448	237.147	298.312
31	179	31179	NE	Wayne, NE	U2	ND	9364	9311	10034	10661	71.912	84.347	103.839	127.874
31	181	31181	NE	Webster, NE	R	ND	4279	4062	4378	4651	57.380	78.956	97.347	119.985
31	183	31183	NE	Wheeler, NE	R	ND	948	951	1025	1089	12.520	17.491	21.567	26.583
31	185	31185	NE	York, NE	U2	ND	14428	14581	15714	16696	196.578	130.628	160.817	198.052
32	1	32001	NV	Churchill, NV	R	UT	17938	22064	28879	31001	381.355	438.805	639.583	910.538
32	3	32003	**NV**	Clark, NV	**U1**	PX	**741368**	1053950	1379460	1480819	4902.930	7383.166	11026.238	16079.268
32	5	32005	NV	Douglas, NV	R	UT	27637	34888	45663	49018	438.639	582.294	848.635	1208.067
32	7	32007	NV	Elko, NV	U2	UT	33463	43695	57190	61392	362.346	500.099	728.604	1037.003
32	9	32009	**NV**	Esmeralda, NV	**R**	PX	**1344**	1191	1558	1673	28.894	50.658	73.853	105.157
32	11	32011	NV	Eureka, NV	R	UT	1547	1814	2374	2548	44.548	58.309	85.007	121.042
32	13	32013	NV	Humboldt, NV	R	UT	12844	16812	22004	23621	218.542	258.011	376.009	535.259
32	15	32015	NV	Lander, NV	U2	UT	6266	6992	9151	9824	63.735	105.617	153.894	219.061
32	17	32017	**NV**	Lincoln, NV	**R**	PX	**3775**	4341	5681	6099	138.783	142.285	207.438	295.351
32	19	32019	NV	Lyon, NV	R	UT	20001	27559	36071	38721	505.527	563.521	821.437	1169.492
32	21	32021	**NV**	Mineral, NV	**U2**	PX	**6475**	5834	7636	8197	111.663	90.643	132.048	187.942
32	23	32023	**NV**	Nye, NV	**U2**	PX	**17781**	25827	33804	36287	336.476	263.520	400.412	590.024
32	27	32027	NV	Pershing, NV	R	UT	4336	5232	6848	7351	126.734	163.428	238.265	339.243
32	29	32029	NV	Storey, NV	R	UT	2526	2931	3837	4119	55.892	95.209	138.803	197.643
32	31	32031	NV	Washoe, NV	U1	UT	254667	298488	390676	419382	2172.163	3164.253	4180.066	5480.840

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
32	33	32033	NV	White Pine, NV	U2	UT	9264	10080	13193	14163	147.720	173.870	253.370	360.668
32	510	32510	NV	Carson City, NV	U2	UT	40443	47236	61825	66367	167.625	86.058	124.540	176.545
33	1	33001	NH	Belknap, NH	R	NN	49216	51745	57794	62523	484.322	425.366	544.816	698.584
33	3	33003	NH	Carroll, NH	R	NN	35410	38393	42882	46390	303.798	389.349	499.511	641.102
33	5	33005	NH	Cheshire, NH	R	NN	70121	71336	79676	86195	514.588	597.437	765.125	981.013
33	7	33007	NH	Coos, NH	R	NN	34828	33431	37340	40395	294.980	307.382	393.765	504.950
33	9	33009	NH	Grafton, NH	R	NN	74929	77677	86759	93857	740.311	631.506	808.690	1036.809
33	11	33011	NH	Hillsborough, NH	U1	PA	335838	354697	396168	428582	2994.308	3739.916	4601.782	5738.711
33	13	33013	NH	Merrimack, NH	R	PA	120240	125133	139764	151199	1041.242	930.278	1189.321	1523.341
33	15	33015	NH	Rockingham, NH	U1	PA	245845	264068	294942	319074	2319.245	2418.843	2994.724	3748.760
33	17	33017	NH	Strafford, NH	U2	PA	104233	107546	120120	129948	787.543	1225.154	1504.543	1873.994
33	19	33019	NH	Sullivan, NH	R	NN	38592	39619	44251	47872	362.528	291.852	373.398	478.476
34	1	34001	NJ	Atlantic, NJ	U1	NY	224327	234820	249712	271532	2369.914	2222.893	2865.771	3704.889
34	3	34003	NJ	Bergen, NJ	U1	NY	825380	847635	901389	980153	6628.678	5992.499	7041.897	8407.386
34	5	34005	NJ	Burlington, NJ	U1	PA	395066	414664	440960	479492	3401.506	3299.475	3954.456	4804.005
34	7	34007	NJ	Camden, NJ	U1	PA	502824	504339	536322	583186	3702.900	4102.217	4892.162	5925.537
34	9	34009	NJ	Cape May, NJ	U1	NY	95089	97691	103887	112964	650.968	673.175	873.562	1133.849
34	11	34011	NJ	Cumberland, NJ	U1	PA	138053	140499	149409	162465	839.637	1096.421	1330.224	1623.365
34	13	34013	NJ	Essex, NJ	U1	NY	777964	754717	802578	872708	4606.230	5643.169	6608.289	7835.624
34	15	34015	NJ	Gloucester, NJ	U1	PA	230082	243786	259246	281899	1988.796	2054.659	2461.302	2989.182
34	17	34017	NJ	Hudson, NJ	U1	NY	553099	551686	586672	637937	2403.034	4011.752	4701.390	5612.070
34	19	34019	NJ	Hunterdon, NJ	U1	NY	107802	118753	126284	137319	983.190	1413.393	1835.293	2364.689
34	21	34021	NJ	Mercer, NJ	U1	PA	325824	329220	350098	380690	2480.556	3342.998	4149.584	5175.926
34	23	34023	NJ	Middlesex, NJ	U1	NY	671811	702931	747509	812827	6126.222	5073.208	6468.895	8244.564
34	25	34025	NJ	Monmouth, NJ	U1	NY	553093	590085	627506	682338	4080.968	4407.450	5775.256	7576.206
34	27	34027	NJ	Morris, NJ	U1	NY	421361	449469	477973	519739	4155.851	3530.924	4156.767	4944.521
34	29	34029	NJ	Ocean, NJ	U1	NY	433203	473933	503988	548027	3043.619	3623.851	4765.569	6264.885
34	31	34031	NJ	Passaic, NJ	U1	NY	470864	482165	512743	557547	2797.254	3102.472	3645.540	4352.275
34	33	34033	NJ	Salem, NJ	U1	PA	65294	65933	70115	76241	738.547	691.207	833.658	1016.545
34	35	34035	NJ	Somerset, NJ	U1	NY	240245	271600	288824	314062	2452.715	2096.607	2686.859	3434.769
34	37	34037	NJ	Sussex, NJ	U1	NY	130943	140469	149377	162430	697.617	1306.304	1556.458	1864.750
34	39	34039	NJ	Union, NJ	U1	NY	493819	497530	529081	575313	3255.037	3581.657	4194.211	4973.180
34	41	34041	NJ	Warren, NJ	U1	NY	91607	97338	103511	112556	905.386	896.306	1064.306	1272.530
35	1	35001	NM	Bernalillo, NM	U1	UT	480577	519586	626162	741921	4020.159	5682.501	7545.324	10011.046
35	3	35003	NM	Catron, NM	R	UT	2563	2762	3328	3944	72.894	83.134	109.535	143.260
35	5	35005	NM	Chaves, NM	U2	UT	57849	62265	75037	88909	467.205	516.898	678.761	885.949
35	6	35006	NM	Cibola, NM	R	UT	23794	25623	30879	36587	299.526	255.362	419.408	561.752
35	7	35007	NM	Colfax, NM	U2	UT	12925	13605	16395	19426	179.210	194.796	256.278	334.894
35	9	35009	NM	Curry, NM	U2	UT	42207	46090	55544	65812	330.284	325.797	427.503	557.748
35	11	35011	NM	DeBaca, NM	R	UT	2252	2303	2775	3288	65.765	73.047	96.244	125.882
35	13	35013	NM	Dona Ana, NM	U2	UT	135510	163761	197352	233836	1489.381	2222.804	3097.630	4277.810
35	15	35015	NM	Eddy, NM	U2	UT	48605	52592	63379	75096	466.469	495.572	651.130	850.188
35	17	35017	NM	Grant, NM	R	UT	27676	30825	37148	44015	408.348	497.716	655.103	856.283
35	19	35019	NM	Guadalupe, NM	R	UT	4156	4090	4929	5840	120.489	134.806	177.616	232.309

State	County		State		Urban/	Mapped		Population				Annual VMT (Millions)		
No.	No.	FIPS	Code	County	Rural	Area	1990	1996	2007	2020	1990	1996	2007	2020
35	21	35021	NM	Harding, NM	R	UT	987	912	1099	1302	29.210	32.015	42.182	55.166
35	23	35023	NM	Hidalgo, NM	R	UT	5958	6297	7589	8992	89.442	104.294	137.265	179.414
35	25	35025	NM	Lea, NM	U2	UT	55765	56298	67846	80389	487.975	557.108	731.921	955.627
35	27	35027	NM	Lincoln, NM	R	UT	12219	15460	18631	22075	197.826	256.292	337.445	441.165
35	28	35028	NM	Los Alamos, NM	U2	UT	18115	18252	21996	26062	71.402	51.378	70.194	94.933
35	29	35029	NM	Luna, NM	U2	UT	18110	23092	27828	32973	191.063	253.436	333.359	435.551
35	31	35031	NM	McKinley, NM	R	UT	60686	66650	80321	95170	973.523	1206.171	1587.930	2075.857
35	33	35033	NM	Mora, NM	R	UT	4264	4705	5670	6718	112.688	138.309	182.230	238.343
35	35	35035	NM	Otero, NM	U2	UT	51928	55212	66537	78837	428.195	585.213	769.208	1004.588
35	37	35037	NM	Quay, NM	U2	UT	10823	10209	12303	14578	129.605	143.086	188.176	245.836
35	39	35039	NM	Rio Arriba, NM	R	UT	34365	37292	44941	53250	655.885	860.790	1133.725	1482.478
35	41	35041	NM	Roosevelt, NM	U2	UT	16702	18265	22011	26080	194.557	216.288	284.429	371.578
35	43	35043	NM	Sandoval, NM	U2	UT	63319	82608	99552	117957	622.646	985.613	1320.413	1761.241
35	45	35045	NM	San Juan, NM	U2	UT	91605	101818	122702	145386	1071.339	1268.549	1668.533	2180.034
35	47	35047	NM	San Miguel, NM	U2	UT	25743	28470	34310	40653	283.992	385.847	507.625	663.325
35	49	35049	NM	Santa Fe, NM	U2	UT	98928	118525	142836	169242	995.774	1688.948	2317.235	3141.844
35	51	35051	NM	Sierra, NM	U2	UT	9912	10835	13058	15472	107.865	133.234	175.228	228.934
35	53	35053	NM	Socorro, NM	U2	UT	14764	16038	19327	22900	173.632	231.218	304.228	397.568
35	55	35055	NM	Taos, NM	R	UT	23118	26065	31411	37218	444.779	626.102	824.726	1078.505
35	57	35057	NM	Torrance, NM	R	UT	10285	14067	16952	20086	200.752	318.993	420.271	549.664
35	59	35059	NM	Union, NM	R	UT	4124	4113	4956	5873	59.124	133.767	176.248	230.522
35	61	35061	NM	Valencia, NM	U2	UT	45235	60399	72787	86244	708.773	604.268	992.452	1329.283
36	1	36001	NY	Albany, NY	U1	NI	292793	294095	298071	314120	2567.658	2789.570	3416.598	4214.885
36	3	36003	NY	Allegany, NY	R	NI	50470	51467	52163	54971	434.067	458.714	540.687	639.030
36	5	36005	**NY**	Bronx, NY	**U1**	NY	**1203789**	1190242	1206332	1271284	5207.139	6329.190	7158.654	8169.457
36	7	36007	NY	Broome, NY	U1	NI	212160	200652	203365	214314	1942.441	2365.065	2749.765	3239.299
36	9	36009	NY	Cattaraugus, NY	R	NI	84234	85102	86253	90897	653.150	666.162	785.115	927.858
36	11	36011	NY	Cayuga, NY	R	NI	82313	82314	83427	87919	722.260	582.544	696.240	832.139
36	13	36013	NY	Chautauqua, NY	U2	NI	141895	140284	142180	149835	1184.894	782.384	912.307	1065.603
36	15	36015	NY	Chemung, NY	U2	NI	95195	93389	94651	99748	787.496	902.631	1059.439	1253.766
36	17	36017	NY	Chenango, NY	R	NI	51768	52274	52980	55833	540.296	496.953	585.785	692.343
36	19	36019	NY	Clinton, NY	R	NI	85969	81418	82518	86961	746.965	629.180	741.474	876.250
36	21	36021	NY	Columbia, NY	R	NI	62982	63925	64789	68277	665.136	617.917	728.381	860.900
36	23	36023	NY	Cortland, NY	R	NI	48963	48861	49522	52188	410.899	295.748	348.459	411.749
36	25	36025	NY	Delaware, NY	R	NI	47225	46651	47281	49827	482.178	408.190	481.114	568.607
36	27	36027	NY	Dutchess, NY	U1	NI	259462	263941	267509	281912	2623.823	2807.986	3320.268	3962.119
36	29	36029	NY	Erie, NY	U1	NI	968584	947917	960731	1012459	6953.883	7806.544	9194.138	10937.041
36	31	36031	NY	Essex, NY	R	NI	37152	38194	38711	40795	408.070	371.047	437.384	516.966
36	33	36033	NY	Franklin, NY	R	NI	46540	48588	49245	51896	338.130	359.696	423.916	500.979
36	35	36035	NY	Fulton, NY	R	NI	54191	53416	54138	57053	373.734	327.849	386.285	456.438
36	37	36037	NY	Genesee, NY	R	NI	60060	61558	62390	65750	557.212	441.452	531.644	640.559
36	39	36039	NY	Greene, NY	U1	NI	44739	47408	48049	50636	441.074	419.725	494.741	584.741
36	41	36041	NY	Hamilton, NY	R	NI	5279	5222	5293	5578	48.071	59.093	69.662	82.347
36	43	36043	NY	Herkimer, NY	U1	NI	65809	65708	66596	70182	561.248	427.974	492.921	574.936

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
36	45	36045	NY	Jefferson, NY	R	NI	110943	112818	114344	120500	831.451	750.245	884.076	1044.710
36	47	36047	**NY**	Kings, NY	**U1**	NY	**2300664**	2248995	2279399	2402127	9938.742	12100.464	13686.274	15618.774
36	49	36049	NY	Lewis, NY	R	NI	26796	27999	28377	29905	220.259	260.577	307.158	363.035
36	51	36051	NY	Livingston, NY	U1	NI	62372	65903	66793	70390	558.093	499.950	602.145	725.535
36	53	36053	NY	Madison, NY	U1	NI	69166	71297	72261	76151	570.452	457.107	546.283	652.892
36	55	36055	NY	Monroe, NY	U1	NI	713968	717235	726931	766071	5679.581	6393.131	7572.016	9033.059
36	57	36057	NY	Montgomery, NY	U1	NI	51981	51528	52225	55037	462.281	357.313	444.673	553.826
36	59	36059	**NY**	Nassau, NY	**U1**	NY	**1287444**	1301366	1318958	1389975	5922.251	6800.351	7895.326	9295.025
36	61	36061	**NY**	New York, NY	**U1**	NY	**1487536**	1529265	1549939	1633391	6362.701	7823.635	8848.951	10098.426
36	63	36063	NY	Niagara, NY	U1	NI	220756	220321	223300	235323	1740.043	1691.614	2002.604	2389.692
36	65	36065	NY	Oneida, NY	U1	NI	250836	235708	238895	251757	2429.994	2468.944	2812.689	3259.351
36	67	36067	NY	Onondaga, NY	U1	NI	468973	462559	468812	494054	3572.215	4235.879	4985.948	5904.887
36	69	36069	NY	Ontario, NY	U1	NI	95101	99280	100622	106039	887.382	794.960	957.492	1153.723
36	71	36071	**NY**	Orange, NY	**U1**	NY	**307647**	324372	328757	346459	2666.813	2616.769	3460.236	4560.443
36	73	36073	NY	Orleans, NY	U1	NI	41846	44321	44921	47339	304.495	332.378	400.316	482.351
36	75	36075	NY	Oswego, NY	U1	NI	121785	124811	126498	133309	1133.918	972.326	1161.715	1388.202
36	77	36077	NY	Otsego, NY	R	NI	60517	61342	62172	65519	605.640	526.148	620.149	732.927
36	79	36079	**NY**	Putnam, NY	**U1**	NI	**83941**	91176	92409	97384	705.055	736.580	844.887	972.470
36	81	36081	**NY**	Queens, NY	**U1**	NY	**1951598**	1972236	1998898	2106524	8426.536	10261.203	11605.970	13244.743
36	83	36083	NY	Rensselaer, NY	U1	NI	154429	154373	156460	164884	1503.520	1539.405	1895.821	2346.490
36	85	36085	**NY**	Richmond, NY	**U1**	NY	**378977**	399030	404424	426199	1569.276	1994.610	2256.012	2574.558
36	87	36087	**NY**	Rockland, NY	**U1**	NY	**265475**	277805	281561	296720	1178.809	1405.565	1590.222	1815.083
36	89	36089	**NY**	St. Lawrence, NY	R	NI	**111974**	113865	115404	121618	827.166	749.613	883.320	1043.815
36	91	36091	**NY**	Saratoga, NY	U1	NI	**181276**	194397	197025	207633	1465.358	1537.214	1901.263	2359.268
36	93	36093	**NY**	Schenectady, NY	U1	NI	**149285**	147518	149513	157563	1343.537	1445.130	1768.322	2180.272
36	95	36095	**NY**	Schoharie, NY	R	NI	**31859**	32394	32832	34600	322.139	299.516	372.848	464.437
36	97	36097	**NY**	Schuyler, NY	R	NI	**18662**	19091	19349	20390	168.882	208.900	246.265	291.091
36	99	36099	**NY**	Seneca, NY	R	NI	**33683**	32942	33388	35185	312.585	241.686	284.816	336.581
36	101	36101	**NY**	Steuben, NY	R	NI	**99088**	99061	100401	105806	963.663	780.357	919.696	1086.905
36	103	36103	**NY**	Suffolk, NY	**U1**	NY	**1321768**	1356781	1375122	1449163	6089.956	6912.807	8037.253	9470.193
36	105	36105	NY	Sullivan, NY	R	NI	69277	70201	71150	74981	562.917	659.210	777.037	918.398
36	107	36107	NY	Tioga, NY	U1	NI	52337	52874	53589	56475	410.751	485.333	570.246	676.011
36	109	36109	NY	Tompkins, NY	U2	NI	94097	96282	97583	102838	592.069	828.474	968.915	1139.868
36	111	36111	NY	Ulster, NY	R	NI	165304	166700	168954	178051	1504.017	1362.069	1604.167	1895.050
36	113	36113	NY	Warren, NY	U2	NI	59209	61510	62341	65698	541.748	595.349	730.393	897.182
36	115	36115	NY	Washington, NY	R	NI	59330	60495	61313	64614	448.955	586.433	723.398	891.582
36	117	36117	NY	Wayne, NY	U1	NI	89123	94412	95688	100840	707.569	806.107	970.980	1170.023
36	119	36119	**NY**	Westchester, NY	**U1**	NY	**874866**	893170	905245	953985	4215.756	4895.223	5549.761	6342.505
36	121	36121	NY	Wyoming, NY	R	NI	42507	44298	44896	47314	322.489	360.135	424.468	501.667
36	123	36123	NY	Yates, NY	R	NI	22810	23947	24271	25578	175.621	198.440	233.893	276.429
37	1	37001	NC	Alamance, NC	U2	SE	108213	116532	133080	144952	950.357	1698.252	2154.951	2759.307
37	3	37003	NC	Alexander, NC	R	SE	27544	30215	34505	37584	158.636	297.463	381.635	490.119
37	5	37005	NC	Alleghany, NC	R	SE	9590	9732	11114	12106	76.373	114.081	148.137	192.369
37	7	37007	NC	Anson, NC	R	SE	23474	24208	27645	30111	231.003	244.851	317.713	412.433

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
37	9	37009	NC	Ashe, NC	R	SE	22209	23705	27071	29486	176.919	264.193	343.062	445.512
37	11	37011	NC	Avery, NC	R	SE	14867	15542	17748	19332	170.789	176.853	229.651	298.227
37	13	37013	NC	Beaufort, NC	R	SE	42283	43947	50187	54664	348.492	380.703	493.542	640.337
37	15	37015	NC	Bertie, NC	R	SE	20388	20435	23337	25419	210.021	242.530	314.933	408.987
37	17	37017	NC	Bladen, NC	R	SE	28663	30327	34633	37723	320.476	306.020	397.141	515.581
37	19	37019	NC	Brunswick, NC	R	SE	50985	63802	72862	79362	655.137	572.870	787.692	1068.855
37	21	37021	NC	Buncombe, NC	U2	SE	174819	190218	217228	236608	1553.477	3001.599	3818.965	4917.896
37	23	37023	NC	Burke, NC	R	SE	75740	80864	92346	100585	723.161	762.566	975.080	1249.742
37	25	37025	NC	Cabarrus, NC	U1	SE	98935	113563	129689	141259	834.227	1453.743	1884.290	2453.695
37	27	37027	NC	Caldwell, NC	R	SE	70709	74918	85556	93188	480.067	579.688	742.394	952.393
37	29	37029	NC	Camden, NC	R	SE	5904	6570	7503	8172	76.536	70.082	91.002	118.173
37	31	37031	NC	Carteret, NC	R	SE	52553	58700	67036	73016	521.130	507.976	658.843	855.029
37	33	37033	NC	Caswell, NC	R	SE	20693	21547	24606	26802	159.506	246.160	319.644	415.104
37	35	37035	NC	Catawba, NC	U2	SE	118412	128663	146932	160041	1075.313	1845.540	2336.896	2977.591
37	37	37037	NC	Chatham, NC	R	SE	38759	43988	50235	54716	384.087	415.703	578.520	793.098
37	39	37039	NC	Cherokee, NC	R	SE	20170	21980	25101	27341	161.188	215.866	280.151	363.689
37	41	37041	NC	Chowan, NC	R	SE	13506	14069	16067	17500	96.881	110.958	143.752	186.435
37	43	37043	NC	Clay, NC	R	SE	7155	8130	9284	10112	52.823	85.114	110.523	143.532
37	45	37045	NC	Cleveland, NC	R	SE	84713	90891	103798	113058	710.281	793.776	1029.321	1335.665
37	47	37047	NC	Columbus, NC	R	SE	49587	52071	59465	64770	444.835	541.961	703.434	913.276
37	49	37049	NC	Craven, NC	U2	SE	81613	86545	98834	107652	598.971	575.404	744.556	964.943
37	51	37051	NC	Cumberland, NC	U1	SE	274713	282714	322858	351662	1860.029	3152.867	3926.785	4940.008
37	53	37053	NC	Currituck, NC	R	SE	13736	16636	18998	20693	169.800	163.400	204.897	261.228
37	55	37055	NC	Dare, NC	R	SE	22746	27142	30996	33762	389.983	230.592	299.167	388.305
37	57	37057	NC	Davidson, NC	U1	AT	126677	137376	156883	170879	1081.716	1406.600	1801.624	2319.870
37	59	37059	NC	Davie, NC	U1	AT	27859	30721	35083	38213	349.262	299.332	385.202	497.402
37	61	37061	NC	Duplin, NC	R	SE	39995	42709	48773	53124	464.039	421.035	546.363	709.266
37	63	37063	NC	Durham, NC	U1	AT	181855	197110	225100	245182	1593.594	2627.212	3595.463	4879.771
37	65	37065	NC	Edgecombe, NC	R	SE	56692	55754	63671	69352	472.417	554.788	703.365	893.271
37	67	37067	NC	Forsyth, NC	U1	AT	265878	282960	323140	351968	2324.466	3780.375	4792.340	6132.749
37	69	37069	NC	Franklin, NC	U1	SE	36414	42524	48562	52894	291.577	403.715	561.941	770.463
37	71	37071	NC	Gaston, NC	U1	AT	175093	182186	208056	226617	1337.221	2473.203	3201.000	4164.643
37	73	37073	NC	Gates, NC	R	SE	9305	9905	11311	12321	94.565	110.689	143.734	186.661
37	75	37075	NC	Graham, NC	R	SE	7196	7591	8669	9442	39.740	85.603	111.156	144.352
37	77	37077	NC	Granville, NC	R	AT	38341	41598	47505	51743	408.060	337.332	437.244	567.244
37	79	37079	NC	Greene, NC	R	SE	15384	17649	20155	21953	150.115	183.004	237.635	308.608
37	81	37081	NC	Guilford, NC	U1	AT	347420	376988	430519	468928	3004.844	5227.403	6621.438	8469.365
37	83	37083	NC	Halifax, NC	R	SE	55516	56538	64566	70326	575.490	458.681	594.272	770.756
37	85	37085	NC	Harnett, NC	R	SE	67833	78793	89982	98009	587.904	688.261	891.962	1157.021
37	87	37087	NC	Haywood, NC	R	SE	46942	50537	57713	62862	577.852	458.715	594.991	772.199
37	89	37089	NC	Henderson, NC	R	SE	69285	77906	88969	96906	611.112	748.653	970.038	1258.149
37	91	37091	NC	Hertford, NC	R	SE	22523	22402	25583	27866	169.847	201.493	261.202	338.879
37	93	37093	NC	Hoke, NC	R	SE	22856	28459	32500	35400	170.608	239.866	311.260	404.055
37	95	37095	NC	Hyde, NC	R	SE	5411	5389	6154	6703	46.735	64.368	83.583	108.546

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37	97	37097	NC	Iredell, NC	R	SE	92935	106604	121741	132602	1235.764	851.820	1104.428	1433.005
37	99	37099	NC	Jackson, NC	R	SE	26846	29231	33382	36360	287.370	281.338	365.072	473.924
37	101	37101	NC	Johnston, NC	R	SE	81306	98965	113018	123100	1106.503	785.128	1091.955	1496.440
37	103	37103	NC	Jones, NC	R	SE	9414	9039	10323	11244	156.133	111.987	145.417	188.854
37	105	37105	NC	Lee, NC	R	SE	41370	47429	54164	58996	390.095	355.595	460.844	597.790
37	107	37107	NC	Lenoir, NC	R	SE	57274	59294	67714	73755	471.661	416.179	538.662	698.203
37	109	37109	NC	Lincoln, NC	U1	SE	50319	56225	64208	69937	362.132	533.977	700.902	919.609
37	111	37111	NC	McDowell, NC	R	SE	35681	38580	44058	47989	218.405	379.491	492.482	639.341
37	113	37113	NC	Macon, NC	R	SE	23499	27023	30860	33613	132.289	252.789	328.075	425.924
37	115	37115	NC	Madison, NC	R	SE	16953	18279	20875	22737	245.869	201.668	260.327	338.126
37	117	37117	NC	Martin, NC	R	SE	25078	26146	29859	32522	256.934	246.396	319.610	414.807
37	119	37119	NC	Mecklenburg, NC	U1	AT	511481	598763	683786	744789	3902.933	6934.567	8945.101	11614.335
37	121	37121	NC	Mitchell, NC	R	SE	14433	14765	16861	18366	98.733	171.692	222.947	289.516
37	123	37123	NC	Montgomery, NC	R	SE	23352	24149	27578	30039	249.278	245.599	318.705	413.728
37	125	37125	NC	Moore, NC	R	SE	59000	68578	78316	85302	533.550	542.242	703.056	912.232
37	127	37127	NC	Nash, NC	R	SE	76677	88074	100580	109553	1011.741	852.281	1079.283	1369.724
37	129	37129	NC	New Hanover, NC	U2	SE	120284	143734	164144	178787	820.208	1438.619	1946.842	2616.356
37	131	37131	NC	Northampton, NC	R	SE	20798	21166	24171	26328	263.686	247.407	321.265	417.216
37	133	37133	NC	Onslow, NC	U2	SE	149838	143988	164434	179104	824.202	1349.435	1641.106	2026.626
37	135	37135	NC	Orange, NC	U1	SE	93851	106410	121520	132361	822.483	1231.077	1693.121	2304.785
37	137	37137	NC	Pamlico, NC	R	SE	11368	12055	13766	14994	97.046	135.279	175.663	228.129
37	139	37139	NC	Pasquotank, NC	R	SE	31298	33806	38606	42051	192.730	237.733	307.812	399.062
37	141	37141	NC	Pender, NC	R	SE	28855	36710	41923	45663	392.197	343.102	445.525	578.584
37	143	37143	NC	Perquimans, NC	R	SE	10447	11038	12606	13730	97.894	124.275	161.374	209.573
37	145	37145	NC	Person, NC	R	SE	30180	32805	37463	40805	207.713	289.833	375.897	487.805
37	147	37147	NC	Pitt, NC	U2	SE	108480	119260	136195	148345	752.722	1142.348	1490.297	1945.190
37	149	37149	NC	Polk, NC	R	SE	14416	16224	18527	20180	167.990	171.489	222.684	289.192
37	151	37151	NC	Randolph, NC	U1	SE	106546	117679	134389	146378	973.560	1150.594	1474.478	1899.183
37	153	37153	NC	Richmond, NC	R	SE	44518	45906	52424	57101	355.998	343.195	444.410	576.218
37	155	37155	NC	Robeson, NC	R	SE	105170	112959	128999	140507	1195.449	1038.827	1347.536	1748.929
37	157	37157	NC	Rockingham, NC	R	SE	86064	89509	102219	111338	703.214	765.064	991.740	1286.644
37	159	37159	NC	Rowan, NC	U1	SE	110605	121681	138959	151356	879.848	1158.865	1512.130	1976.977
37	161	37161	NC	Rutherford, NC	R	SE	56919	59673	68146	74226	443.254	534.303	692.859	899.082
37	163	37163	NC	Sampson, NC	R	SE	47297	51151	58414	63625	566.097	485.225	629.562	817.202
37	165	37165	NC	Scotland, NC	R	SE	33763	35362	40384	43987	305.573	291.738	378.101	490.471
37	167	37167	NC	Stanly, NC	R	SE	51765	55034	62849	68456	403.610	474.825	615.639	798.805
37	169	37169	NC	Stokes, NC	U1	SE	37223	41922	47875	52146	260.644	404.498	520.571	672.210
37	171	37171	NC	Surry, NC	R	SE	61704	65812	75157	81863	701.386	631.396	819.203	1063.344
37	173	37173	NC	Swain, NC	R	SE	11268	12057	13770	14998	142.526	134.040	174.058	226.034
37	175	37175	NC	Transylvania, NC	R	SE	25520	27543	31454	34260	213.213	252.742	327.854	425.513
37	177	37177	NC	Tyrrell, NC	R	SE	3856	3776	4313	4697	38.879	45.869	59.564	77.345
37	179	37179	NC	Union, NC	U1	SE	84210	103167	117816	128327	706.707	769.876	1007.959	1320.471
37	181	37181	NC	Vance, NC	R	SE	38892	41200	47051	51248	327.420	313.936	406.669	527.379
37	183	37183	NC	Wake, NC	U1	AT	426300	533690	609472	663846	3993.888	6709.014	9191.994	12483.970

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37	185	37185	NC	Warren, NC	R	SE	17265	18059	20623	22463	153.384	205.382	266.693	346.335
37	187	37187	NC	Washington, NC	R	SE	13997	13776	15732	17136	125.319	125.668	162.911	211.364
37	189	37189	NC	Watauga, NC	R	SE	36952	40188	45894	49989	301.079	317.712	411.748	534.123
37	191	37191	NC	Wayne, NC	U2	SE	104666	110936	126689	137991	745.967	1260.376	1563.288	1963.060
37	193	37193	NC	Wilkes, NC	R	SE	59393	62017	70823	77141	501.133	649.941	843.590	1095.246
37	195	37195	NC	Wilson, NC	U2	SE	66061	67536	77126	84007	672.044	437.391	565.652	732.851
37	197	37197	NC	Yadkin, NC	U1	SE	30488	33962	38785	42245	367.327	338.854	436.143	563.240
37	199	37199	NC	Yancey, NC	R	SE	15419	16256	18565	20221	116.075	183.422	238.177	309.308
38	1	38001	ND	Adams, ND	R	ND	3174	2809	2971	3119	36.702	53.278	63.461	76.292
38	3	38003	ND	Barnes, ND	U2	ND	12545	12134	12834	13475	141.702	102.212	121.470	145.839
38	5	38005	ND	Benson, ND	R	ND	7198	6853	7248	7610	81.343	120.823	143.917	173.013
38	7	38007	ND	Billings, ND	R	ND	1108	1109	1173	1231	20.606	18.599	22.153	26.630
38	9	38009	ND	Bottineau, ND	R	ND	8011	7558	7994	8394	75.863	95.167	113.255	136.082
38	11	38011	ND	Bowman, ND	R	ND	3596	3334	3526	3702	43.305	60.362	71.898	86.437
38	13	38013	ND	Burke, ND	R	ND	3002	2428	2568	2696	39.136	50.391	60.020	72.168
38	15	38015	ND	Burleigh, ND	U2	ND	60131	65716	69505	72978	428.458	515.610	642.538	803.862
38	17	38017	ND	Cass, ND	U2	ND	102874	112908	119418	125385	772.797	977.956	1221.568	1522.898
38	19	38019	ND	Cavalier, ND	R	ND	6064	5276	5580	5859	78.190	101.790	121.243	145.760
38	21	38021	ND	Dickey, ND	R	ND	6107	5703	6032	6334	73.799	102.512	122.102	146.806
38	23	38023	ND	Divide, ND	R	ND	2899	2485	2628	2760	35.785	48.660	57.962	69.686
38	25	38025	ND	Dunn, ND	R	ND	4005	3693	3906	4101	47.380	67.226	80.076	96.262
38	27	38027	ND	Eddy, ND	R	ND	2951	2879	3045	3197	36.392	49.535	59.002	70.930
38	29	38029	ND	Emmons, ND	R	ND	4830	4437	4693	4928	60.175	81.074	96.572	116.090
38	31	38031	ND	Foster, ND	R	ND	3983	3802	4021	4222	29.718	66.857	79.636	95.734
38	33	38033	ND	Golden Valley, ND	R	ND	2108	1931	2042	2144	43.260	35.385	42.147	50.673
38	35	38035	ND	Grand Forks, ND	U2	ND	70683	69762	73785	77472	479.734	523.815	625.033	751.655
38	37	38037	ND	Grant, ND	R	ND	3549	3115	3295	3460	43.767	59.572	70.958	85.306
38	39	38039	ND	Griggs, ND	R	ND	3303	2901	3068	3222	38.031	55.443	66.040	79.392
38	41	38041	ND	Hettinger, ND	R	ND	3445	3034	3209	3370	43.778	57.826	68.879	82.808
38	43	38043	ND	Kidder, ND	R	ND	3332	2987	3159	3317	69.341	55.930	66.620	80.093
38	45	38045	ND	LaMoure, ND	R	ND	5383	4975	5262	5525	66.278	90.359	107.628	129.380
38	47	38047	ND	Logan, ND	R	ND	2847	2478	2621	2752	35.769	47.790	56.922	68.436
38	49	38049	ND	McHenry, ND	R	ND	6528	6219	6578	6907	80.463	109.578	130.521	156.914
38	51	38051	ND	McIntosh, ND	R	ND	4021	3634	3843	4035	49.149	67.495	80.396	96.652
38	53	38053	ND	McKenzie, ND	R	ND	6383	5858	6196	6506	73.033	107.142	127.621	153.427
38	55	38055	ND	McLean, ND	R	ND	10457	9854	10422	10942	126.799	175.527	209.076	251.363
38	57	38057	ND	Mercer, ND	U2	ND	9808	9493	10040	10542	77.029	71.124	84.480	101.400
38	59	38059	ND	Morton, ND	U2	ND	23700	24297	25698	26982	261.334	249.614	312.727	392.512
38	61	38061	ND	Mountrail, ND	R	ND	7021	6703	7089	7444	78.633	117.853	140.378	168.762
38	63	38063	ND	Nelson, ND	R	ND	4410	3897	4121	4327	53.587	74.025	88.174	105.998
38	65	38065	ND	Oliver, ND	R	ND	2381	2240	2370	2488	25.551	39.967	47.606	57.225
38	67	38067	ND	Pembina, ND	R	ND	9238	8706	9208	9668	188.120	155.066	184.704	222.057
38	69	38069	ND	Pierce, ND	U2	ND	5052	4636	4904	5149	41.050	40.792	48.476	58.202
38	71	38071	ND	Ramsey, ND	U2	ND	12681	12420	13136	13792	84.306	95.130	113.011	135.648

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38	73	38073	ND	Ransom, ND	R	ND	5921	5840	6176	6485	68.586	99.387	118.385	142.320
38	75	38075	ND	Renville, ND	R	ND	3160	2896	3063	3216	36.947	53.044	63.180	75.960
38	77	38077	ND	Richland, ND	R	ND	18148	18211	19261	20224	218.244	172.237	204.820	245.991
38	79	38079	ND	Rolette, ND	R	ND	12772	13936	14740	15476	124.689	214.388	255.362	307.008
38	81	38081	ND	Sargent, ND	R	ND	4549	4447	4703	4938	56.445	76.359	90.953	109.336
38	83	38083	ND	Sheridan, ND	R	ND	2148	1836	1942	2039	28.869	36.055	42.948	51.632
38	85	38085	ND	Sioux, ND	R	ND	3761	4041	4274	4488	37.066	63.131	75.197	90.406
38	87	38087	ND	Slope, ND	R	ND	907	855	904	949	11.847	15.226	18.135	21.797
38	89	38089	ND	Stark, ND	U2	ND	22832	22716	24026	25227	201.641	139.729	165.813	198.896
38	91	38091	ND	Steele, ND	R	ND	2420	2276	2407	2528	31.805	40.620	48.385	58.173
38	93	38093	ND	Stutsman, ND	U2	ND	22241	21278	22504	23629	204.835	137.766	163.496	196.119
38	95	38095	ND	Towner, ND	R	ND	3627	3156	3338	3504	41.489	60.881	72.517	87.192
38	97	38097	ND	Traill, ND	R	ND	8752	8647	9146	9603	174.102	146.909	174.987	210.376
38	99	38099	ND	Walsh, ND	R	ND	13840	13695	14485	15209	202.604	159.092	189.313	227.462
38	101	38101	ND	Ward, ND	U2	ND	57921	58629	62009	65108	314.872	312.053	370.013	443.619
38	103	38103	ND	Wells, ND	R	ND	5864	5347	5655	5938	54.725	98.430	117.244	140.956
38	105	38105	ND	Williams, ND	U2	ND	21129	20514	21697	22781	139.350	156.013	185.325	222.435
39	1	39001	OH	Adams, OH	R	ON	25371	28036	28726	29243	196.537	314.276	379.722	461.115
39	3	39003	OH	Allen, OH	U2	ON	109755	108233	110898	112891	880.407	1149.927	1354.248	1615.607
39	5	39005	OH	Ashland, OH	R	ON	47507	51367	52632	53578	459.254	362.013	437.042	530.458
39	7	39007	OH	Ashtabula, OH	U2	OI	99821	102666	105194	107085	866.696	701.179	811.393	951.552
39	9	39009	OH	Athens, OH	R	ON	59549	61029	62532	63656	391.363	457.192	551.959	669.950
39	11	39011	OH	Auglaize, OH	U2	ON	44585	46625	47773	48632	379.057	312.877	371.704	445.759
39	13	39013	OH	Belmont, OH	R	ON	71074	69806	71525	72811	724.073	776.213	887.579	1030.329
39	15	39015	OH	Brown, OH	R	ON	34966	39489	40461	41189	318.811	441.591	542.845	670.173
39	17	39017	OH	Butler, OH	U1	OI	291479	321710	329632	335557	1603.323	2571.097	3282.012	4190.900
39	19	39019	OH	Carroll, OH	U1	ON	26521	28582	29285	29812	194.099	304.274	363.106	436.282
39	21	39021	OH	Champaign, OH	R	ON	36019	37906	38840	39538	235.112	354.168	427.776	519.372
39	23	39023	OH	Clark, OH	U1	ON	147548	146380	149984	152680	1124.718	1249.362	1494.116	1809.881
39	25	39025	OH	Clermont, OH	U1	ON	150167	169878	174061	177190	1105.980	1754.534	2138.652	2626.584
39	27	39027	OH	Clinton, OH	U2	ON	35417	38761	39715	40429	394.782	256.928	310.145	376.422
39	29	39029	OH	Columbiana, OH	R	ON	108276	111163	113900	115947	803.470	939.692	1100.512	1298.105
39	31	39031	OH	Coshocton, OH	R	ON	35427	36052	36940	37604	273.287	334.771	404.323	490.876
39	33	39033	OH	Crawford, OH	U2	ON	47870	47201	48363	49232	282.405	269.807	317.496	375.910
39	35	39035	OH	Cuyahoga, OH	U1	OI	1412140	1390423	1424659	1450268	8529.891	12870.466	14619.628	16955.539
39	37	39037	OH	Darke, OH	R	ON	53619	54218	55553	56552	369.592	580.615	701.395	851.633
39	39	39039	OH	Defiance, OH	U2	ON	39350	39849	40830	41564	320.926	280.746	338.886	411.286
39	41	39041	OH	Delaware, OH	U1	ON	66929	84472	86552	88108	814.860	632.405	810.475	1035.185
39	43	39043	OH	Erie, OH	U2	ON	76779	78464	80396	81841	810.853	473.780	570.263	690.893
39	45	39045	OH	Fairfield, OH	U1	ON	103472	118888	121815	124005	703.192	849.461	1089.857	1392.957
39	47	39047	OH	Fayette, OH	R	ON	27466	28437	29137	29661	348.322	212.864	256.992	311.927
39	49	39049	OH	Franklin, OH	U1	ON	961437	1009297	1034149	1052739	6738.587	9711.176	12256.823	15510.342
39	51	39051	OH	Fulton, OH	U1	ON	38498	40920	41928	42682	410.173	327.572	394.833	479.289
39	53	39053	OH	Gallia, OH	R	ON	30954	32781	33588	34191	280.645	369.499	446.422	542.104

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
39	55	39055	OH	Geauga, OH	U1	OI	81129	86944	89085	90686	586.419	1036.216	1198.685	1405.472
39	57	39057	OH	Greene, OH	U1	ON	136731	139279	142709	145274	1110.892	1188.181	1416.305	1712.260
39	59	39059	OH	Guernsey, OH	R	ON	39024	40531	41529	42275	607.213	391.018	472.300	573.433
39	61	39061	OH	Hamilton, OH	U1	OI	866228	853689	874709	890433	6213.921	8400.599	10135.637	12369.431
39	63	39063	OH	Hancock, OH	U2	ON	65536	68345	70028	71287	725.186	402.470	485.640	589.261
39	65	39065	OH	Hardin, OH	R	ON	31111	31636	32415	32998	247.024	253.503	306.087	371.545
39	67	39067	OH	Harrison, OH	R	ON	16085	16148	16546	16843	150.331	179.728	217.124	263.649
39	69	39069	OH	Henry, OH	R	ON	29108	29781	30514	31063	280.853	290.059	350.351	425.350
39	71	39071	OH	Highland, OH	R	ON	35728	39230	40196	40919	233.551	349.380	421.990	512.338
39	73	39073	OH	Hocking, OH	R	ON	25533	28295	28991	29513	237.443	268.554	324.405	393.879
39	75	39075	OH	Holmes, OH	R	ON	32849	36727	37631	38307	211.626	418.287	505.410	613.751
39	77	39077	OH	Huron, OH	R	ON	56240	59493	60958	62054	428.937	423.847	511.685	621.050
39	79	39079	OH	Jackson, OH	R	ON	30230	32093	32884	33475	252.096	262.010	316.394	384.088
39	81	39081	OH	Jefferson, OH	U2	ON	80298	76626	78513	79924	557.775	897.950	1020.449	1174.882
39	83	39083	OH	Knox, OH	R	ON	47473	51780	53055	54009	275.522	472.126	570.262	692.359
39	85	39085	OH	Lake, OH	U1	OI	215499	222541	228021	232120	1592.339	1999.587	2278.170	2646.981
39	87	39087	OH	Lawrence, OH	U1	ON	61834	64106	65685	66866	475.898	710.868	850.665	1025.937
39	89	39089	OH	Licking, OH	U1	ON	128300	137824	141217	143756	1209.485	1236.844	1580.376	2014.901
39	91	39091	OH	Logan, OH	R	ON	42310	45419	46537	47374	301.137	431.816	521.592	633.285
39	93	39093	OH	Lorain, OH	U1	OI	271126	280845	287760	292933	1804.367	2571.065	2932.055	3408.666
39	95	39095	OH	Lucas, OH	U1	ON	462361	452902	464053	472395	3076.923	4431.831	5249.260	6305.776
39	97	39097	OH	Madison, OH	U1	ON	37068	40855	41861	42613	465.919	356.172	457.849	585.868
39	99	39099	OH	Mahoning, OH	U1	ON	264806	258534	264900	269662	1743.318	2354.125	2718.661	3179.650
39	101	39101	OH	Marion, OH	U2	ON	64274	64995	66595	67792	462.745	449.294	542.312	658.147
39	103	39103	OH	Medina, OH	U1	OI	122354	139160	142587	145150	1011.998	1192.249	1370.770	1601.405
39	105	39105	OH	Meigs, OH	R	ON	22987	23850	24437	24877	168.995	285.646	345.130	419.108
39	107	39107	OH	Mercer, OH	R	ON	39443	40764	41768	42518	335.787	367.302	443.602	538.541
39	109	39109	OH	Miami, OH	U1	ON	93182	97091	99481	101269	760.583	641.291	772.813	940.396
39	111	39111	OH	Monroe, OH	R	ON	15497	15355	15733	16016	183.554	179.521	216.886	263.364
39	113	39113	OH	Montgomery, OH	U1	ON	573809	563090	576955	587326	4066.156	5986.740	7103.306	8563.856
39	115	39115	OH	Morgan, OH	R	ON	14194	14555	14913	15181	141.907	198.728	240.148	291.657
39	117	39117	OH	Morrow, OH	R	ON	27749	30604	31358	31921	392.321	350.215	423.154	513.865
39	119	39119	OH	Muskingum, OH	R	ON	82068	84186	86259	87809	820.584	794.917	960.109	1165.641
39	121	39121	OH	Noble, OH	R	ON	11336	12166	12465	12689	167.860	158.715	191.794	232.919
39	123	39123	OH	Ottawa, OH	R	ON	40029	40562	41561	42308	367.213	430.809	520.379	631.810
39	125	39125	OH	Paulding, OH	R	ON	20488	20204	20702	21074	176.081	252.613	305.217	370.644
39	127	39127	OH	Perry, OH	R	ON	31557	33774	34606	35228	266.793	339.764	410.438	498.355
39	129	39129	OH	Pickaway, OH	U1	ON	48244	52507	53800	54767	515.330	520.775	669.564	856.853
39	131	39131	OH	Pike, OH	R	ON	24249	27091	27758	28257	268.444	280.304	338.645	411.205
39	133	39133	OH	Portage, OH	U1	OI	142585	149620	153304	156059	1272.664	1499.534	1807.234	2195.720
39	135	39135	OH	Preble, OH	R	ON	40113	42469	43515	44297	353.367	463.815	560.350	680.416
39	137	39137	OH	Putnam, OH	R	ON	33819	34900	35759	36402	283.681	420.613	508.207	617.136
39	139	39139	OH	Richland, OH	U2	ON	126137	127530	130670	133019	915.503	1106.076	1291.218	1521.512
39	141	39141	OH	Ross, OH	R	ON	69330	74357	76188	77558	601.991	680.803	822.296	998.348

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
39	143	39143	OH	Sandusky, OH	U2	ON	61963	62248	63781	64928	729.908	426.880	515.244	625.285
39	145	39145	OH	Scioto, OH	R	ON	80327	80695	82682	84168	464.172	673.360	813.081	986.991
39	147	39147	OH	Seneca, OH	R	ON	59733	59983	61460	62565	374.050	446.848	539.443	654.726
39	149	39149	OH	Shelby, OH	R	ON	44915	47058	48217	49083	461.958	381.432	460.589	559.117
39	151	39151	OH	Stark, OH	U1	ON	367585	372843	382023	388890	2010.726	3361.137	3959.974	4722.114
39	153	39153	OH	Summit, OH	U1	OI	514990	529270	542302	552050	3947.795	4989.990	5953.931	7190.379
39	155	39155	OH	Trumbull, OH	U1	ON	227813	226329	231902	236071	1656.246	2109.367	2444.279	2864.667
39	157	39157	OH	Tuscarawas, OH	R	ON	84090	87621	89778	91392	868.845	649.375	783.990	951.576
39	159	39159	OH	Union, OH	U1	ON	31969	37682	38610	39304	354.160	319.787	386.261	468.966
39	161	39161	OH	Van Wert, OH	R	ON	30464	30305	31051	31609	251.104	240.319	290.149	352.187
39	163	39163	OH	Vinton, OH	R	ON	11098	11900	12193	12412	93.446	155.381	187.768	228.034
39	165	39165	OH	Warren, OH	U1	ON	113927	136344	139701	142212	1036.333	1217.157	1481.286	1817.475
39	167	39167	OH	Washington, OH	R	ON	62254	63418	64980	66148	517.339	604.366	723.230	874.286
39	169	39169	OH	Wayne, OH	R	ON	101461	108393	111062	113058	911.052	932.802	1125.926	1366.431
39	171	39171	OH	Williams, OH	R	ON	36956	37739	38669	39364	385.759	350.176	422.930	513.454
39	173	39173	OH	Wood, OH	U1	ON	113269	118315	121228	123407	1218.369	979.192	1171.694	1416.181
39	175	39175	OH	Wyandot, OH	R	ON	22254	22644	23202	23619	283.119	184.760	223.094	270.799
40	1	40001	OK	Adair, OK	R	WT	18421	19870	21399	23643	241.530	295.908	366.452	456.218
40	3	40003	OK	Alfalfa, OK	R	WT	6416	6107	6577	7267	92.025	118.203	146.438	182.342
40	5	40005	OK	Atoka, OK	R	WT	12778	13255	14275	15772	138.166	181.582	224.784	279.796
40	7	40007	OK	Beaver, OK	R	WT	6023	5987	6448	7124	88.501	110.963	137.467	171.177
40	9	40009	OK	Beckham, OK	U2	WT	18812	18592	20022	22122	198.657	129.363	159.585	198.226
40	11	40011	OK	Blaine, OK	R	WT	11470	10716	11540	12750	141.294	155.688	192.703	239.836
40	13	40013	OK	Bryan, OK	R	WT	32089	33884	36490	40317	300.150	385.589	477.050	593.562
40	15	40015	OK	Caddo, OK	R	WT	29550	30734	33098	36569	526.051	436.907	540.933	673.341
40	17	40017	OK	Canadian, OK	U1	WT	74409	83204	89604	99002	549.726	890.406	1101.990	1377.996
40	19	40019	OK	Carter, OK	U2	WT	42919	43948	47329	52293	422.061	324.318	400.330	497.440
40	21	40021	OK	Cherokee, OK	R	WT	34049	37688	40587	44844	320.405	457.575	566.340	704.840
40	23	40023	OK	Choctaw, OK	R	WT	15302	15263	16437	18160	165.637	184.337	228.063	283.780
40	25	40025	OK	Cimarron, OK	R	WT	3301	3113	3353	3704	47.438	60.815	75.342	93.821
40	27	40027	OK	Cleveland, OK	U1	WT	174253	193891	208805	230705	1537.146	2482.306	3068.287	3833.851
40	29	40029	OK	Coal, OK	R	WT	5780	6018	6481	7161	78.552	106.486	131.921	164.272
40	31	40031	OK	Comanche, OK	U2	WT	111486	113604	122342	135174	843.502	1187.374	1418.890	1726.396
40	33	40033	OK	Cotton, OK	R	WT	6651	6685	7200	7955	106.365	82.953	102.641	127.725
40	35	40035	OK	Craig, OK	R	WT	14104	14394	15501	17127	202.139	165.107	204.249	254.122
40	37	40037	OK	Creek, OK	U1	WT	60915	65384	70413	77799	824.712	700.382	889.946	1127.059
40	39	40039	OK	Custer, OK	U2	WT	26897	25946	27942	30873	250.692	178.586	220.254	273.552
40	41	40041	OK	Delaware, OK	R	WT	28070	33049	35591	39324	284.025	451.524	559.170	696.145
40	43	40043	OK	Dewey, OK	R	WT	5551	5111	5504	6082	77.004	102.268	126.695	157.767
40	45	40045	OK	Ellis, OK	R	WT	4497	4262	4590	5071	72.763	82.848	102.638	127.805
40	47	40047	OK	Garfield, OK	U2	WT	56735	56704	61066	67471	466.930	310.159	370.508	447.131
40	49	40049	OK	Garvin, OK	R	WT	26605	26957	29031	32076	386.350	342.386	423.706	527.278
40	51	40051	OK	Grady, OK	R	WT	41747	44881	48333	53402	514.757	481.469	595.575	740.973
40	53	40053	OK	Grant, OK	R	WT	5689	5440	5859	6473	84.753	104.809	129.844	161.685

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
40	55	40055	OK	Greer, OK	U2	WT	6559	6403	6896	7619	60.372	66.255	81.913	101.868
40	57	40057	OK	Harmon, OK	U2	WT	3793	3519	3789	4187	34.825	28.193	34.797	43.233
40	59	40059	OK	Harper, OK	R	WT	4063	3683	3967	4383	61.309	74.852	92.732	115.478
40	61	40061	OK	Haskell, OK	R	WT	10940	11324	12195	13474	121.880	159.537	197.512	245.851
40	63	40063	OK	Hughes, OK	R	WT	13014	13089	14095	15574	142.169	161.710	200.091	248.980
40	65	40065	OK	Jackson, OK	U2	WT	28764	28719	30928	34172	207.719	172.308	212.350	263.616
40	67	40067	OK	Jefferson, OK	R	WT	7010	6718	7234	7993	106.409	129.145	159.994	199.231
40	69	40069	OK	Johnston, OK	R	WT	10032	10236	11023	12180	108.659	132.803	164.361	204.547
40	71	40071	OK	Kay, OK	U2	WT	48056	47011	50627	55937	439.593	281.038	346.279	429.824
40	73	40073	OK	Kingfisher, OK	R	WT	13212	13442	14476	15994	150.109	176.569	218.534	271.981
40	75	40075	OK	Kiowa, OK	R	WT	11347	10901	11740	12971	126.955	138.782	171.712	213.660
40	77	40077	OK	Latimer, OK	R	WT	10333	10292	11083	12246	103.704	141.385	175.001	217.812
40	79	40079	OK	Le Flore, OK	R	WT	43270	46027	49567	54766	403.471	566.822	701.231	872.470
40	81	40081	OK	Lincoln, OK	R	WT	29216	30816	33187	36667	444.348	453.819	561.953	699.572
40	83	40083	OK	Logan, OK	U1	WT	29011	30379	32716	36147	372.085	357.505	448.457	565.255
40	85	40085	OK	Love, OK	R	WT	7788	8481	9133	10091	149.751	150.279	186.173	231.834
40	87	40087	OK	McClain, OK	U1	WT	22795	25384	27337	30204	293.643	288.695	362.450	457.074
40	89	40089	OK	McCurtain, OK	R	WT	33433	34292	36930	40803	376.280	437.738	541.739	674.192
40	91	40091	OK	McIntosh, OK	R	WT	16779	18510	19933	22024	214.990	212.153	262.526	326.681
40	93	40093	OK	Major, OK	R	WT	8055	7812	8413	9296	86.783	102.615	126.984	158.014
40	95	40095	OK	Marshall, OK	R	WT	10829	11871	12784	14125	111.493	149.623	185.208	230.521
40	97	40097	OK	Mayes, OK	R	WT	33366	36544	39355	43483	522.344	478.795	592.734	737.782
40	99	40099	OK	Murray, OK	U2	WT	12042	12321	13268	14660	121.794	102.423	126.514	157.272
40	101	40101	OK	Muskogee, OK	U2	WT	68078	69190	74512	82327	755.049	585.465	723.225	899.050
40	103	40103	OK	Noble, OK	R	WT	11045	11217	12080	13347	146.991	122.234	151.175	188.066
40	105	40105	OK	Nowata, OK	R	WT	9992	9915	10677	11797	114.784	120.495	149.076	185.494
40	107	40107	OK	Okfuskee, OK	R	WT	11551	11309	12179	13457	173.466	162.453	201.099	250.305
40	109	40109	OK	Oklahoma, OK	U1	WT	599611	625991	674142	744848	5914.107	8480.646	10456.352	13045.781
40	111	40111	OK	Okmulgee, OK	U2	WT	36490	37950	40869	45155	452.335	357.033	441.332	548.833
40	113	40113	OK	Osage, OK	U1	WT	41645	42390	45650	50438	411.374	628.919	797.798	1009.349
40	115	40115	OK	Ottawa, OK	R	WT	30561	30578	32930	36384	412.636	348.526	431.104	536.345
40	117	40117	OK	Pawnee, OK	R	WT	15575	16117	17356	19177	175.026	235.431	291.503	362.869
40	119	40119	OK	Payne, OK	U2	WT	61507	63877	68790	76005	577.047	416.060	513.204	637.428
40	121	40121	OK	Pittsburg, OK	R	WT	40950	42875	46173	51016	387.260	480.113	593.957	739.010
40	123	40123	OK	Pontotoc, OK	R	WT	34119	34710	37380	41301	295.150	370.365	458.026	569.757
40	125	40125	OK	Pottawatomie, OK	U1	WT	58760	61416	66140	73077	583.863	549.524	688.994	868.190
40	127	40127	OK	Pushmataha, OK	R	WT	10997	11433	12313	13604	128.890	162.432	201.102	250.334
40	129	40129	OK	Roger Mills, OK	R	WT	4147	3680	3963	4379	62.402	76.401	94.648	117.861
40	131	40131	OK	Rogers, OK	U1	WT	55170	64156	69091	76338	734.185	786.255	998.649	1264.409
40	133	40133	OK	Seminole, OK	R	WT	25412	25074	27003	29835	344.382	286.897	354.860	441.472
40	135	40135	OK	Sequoyah, OK	R	WT	33828	36446	39249	43366	480.748	459.140	590.162	758.314
40	137	40137	OK	Stephens, OK	U2	WT	42299	43418	46758	51662	341.697	352.672	435.581	541.420
40	139	40139	OK	Texas, OK	R	WT	16419	17844	19216	21232	161.757	175.129	216.563	269.385
40	141	40141	OK	Tillman, OK	U2	WT	10384	9760	10511	11613	111.404	106.087	131.164	163.131

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
40	143	40143	OK	Tulsa, OK	U1	WT	503341	531245	572108	632113	5412.274	7282.669	9097.590	11404.662
40	145	40145	OK	Wagoner, OK	U1	WT	47883	53300	57400	63420	440.927	638.147	808.144	1021.409
40	147	40147	OK	Washington, OK	U2	WT	48066	47500	51154	56519	317.100	273.468	336.878	418.099
40	149	40149	OK	Washita, OK	R	WT	11441	11651	12547	13863	228.210	163.397	202.278	251.772
40	151	40151	OK	Woods, OK	U2	WT	9103	8373	9017	9962	90.094	78.066	96.433	119.865
40	153	40153	OK	Woodward, OK	U2	WT	18976	18709	20148	22261	165.125	148.184	182.950	227.367
41	1	41001	OR	Baker, OR	U2	SP	15317	16261	18790	21244	156.313	126.227	163.506	211.281
41	3	41003	OR	Benton, OR	U2	WA	70811	75725	87505	98932	555.467	420.694	544.079	702.398
41	5	41005	OR	Clackamas, OR	U1	WA	278850	323641	373989	422826	2694.951	3452.162	4546.587	5973.008
41	7	41007	OR	Clatsop, OR	U2	WA	33301	35225	40705	46021	365.280	303.664	393.499	508.593
41	9	41009	OR	Columbia, OR	R	WA	37557	42866	49535	56003	471.998	479.949	637.217	841.183
41	11	41011	OR	Coos, OR	U2	WA	60273	62208	71886	81273	699.319	569.078	737.518	953.315
41	13	41013	OR	Crook, OR	R	SP	14111	16551	19126	21624	158.187	167.069	216.676	280.199
41	15	41015	OR	Curry, OR	R	WA	19327	21004	24271	27440	213.236	276.292	358.503	463.727
41	17	41017	OR	Deschutes, OR	R	SP	74976	97597	112780	127507	768.204	900.956	1168.519	1511.127
41	19	41019	OR	Douglas, OR	U2	WA	94649	100794	116474	131684	1100.713	900.990	1167.711	1509.404
41	21	41021	OR	Gilliam, OR	R	SP	1717	1921	2220	2510	35.647	31.124	40.403	52.271
41	23	41023	OR	Grant, OR	R	SP	7853	7981	9222	10427	142.277	142.344	184.789	239.110
41	25	41025	OR	Harney, OR	R	SP	7060	7037	8132	9193	97.497	79.714	103.368	133.665
41	27	41027	OR	Hood River, OR	R	SP	16903	19230	22222	25124	218.063	229.654	297.951	385.387
41	29	41029	OR	Jackson, OR	U2	WA	146387	167450	193499	218767	1420.974	1574.525	2037.569	2639.238
41	31	41031	OR	Jefferson, OR	R	SP	13676	16171	18687	21127	201.002	190.857	247.633	320.313
41	33	41033	OR	Josephine, OR	R	WA	62649	71915	83102	93954	721.374	718.593	931.875	1204.997
41	35	41035	OR	Klamath, OR	U2	SP	57702	62251	71935	81329	549.806	444.118	575.113	743.034
41	37	41037	OR	Lake, OR	R	SP	7186	7307	8444	9546	94.468	88.409	114.674	148.293
41	39	41039	OR	Lane, OR	U1	WA	282912	307293	355097	401467	2730.959	2934.656	3729.912	4757.444
41	41	41041	OR	Lincoln, OR	R	WA	38889	44630	51573	58308	401.030	414.330	537.185	694.536
41	43	41043	OR	Linn, OR	U2	WA	91227	101695	117516	132861	979.811	873.088	1131.568	1462.712
41	45	41045	OR	Malheur, OR	R	SP	26038	28152	32531	36779	314.110	272.833	353.714	457.301
41	47	41047	OR	Marion, OR	U1	WA	228483	259889	300319	339536	2020.104	2318.398	3022.728	3933.488
41	49	41049	OR	Morrow, OR	R	SP	7625	9344	10798	12208	130.296	138.211	179.425	232.164
41	51	41051	OR	Multnomah, OR	U1	WA	583887	618800	715065	808441	4553.328	6215.976	8109.838	10593.652
41	53	41053	OR	Polk, OR	U1	WA	49541	58617	67736	76581	437.965	435.638	570.360	744.042
41	55	41055	OR	Sherman, OR	R	SP	1918	1818	2100	2375	37.640	34.765	45.133	58.397
41	57	41057	OR	Tillamook, OR	R	WA	21570	23982	27713	31332	314.942	324.699	421.366	545.085
41	59	41059	OR	Umatilla, OR	U2	SP	59249	63968	73919	83571	600.717	517.847	670.936	867.108
41	61	41061	OR	Union, OR	R	SP	23598	24861	28728	32479	266.749	232.878	301.856	390.216
41	63	41063	OR	Wallowa, OR	R	SP	6911	7341	8483	9591	126.037	125.269	162.623	210.424
41	65	41065	OR	Wasco, OR	U2	SP	21683	23028	26610	30085	199.054	156.042	202.006	260.936
41	67	41067	OR	Washington, OR	U1	WA	311554	379938	439043	496376	2295.106	3509.106	4591.669	6008.628
41	69	41069	OR	Wheeler, OR	R	SP	1396	1573	1818	2056	26.223	25.303	32.849	42.514
41	71	41071	OR	Yamhill, OR	U1	WA	65551	78118	90270	102058	640.307	609.068	808.538	1067.248
42	1	42001	PA	Adams, PA	U1	NN	78274	84685	86202	87961	631.940	749.156	904.696	1105.673
42	3	42003	PA	Allegheny, PA	U1	NI	1336449	1288599	1311670	1338447	8952.594	11308.287	13198.658	15779.873

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
42	5	42005	PA	Armstrong, PA	R	NN	73478	73559	74876	76404	539.057	714.497	862.860	1054.568
42	7	42007	PA	Beaver, PA	U1	NI	186093	185741	189066	192926	1432.379	1636.776	1920.507	2303.400
42	9	42009	PA	Bedford, PA	R	NN	47919	49062	49941	50960	714.600	508.167	613.754	750.167
42	11	42011	PA	Berks, PA	U1	NN	336523	351552	357846	365152	2398.202	2925.874	3548.699	4360.445
42	13	42013	PA	Blair, PA	U2	NN	130542	130869	133212	135931	877.499	1055.783	1257.816	1528.823
42	15	42015	PA	Bradford, PA	R	NN	60967	62103	63215	64505	438.324	555.776	671.119	820.188
42	17	42017	PA	Bucks, PA	U1	PA	541174	576710	587036	599020	4195.583	3817.707	4575.914	5559.220
42	19	42019	PA	Butler, PA	R	NN	152013	166742	169727	173192	1282.981	1189.848	1414.197	1709.203
42	21	42021	PA	Cambria, PA	U2	NN	163062	158225	161058	164346	1057.905	1374.021	1619.583	1945.592
42	23	42023	PA	Cameron, PA	R	NN	5913	5747	5850	5969	48.185	40.181	48.495	59.255
42	25	42025	PA	Carbon, PA	U1	NN	56846	58559	59607	60824	535.614	324.751	399.407	494.451
42	27	42027	PA	Centre, PA	U2	NN	124812	131824	134184	136924	1046.919	1007.456	1278.417	1631.441
42	29	42029	PA	Chester, PA	U1	PA	376396	410806	418161	426698	3272.784	3104.577	3738.601	4554.604
42	31	42031	PA	Clarion, PA	R	NN	41699	41803	42551	43420	504.834	402.454	486.016	593.994
42	33	42033	PA	Clearfield, PA	R	NN	78097	80290	81728	83396	854.848	692.422	836.090	1021.767
42	35	42035	PA	Clinton, PA	R	NN	37182	36927	37589	38356	390.384	321.825	388.584	474.868
42	37	42037	PA	Columbia, PA	U1	NN	63202	64083	65230	66562	551.858	464.604	553.917	670.842
42	39	42039	PA	Crawford, PA	R	NN	86170	88872	90463	92310	773.812	752.633	908.773	1110.578
42	41	42041	PA	Cumberland, PA	U1	NN	195257	206053	209742	214024	1966.021	2010.878	2514.952	3167.364
42	43	42043	PA	Dauphin, PA	U1	NN	237813	244653	249033	254117	2249.397	2834.538	3533.704	4441.755
42	45	42045	PA	Delaware, PA	U1	PA	547651	543673	553407	564704	2713.141	3638.330	4337.947	5253.524
42	47	42047	PA	Elk, PA	R	NN	34878	34906	35531	36257	242.222	248.598	300.069	366.631
42	49	42049	PA	Erie, PA	U1	NN	275572	278854	283847	289641	1743.698	1858.714	2191.185	2647.742
42	51	42051	PA	Fayette, PA	U1	NN	145351	145081	147678	150693	998.186	1265.970	1503.067	1815.475
42	53	42053	PA	Forest, PA	R	NN	4802	4895	4982	5084	85.878	54.277	65.559	80.134
42	55	42055	PA	Franklin, PA	R	NN	121082	126474	128739	131367	1123.538	1048.792	1265.024	1544.967
42	57	42057	PA	Fulton, PA	R	NN	13837	14368	14626	14924	361.557	156.399	188.910	230.900
42	59	42059	PA	Greene, PA	R	NN	39550	41830	42579	43448	347.371	401.488	484.884	592.629
42	61	42061	PA	Huntingdon, PA	R	NN	44164	45028	45834	46770	395.789	395.504	477.572	583.630
42	63	42063	PA	Indiana, PA	R	NN	89994	89298	90897	92752	725.973	816.408	985.834	1204.792
42	65	42065	PA	Jefferson, PA	R	NN	46083	46498	47330	48297	474.215	373.862	451.370	551.560
42	67	42067	PA	Juniata, PA	R	NN	20625	21716	22105	22556	215.257	233.122	281.582	344.182
42	69	42069	PA	Lackawanna, PA	U1	NN	219097	211697	215487	219887	1550.621	1703.000	2001.633	2403.741
42	71	42071	PA	Lancaster, PA	U1	NN	422822	449600	457650	466992	3015.961	3627.052	4594.775	5827.612
42	73	42073	PA	Lawrence, PA	R	NN	96246	95557	97268	99253	696.748	698.670	841.307	1026.470
42	75	42075	PA	Lebanon, PA	U1	NN	113744	116720	118810	121235	816.257	887.493	1119.568	1417.335
42	77	42077	PA	Lehigh, PA	U1	NI	291130	296764	302077	308244	2298.931	2559.725	3104.966	3811.508
42	79	42079	PA	Luzerne, PA	U1	NN	328149	319073	324785	331416	2289.545	2483.691	2928.501	3523.466
42	81	42081	PA	Lycoming, PA	U2	NN	118710	118449	120569	123031	976.238	1164.388	1403.027	1714.353
42	83	42083	PA	McKean, PA	R	NN	47131	46852	47691	48665	323.887	381.110	460.119	562.253
42	85	42085	PA	Mercer, PA	U2	NN	121003	121896	124079	126612	1019.529	999.454	1177.943	1410.086
42	87	42087	PA	Mifflin, PA	R	NN	46197	47036	47878	48856	318.660	422.536	510.229	623.554
42	89	42089	PA	Monroe, PA	U1	NN	95709	118699	120824	123291	1073.695	880.631	1063.408	1299.606
42	91	42091	PA	Montgomery, PA	U1	PA	678193	707570	720238	734942	5518.234	4818.155	5758.668	6984.293

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
42	93	42093	PA	Montour, PA	R	NN	17735	17937	18258	18631	194.228	115.474	139.359	170.254
42	95	42095	PA	Northampton, PA	U1	NI	247105	255834	260415	265731	1468.004	2165.396	2634.307	3239.550
42	97	42097	PA	Northumberland, PA	R	NN	96771	95339	97046	99027	662.826	588.202	709.759	867.027
42	99	42099	PA	Perry, PA	U1	NN	41172	43737	44520	45428	403.866	467.565	591.002	749.072
42	101	42101	PA	Philadelphia, PA	U1	PA	1585577	1470544	1496872	1527431	5439.178	10420.259	12415.797	15030.388
42	103	42103	PA	Pike, PA	R	NN	27966	37516	38188	38968	384.802	316.098	421.773	558.849
42	105	42105	PA	Potter, PA	R	NN	16717	17097	17403	17758	156.236	158.512	191.419	233.952
42	107	42107	PA	Schuylkill, PA	R	NN	152585	151446	154157	157304	1163.824	1046.762	1263.400	1543.578
42	109	42109	PA	Snyder, PA	R	NN	36680	38051	38732	39523	319.508	357.168	431.334	527.164
42	111	42111	PA	Somerset, PA	R	NN	78218	79964	81396	83057	899.840	759.206	899.971	1084.837
42	113	42113	PA	Sullivan, PA	R	NN	6104	6103	6212	6339	70.785	68.995	83.335	101.859
42	115	42115	PA	Susquehanna, PA	R	NN	40380	41841	42591	43460	465.453	456.412	551.287	673.844
42	117	42117	PA	Tioga, PA	R	NN	41126	41543	42287	43150	378.361	390.527	471.604	576.367
42	119	42119	PA	Union, PA	R	NN	36176	40974	41708	42559	380.753	310.079	374.397	457.533
42	121	42121	PA	Venango, PA	R	NN	59381	58255	59298	60508	525.792	419.591	506.459	618.794
42	123	42123	PA	Warren, PA	R	NN	45049	44345	45139	46061	380.797	390.149	471.082	575.692
42	125	42125	PA	Washington, PA	U1	NI	204584	205632	209314	213587	1895.332	1888.600	2224.544	2674.229
42	127	42127	PA	Wayne, PA	R	NN	39944	44609	45408	46335	342.691	398.455	481.209	588.134
42	129	42129	PA	Westmoreland, PA	U1	NI	370321	374051	380748	388521	3079.507	3239.394	3813.187	4582.261
42	131	42131	PA	Wyoming, PA	U1	NN	28076	29200	29722	30329	251.024	317.341	378.582	458.663
42	133	42133	PA	York, PA	U1	NN	339574	366097	372652	380260	2541.890	3196.209	3948.569	4901.002
44	1	44001	RI	Bristol, RI	U1	PA	48859	48954	50534	54577	265.516	362.389	436.595	537.442
44	3	44003	RI	Kent, RI	U1	PA	161135	161655	166872	180224	1187.809	1188.140	1432.713	1764.641
44	5	44005	RI	Newport, RI	U1	PA	87194	83255	85941	92818	646.972	658.075	794.326	978.196
44	7	44007	RI	Providence, RI	U1	PA	596270	577549	596187	643889	4421.189	4359.944	5257.865	6476.325
44	9	44009	RI	Washington, RI	U1	PA	110006	118307	122124	131896	843.066	531.654	649.571	806.443
45	1	45001	SC	Abbeville, SC	R	SE	23862	24331	26890	29558	220.703	286.890	368.445	475.185
45	3	45003	SC	Aiken, SC	U1	SE	120991	132124	146021	160508	1221.763	1514.968	1952.568	2527.357
45	5	45005	SC	Allendale, SC	R	SE	11722	11592	12811	14082	93.582	119.775	153.765	198.257
45	7	45007	SC	Anderson, SC	R	SE	145177	156383	172831	189978	1516.896	1663.486	2127.767	2737.506
45	9	45009	SC	Bamberg, SC	R	SE	16902	16655	18407	20233	154.052	158.021	202.814	261.462
45	11	45011	SC	Barnwell, SC	U2	SE	20293	21610	23883	26253	150.773	158.521	203.338	262.050
45	13	45013	SC	Beaufort, SC	U2	SE	86425	103702	114609	125980	486.260	514.862	659.703	849.676
45	15	45015	SC	Berkeley, SC	U1	SE	128776	133520	147563	162204	1117.632	1387.222	1775.043	2291.777
45	17	45017	SC	Calhoun, SC	R	SE	12753	13624	15057	16551	210.199	199.091	255.820	330.031
45	19	45019	SC	Charleston, SC	U1	SE	295041	286276	316385	347775	2587.204	2806.605	3569.441	4591.780
45	21	45021	SC	Cherokee, SC	R	SE	44506	47807	52835	58077	487.511	459.362	590.481	761.937
45	23	45023	SC	Chester, SC	R	SE	32170	33493	37015	40688	401.982	401.291	515.412	664.762
45	25	45025	SC	Chesterfield, SC	R	SE	38575	39830	44019	48386	383.039	480.010	616.513	795.156
45	27	45027	SC	Clarendon, SC	R	SE	28450	30364	33558	36887	413.923	380.661	488.988	630.730
45	29	45029	SC	Colleton, SC	R	SE	34377	36642	40495	44513	469.970	457.939	588.247	758.767
45	31	45031	SC	Darlington, SC	R	SE	61851	65222	72082	79233	836.181	685.890	880.321	1134.934
45	33	45033	SC	Dillon, SC	R	SE	29114	29610	32725	35971	447.462	356.608	458.003	590.711
45	35	45035	SC	Dorchester, SC	U1	SE	83060	89634	99062	108890	704.507	912.471	1166.828	1505.937

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
45	37	45037	SC	Edgefield, SC	R	SE	18360	19551	21608	23752	165.894	211.980	275.711	358.814
45	39	45039	SC	Fairfield, SC	R	SE	22295	22360	24712	27164	320.160	296.444	380.801	491.186
45	41	45041	SC	Florence, SC	U2	SE	114344	122945	135876	149357	1276.448	1337.084	1695.684	2165.760
45	43	45043	SC	Georgetown, SC	R	SE	46302	51474	56888	62532	400.202	537.026	688.386	886.832
45	45	45045	SC	Greenville, SC	U1	SE	320167	344472	380702	418473	2854.527	3613.811	4587.862	5875.956
45	47	45047	SC	Greenwood, SC	R	SE	59567	62787	69391	76276	495.401	631.636	810.950	1045.703
45	49	45049	SC	Hampton, SC	R	SE	18191	18923	20913	22988	273.615	239.946	308.217	397.566
45	51	45051	SC	Horry, SC	U2	SE	144053	165589	183005	201161	931.034	1783.078	2384.830	3185.236
45	53	45053	SC	Jasper, SC	R	SE	15487	16744	18505	20341	249.768	241.772	310.663	400.778
45	55	45055	SC	Kershaw, SC	R	SE	43599	47154	52113	57283	542.488	539.215	692.545	893.203
45	57	45057	SC	Lancaster, SC	R	SE	54516	57407	63445	69740	532.483	685.073	879.907	1134.890
45	59	45059	SC	Laurens, SC	R	SE	58092	61363	67817	74545	650.154	641.338	823.490	1061.934
45	61	45061	SC	Lee, SC	R	SE	18437	19936	22033	24219	283.317	236.791	304.148	392.293
45	63	45063	SC	Lexington, SC	U1	SE	167611	195691	216273	237730	1696.701	2031.646	2601.063	3350.424
45	65	45065	SC	McCormick, SC	R	SE	8868	9431	10423	11457	89.781	138.442	177.888	229.496
45	67	45067	SC	Marion, SC	R	SE	33899	34750	38405	42215	300.860	334.702	429.639	553.943
45	69	45069	SC	Marlboro, SC	R	SE	29716	29574	32684	35927	402.323	285.906	366.987	473.159
45	71	45071	SC	Newberry, SC	R	SE	33172	34090	37675	41413	415.284	366.776	470.948	607.304
45	73	45073	SC	Oconee, SC	R	SE	57494	62609	69193	76058	656.414	685.890	880.856	1136.038
45	75	45075	SC	Orangeburg, SC	R	SE	84803	87095	96255	105805	1070.762	961.378	1234.507	1592.024
45	77	45077	SC	Pickens, SC	U1	SE	93896	103086	113928	125232	716.647	953.801	1225.710	1581.344
45	79	45079	SC	Richland, SC	U1	SE	286321	301112	332781	365798	2576.078	3342.087	4251.910	5455.832
45	81	45081	SC	Saluda, SC	R	SE	16357	16732	18492	20327	164.658	208.690	268.052	345.731
45	83	45083	SC	Spartanburg, SC	U1	SE	226793	242382	267874	294451	2469.453	2842.110	3627.588	4661.131
45	85	45085	SC	Sumter, SC	U2	SE	101276	105830	116961	128565	950.660	1132.685	1420.628	1806.308
45	87	45087	SC	Union, SC	R	SE	30337	30526	33737	37084	283.242	332.050	426.348	549.794
45	89	45089	SC	Williamsburg, SC	R	SE	36815	37236	41152	45235	411.601	519.364	667.230	860.707
45	91	45091	SC	York, SC	U1	SE	131497	147787	163331	179535	1291.424	1570.750	2045.399	2670.907
46	3	46003	SD	Aurora, SD	R	ND	3135	3035	3353	3505	72.057	54.160	68.200	85.663
46	5	46005	SD	Beadle, SD	U2	ND	18253	18016	19903	20806	100.664	120.761	151.560	189.973
46	7	46007	SD	Bennett, SD	R	ND	3206	3277	3621	3785	33.818	55.387	69.745	87.596
46	9	46009	SD	Bon Homme, SD	R	ND	7089	7593	8389	8769	89.531	122.470	154.218	193.690
46	11	46011	SD	Brookings, SD	U2	ND	25207	26046	28776	30080	225.217	181.155	227.456	285.174
46	13	46013	SD	Brown, SD	U2	ND	35580	35684	39423	41211	185.849	225.038	282.365	353.872
46	15	46015	SD	Brule, SD	R	ND	5485	5536	6117	6394	104.176	94.760	119.324	149.858
46	17	46017	SD	Buffalo, SD	R	ND	1759	1768	1954	2042	19.947	30.389	38.267	48.051
46	19	46019	SD	Butte, SD	U2	ND	7914	8781	9702	10142	52.379	68.961	86.662	108.703
46	21	46021	SD	Campbell, SD	R	ND	1965	1974	2180	2279	24.915	33.949	42.747	53.683
46	23	46023	SD	Charles Mix, SD	R	ND	9131	9441	10431	10904	107.537	157.747	198.642	249.481
46	25	46025	SD	Clark, SD	R	ND	4403	4375	4833	5052	54.371	76.067	95.785	120.300
46	27	46027	SD	Clay, SD	U2	ND	13186	15058	16636	17390	64.298	70.957	88.945	111.398
46	29	46029	SD	Codington, SD	U2	ND	22698	25059	27685	28940	144.707	117.145	146.799	183.836
46	31	46031	SD	Corson, SD	R	ND	4195	4264	4710	4924	57.725	72.472	91.260	114.614
46	33	46033	SD	Custer, SD	R	ND	6179	6854	7572	7915	66.657	106.749	134.421	168.830

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
46	35	46035	SD	Davison, SD	U2	ND	17503	18621	20572	21505	113.744	86.700	108.618	135.992
46	37	46037	SD	Day, SD	R	ND	6978	6501	7182	7507	90.354	120.552	151.804	190.650
46	39	46039	SD	Deuel, SD	R	ND	4522	4549	5025	5253	105.050	78.122	98.374	123.557
46	41	46041	SD	Dewey, SD	R	ND	5523	5647	6239	6522	59.610	95.416	120.151	150.903
46	43	46043	SD	Douglas, SD	R	ND	3746	3598	3975	4155	46.451	64.717	81.493	102.346
46	45	46045	SD	Edmunds, SD	R	ND	4356	4263	4710	4924	57.311	75.254	94.763	119.022
46	47	46047	SD	Fall River, SD	U2	ND	7353	7156	7906	8264	52.691	59.425	74.655	93.632
46	49	46049	SD	Faulk, SD	R	ND	2744	2562	2831	2959	36.959	47.407	59.695	74.969
46	51	46051	SD	Grant, SD	R	ND	8372	8094	8943	9348	107.904	84.001	105.619	132.530
46	53	46053	SD	Gregory, SD	R	ND	5359	5082	5615	5869	66.833	92.584	116.583	146.426
46	55	46055	SD	Haakon, SD	R	ND	2624	2491	2752	2877	31.036	45.333	57.084	71.695
46	57	46057	SD	Hamlin, SD	R	ND	4974	5259	5811	6074	104.496	85.930	108.207	135.905
46	59	46059	SD	Hand, SD	R	ND	4272	4203	4643	4853	54.969	73.803	92.936	116.726
46	61	46061	SD	Hanson, SD	R	ND	2994	2913	3218	3364	67.830	51.727	65.133	81.805
46	63	46063	SD	Harding, SD	R	ND	1669	1522	1681	1757	18.889	28.834	36.309	45.591
46	65	46065	SD	Hughes, SD	U2	ND	14817	15320	16926	17693	54.303	54.239	67.779	84.731
46	67	46067	SD	Hutchinson, SD	R	ND	8262	8125	8976	9383	103.874	142.735	179.737	225.735
46	69	46069	SD	Hyde, SD	R	ND	1696	1655	1828	1911	22.987	29.301	36.895	46.339
46	71	46071	SD	Jackson, SD	R	ND	2811	2910	3214	3360	68.264	48.564	61.153	76.801
46	73	46073	SD	Jerauld, SD	R	ND	2425	2299	2540	2655	32.539	41.895	52.754	66.257
46	75	46075	SD	Jones, SD	R	ND	1324	1290	1425	1489	29.057	22.874	28.803	36.167
46	77	46077	SD	Kingsbury, SD	R	ND	5925	5844	6456	6749	74.199	102.361	128.896	161.879
46	79	46079	SD	Lake, SD	U2	ND	10550	10633	11747	12280	65.358	84.458	106.097	133.059
46	81	46081	SD	Lawrence, SD	U2	ND	20655	21920	24217	25315	198.891	191.175	240.306	301.481
46	83	46083	SD	Lincoln, SD	R	ND	15427	19477	21518	22494	225.021	211.098	280.187	369.555
46	85	46085	SD	Lyman, SD	R	ND	3638	3885	4292	4487	76.744	62.851	79.143	99.400
46	87	46087	SD	McCook, SD	R	ND	5688	5686	6282	6567	127.990	98.266	123.739	155.415
46	89	46089	SD	McPherson, SD	R	ND	3228	2846	3144	3286	44.739	55.767	70.224	88.198
46	91	46091	SD	Marshall, SD	R	ND	4844	4656	5144	5377	60.038	83.685	105.379	132.347
46	93	46093	SD	Meade, SD	R	ND	21878	21982	24285	25386	239.739	226.967	285.410	358.163
46	95	46095	SD	Mellette, SD	R	ND	2137	2005	2215	2316	24.979	36.921	46.489	58.381
46	97	46097	SD	Miner, SD	R	ND	3272	2975	3287	3436	41.536	56.527	71.181	89.396
46	99	46099	SD	Minnehaha, SD	U2	ND	123809	138131	152606	159526	1038.468	1245.295	1632.494	2137.076
46	101	46101	SD	Moody, SD	R	ND	6507	6534	7218	7546	132.916	112.416	141.557	177.784
46	103	46103	SD	Pennington, SD	U2	ND	81343	86355	95404	99730	784.191	824.737	1096.166	1457.193
46	105	46105	SD	Perkins, SD	R	ND	3932	3598	3975	4155	52.211	67.930	85.539	107.430
46	107	46107	SD	Potter, SD	R	ND	3190	2963	3273	3422	40.818	55.111	69.398	87.148
46	109	46109	SD	Roberts, SD	R	ND	9914	9965	11009	11508	168.577	171.276	215.675	270.876
46	111	46111	SD	Sanborn, SD	R	ND	2833	2770	3061	3200	35.692	48.943	61.631	77.408
46	113	46113	SD	Shannon, SD	R	ND	9902	11709	12936	13522	99.301	130.457	164.170	206.108
46	115	46115	SD	Spink, SD	R	ND	7981	7740	8551	8939	76.009	96.396	121.276	152.225
46	117	46117	SD	Stanley, SD	R	ND	2453	2856	3155	3298	28.142	42.380	53.365	67.019
46	119	46119	SD	Sully, SD	R	ND	1589	1546	1708	1786	22.108	27.452	34.568	43.420
46	121	46121	SD	Todd, SD	R	ND	8352	9161	10121	10580	81.411	144.289	181.693	228.198

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46	123	46123	SD	Tripp, SD	R	ND	6924	6889	7611	7956	50.680	67.192	84.474	105.992
46	125	46125	SD	Turner, SD	R	ND	8576	8625	9529	9961	102.816	148.159	186.568	234.314
46	127	46127	SD	Union, SD	R	ND	10189	11706	12933	13519	193.692	167.543	210.320	263.652
46	129	46129	SD	Walworth, SD	U2	ND	6087	5687	6283	6568	41.737	46.261	58.101	72.854
46	135	46135	SD	Yankton, SD	U2	ND	19252	20761	22937	23977	106.532	134.034	168.264	210.939
46	137	46137	SD	Ziebach, SD	R	ND	2220	2255	2491	2604	25.639	38.352	48.295	60.662
47	1	47001	TN	Anderson, TN	U1	SE	68250	70975	80413	86654	745.619	527.323	682.310	877.648
47	3	47003	TN	Bedford, TN	R	SE	30411	33626	38098	41054	310.665	257.564	328.737	419.250
47	5	47005	TN	Benton, TN	R	SE	14524	16056	18191	19603	197.085	158.232	202.242	258.142
47	7	47007	TN	Bledsoe, TN	R	SE	9669	10466	11858	12778	84.206	133.193	170.416	217.657
47	9	47009	TN	Blount, TN	U1	SE	85969	98319	111393	120038	598.711	1204.980	1547.870	1982.355
47	11	47011	TN	Bradley, TN	U2	SE	73712	79316	89863	96837	767.263	545.941	696.172	887.347
47	13	47013	TN	Campbell, TN	R	SE	35079	37462	42443	45737	435.670	400.623	512.168	653.824
47	15	47015	TN	Cannon, TN	R	SE	10467	11814	13385	14424	90.924	144.184	184.481	235.617
47	17	47017	TN	Carroll, TN	R	SE	27514	28705	32523	35047	351.710	274.978	351.307	448.290
47	19	47019	TN	Carter, TN	U1	SE	51505	52857	59886	64533	415.652	710.843	886.670	1113.664
47	21	47021	TN	Cheatham, TN	U1	SE	27140	33367	37804	40738	323.632	344.551	452.839	591.680
47	23	47023	TN	Chester, TN	R	SE	12819	14280	16179	17435	102.997	121.915	155.714	198.663
47	25	47025	TN	Claiborne, TN	R	SE	26137	28590	32392	34906	212.786	329.540	421.483	538.193
47	27	47027	TN	Clay, TN	R	SE	7238	7318	8291	8934	68.201	99.707	127.570	162.927
47	29	47029	TN	Cocke, TN	R	SE	29141	31246	35401	38149	370.952	319.617	408.529	521.460
47	31	47031	TN	Coffee, TN	U2	SE	40339	44780	50735	54672	393.236	286.156	364.781	464.866
47	33	47033	TN	Crockett, TN	R	SE	13378	13738	15565	16773	126.832	184.286	235.786	301.157
47	35	47035	TN	Cumberland, TN	R	SE	34736	41922	47497	51183	378.628	398.904	509.988	651.059
47	37	47037	TN	Davidson, TN	U1	OI	510786	530417	600951	647590	5382.432	7813.179	10073.050	13008.674
47	39	47039	TN	Decatur, TN	R	SE	10472	10724	12150	13093	162.547	144.256	184.568	235.738
47	41	47041	TN	DeKalb, TN	R	SE	14360	15595	17669	19040	112.041	154.271	197.169	251.652
47	43	47043	TN	Dickson, TN	U1	SE	35061	40172	45514	49046	393.888	382.006	501.717	655.273
47	45	47045	TN	Dyer, TN	U2	SE	34854	36223	41040	44225	371.085	263.844	336.500	428.949
47	47	47047	TN	Fayette, TN	R	SE	25559	28959	32810	35357	378.858	352.082	446.667	566.423
47	49	47049	TN	Fentress, TN	R	SE	14669	15727	17818	19201	131.717	202.069	258.541	330.205
47	51	47051	TN	Franklin, TN	R	SE	34725	36800	41694	44930	270.290	394.459	504.278	643.729
47	53	47053	TN	Gibson, TN	R	SE	46315	47852	54215	58423	387.646	385.532	492.016	627.435
47	55	47055	TN	Giles, TN	R	SE	25741	28087	31822	34292	311.713	263.913	337.215	430.350
47	57	47057	TN	Grainger, TN	U1	SE	17095	19124	21667	23348	148.825	235.487	301.299	384.823
47	59	47059	TN	Greene, TN	R	SE	55853	58933	66769	71951	703.008	613.971	784.781	1001.719
47	61	47061	TN	Grundy, TN	R	SE	13362	13887	15734	16955	206.416	184.066	235.504	300.788
47	63	47063	TN	Hamblen, TN	R	SE	50480	53272	60356	65040	582.027	449.763	574.231	732.464
47	65	47065	TN	Hamilton, TN	U1	SE	285536	293370	332382	358178	2841.811	4271.978	5330.131	6720.339
47	67	47067	TN	Hancock, TN	R	SE	6739	6796	7699	8297	61.188	92.831	118.774	151.700
47	69	47069	TN	Hardeman, TN	R	SE	23377	24044	27241	29355	197.167	253.469	323.963	413.505
47	71	47071	TN	Hardin, TN	R	SE	22633	24444	27695	29844	182.111	236.328	301.998	385.425
47	73	47073	TN	Hawkins, TN	U1	SE	44565	48175	54582	58818	360.157	567.695	710.942	895.073
47	75	47075	TN	Haywood, TN	U2	SE	19437	19746	22372	24109	230.399	152.680	194.774	248.323

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47	77	47077	TN	Henderson, TN	R	SE	21844	23690	26841	28924	273.204	234.176	299.288	382.003
47	79	47079	TN	Henry, TN	R	SE	27888	29443	33358	35947	230.110	275.743	352.263	449.497
47	81	47081	TN	Hickman, TN	R	SE	16754	19456	22043	23754	204.446	189.261	241.944	308.860
47	83	47083	TN	Houston, TN	R	SE	7018	7689	8712	9388	61.047	96.673	123.693	157.977
47	85	47085	TN	Humphreys, TN	R	SE	15813	16656	18871	20336	203.971	172.501	220.482	281.436
47	87	47087	TN	Jackson, TN	R	SE	9297	9516	10782	11619	83.497	128.070	163.860	209.284
47	89	47089	TN	Jefferson, TN	U1	SE	33016	40763	46183	49768	423.870	391.705	500.857	639.458
47	91	47091	TN	Johnson, TN	R	SE	13766	16157	18306	19727	122.119	189.630	242.626	309.884
47	93	47093	TN	Knox, TN	U1	SE	335749	361358	409411	441184	3628.857	4892.137	6251.324	7980.780
47	95	47095	TN	Lake, TN	R	SE	7129	8038	9107	9814	66.234	98.203	125.648	160.481
47	97	47097	TN	Lauderdale, TN	R	SE	23491	24065	27265	29381	203.737	252.524	322.742	411.925
47	99	47099	TN	Lawrence, TN	R	SE	35303	38570	43698	47090	279.988	366.724	468.614	598.060
47	101	47101	TN	Lewis, TN	R	SE	9247	10528	11928	12853	77.295	84.195	107.510	137.145
47	103	47103	TN	Lincoln, TN	R	SE	28157	29054	32917	35472	218.183	308.380	394.165	503.125
47	105	47105	TN	Loudon, TN	R	SE	31255	37237	42189	45463	353.034	314.151	407.026	523.955
47	107	47107	TN	McMinn, TN	R	SE	42383	45389	51425	55416	501.400	401.579	512.895	654.375
47	109	47109	TN	McNairy, TN	R	SE	22422	23499	26623	28690	191.117	264.788	338.568	432.242
47	111	47111	TN	Macon, TN	R	SE	15906	17511	19840	21380	130.864	177.291	226.629	289.291
47	113	47113	TN	Madison, TN	U2	SE	77982	83822	94968	102338	806.714	1034.654	1321.077	1681.033
47	115	47115	TN	Marion, TN	U1	SE	24860	26465	29985	32312	315.844	272.680	345.885	440.463
47	117	47117	TN	Marshall, TN	R	SE	21539	25070	28403	30608	225.452	183.243	233.886	298.283
47	119	47119	TN	Maury, TN	U2	SE	54812	66201	75004	80825	529.100	382.538	487.582	621.317
47	121	47121	TN	Meigs, TN	R	SE	8033	9459	10717	11549	66.021	110.657	141.582	180.826
47	123	47123	TN	Monroe, TN	R	SE	30541	33449	37897	40838	369.353	326.635	417.449	532.803
47	125	47125	TN	Montgomery, TN	U2	SE	100498	120859	136930	147557	861.736	1292.043	1613.166	2020.343
47	127	47127	TN	Moore, TN	R	SE	4721	5155	5840	6293	40.069	57.314	73.294	93.581
47	129	47129	TN	Morgan, TN	R	SE	17300	18323	20760	22371	147.386	237.623	304.028	388.305
47	131	47131	TN	Obion, TN	R	SE	31717	32061	36324	39143	261.414	285.304	364.280	464.675
47	133	47133	TN	Overton, TN	R	SE	17636	18922	21438	23102	148.508	199.193	254.642	325.067
47	135	47135	TN	Perry, TN	R	SE	6612	7362	8341	8988	54.295	91.082	116.537	148.838
47	137	47137	TN	Pickett, TN	R	SE	4548	4597	5208	5612	38.719	62.650	80.159	102.375
47	139	47139	TN	Polk, TN	R	SE	13643	14552	16487	17766	120.845	187.937	240.457	307.115
47	141	47141	TN	Putnam, TN	R	SE	51373	57280	64897	69933	530.473	428.550	546.923	697.458
47	143	47143	TN	Rhea, TN	R	SE	24344	27125	30732	33117	201.926	270.212	345.402	440.901
47	145	47145	TN	Roane, TN	R	SE	47227	49526	56112	60466	550.968	418.747	534.614	681.918
47	147	47147	TN	Robertson, TN	U1	SE	41492	50055	56711	61112	443.306	390.054	511.883	668.239
47	149	47149	TN	Rutherford, TN	U1	SE	118570	153690	174127	187641	884.389	876.224	1148.110	1497.400
47	151	47151	TN	Scott, TN	R	SE	18358	19584	22188	23910	163.692	212.664	271.897	347.120
47	153	47153	TN	Sequatchie, TN	U1	SE	8863	9925	11245	12117	68.112	79.239	101.169	129.050
47	155	47155	TN	Sevier, TN	U1	SE	51043	60951	69056	74415	558.516	487.151	631.167	812.499
47	157	47157	TN	Shelby, TN	U1	OI	826330	860307	974710	1050354	6134.583	9296.232	11573.851	14512.499
47	159	47159	TN	Smith, TN	R	SE	14143	15802	17904	19293	202.411	194.823	249.270	318.369
47	161	47161	TN	Stewart, TN	R	SE	9479	11003	12466	13434	76.984	130.575	167.067	213.372
47	163	47163	TN	Sullivan, TN	U1	SE	143596	149671	169575	182735	1472.260	2014.633	2502.346	3135.041

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
47	165	47165	TN	Sumner, TN	U1	SE	103281	119185	135034	145514	1006.332	1158.282	1507.078	1957.245
47	167	47167	TN	Tipton, TN	U1	SE	37568	44779	50734	54671	278.848	431.520	547.018	693.359
47	169	47169	TN	Trousdale, TN	R	SE	5920	6679	7567	8154	48.477	81.550	104.340	133.260
47	171	47171	TN	Unicoi, TN	U1	SE	16549	17158	19439	20948	128.050	170.886	215.014	271.456
47	173	47173	TN	Union, TN	U1	SE	13694	15596	17670	19041	104.010	188.639	244.829	315.493
47	175	47175	TN	Van Buren, TN	R	SE	4846	4973	5634	6071	42.001	66.756	85.410	109.090
47	177	47177	TN	Warren, TN	R	SE	32992	35381	40086	43197	265.928	325.907	416.346	531.264
47	179	47179	TN	Washington, TN	U1	SE	92315	100238	113567	122381	972.709	1234.502	1535.282	1924.903
47	181	47181	TN	Wayne, TN	R	SE	13935	16179	18330	19753	123.901	191.959	245.604	313.693
47	183	47183	TN	Weakley, TN	R	SE	31972	32719	37070	39947	271.596	340.582	435.265	555.538
47	185	47185	TN	White, TN	R	SE	20090	21870	24779	26702	162.826	222.984	285.031	363.834
47	187	47187	TN	Williamson, TN	U1	SE	81021	107037	121271	130682	682.496	863.536	1127.431	1467.237
47	189	47189	TN	Wilson, TN	U1	SE	67675	79244	89782	96749	704.060	780.822	1019.665	1327.176
48	1	48001	TX	Anderson, TX	R	WT	48024	51895	60204	70270	408.437	535.585	693.268	890.672
48	3	48003	TX	Andrews, TX	U2	WT	14338	14110	16369	19106	85.803	74.679	96.437	123.724
48	5	48005	TX	Angelina, TX	R	WT	69884	75811	87949	102654	610.713	645.816	835.594	1073.268
48	7	48007	TX	Aransas, TX	R	WT	17892	21909	25417	29667	165.721	216.787	280.657	360.606
48	9	48009	TX	Archer, TX	R	WT	7973	8233	9551	11148	104.350	130.670	153.273	178.069
48	11	48011	TX	Armstrong, TX	R	WT	2021	2150	2495	2912	29.618	34.767	45.038	57.878
48	13	48013	TX	Atascosa, TX	R	WT	30533	34592	40130	46840	363.159	298.092	385.741	495.485
48	15	48015	TX	Austin, TX	R	WT	19832	22464	26061	30418	288.888	213.519	276.360	355.049
48	17	48017	TX	Bailey, TX	U2	WT	7064	6864	7963	9295	72.249	47.049	60.816	78.065
48	19	48019	TX	Bandera, TX	R	WT	10562	14370	16671	19458	105.206	181.703	235.367	302.520
48	21	48021	TX	Bastrop, TX	R	WT	38263	47493	55097	64309	247.726	419.976	582.974	793.674
48	23	48023	TX	Baylor, TX	U2	WT	4385	4196	4868	5682	36.010	22.897	29.570	37.940
48	25	48025	TX	Bee, TX	U2	WT	25135	27637	32062	37423	238.930	214.215	277.108	355.870
48	27	48027	TX	Bell, TX	U1	WT	191073	217841	252720	294973	1751.110	2099.133	2626.408	3284.972
48	29	48029	TX	Bexar, TX	U1	WT	1185394	1311525	1521515	1775904	9808.929	13050.671	16781.596	21624.328
48	31	48031	TX	Blanco, TX	R	WT	5972	7893	9157	10688	69.518	102.739	133.082	171.055
48	33	48033	TX	Borden, TX	R	WT	799	755	876	1023	12.755	13.745	17.805	22.882
48	35	48035	TX	Bosque, TX	R	WT	15125	16453	19087	22278	167.997	208.743	270.304	347.356
48	37	48037	TX	Bowie, TX	U2	WT	81665	83385	96736	112910	1087.254	872.203	1050.814	1281.313
48	39	48039	TX	Brazoria, TX	U1	HS	191707	220592	255911	298698	1501.628	1588.909	2050.752	2617.408
48	41	48041	TX	Brazos, TX	U2	WT	121862	131416	152457	177947	782.281	1239.686	1681.290	2265.462
48	43	48043	TX	Brewster, TX	U2	WT	8653	8984	10422	12165	57.103	55.200	71.342	91.567
48	45	48045	TX	Briscoe, TX	R	WT	1971	1980	2298	2682	38.303	33.908	43.923	56.448
48	47	48047	TX	Brooks, TX	U2	WT	8204	8422	9770	11404	63.351	50.007	64.618	82.942
48	49	48049	TX	Brown, TX	U2	WT	34371	36541	42392	49480	294.432	295.151	381.811	490.358
48	51	48051	TX	Burleson, TX	R	WT	13625	15119	17540	20472	152.958	183.162	237.171	304.767
48	53	48053	TX	Burnet, TX	R	WT	22677	29601	34340	40082	196.920	271.064	350.917	450.874
48	55	48055	TX	Caldwell, TX	U2	WT	26392	30877	35821	41810	316.990	230.701	320.068	435.609
48	57	48057	TX	Calhoun, TX	U2	WT	19053	20556	23847	27834	180.154	152.442	197.163	253.180
48	59	48059	TX	Callahan, TX	R	WT	11859	12679	14709	17169	206.608	155.664	201.556	258.994
48	61	48061	TX	Cameron, TX	U1	WT	260120	312132	362108	422651	1697.692	2375.415	3097.901	4030.641

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
48	63	48063	TX	Camp, TX	R	WT	9904	10825	12558	14657	94.739	105.844	136.994	175.991
48	65	48065	TX	Carson, TX	R	WT	6576	6681	7750	9046	151.868	113.131	146.543	188.349
48	67	48067	TX	Cass, TX	R	WT	29982	30441	35315	41220	373.541	417.254	540.319	694.348
48	69	48069	TX	Castro, TX	R	WT	9070	8416	9763	11396	105.924	85.119	110.135	141.474
48	71	48071	TX	Chambers, TX	R	HS	20088	23051	26742	31213	585.024	327.766	434.048	567.033
48	73	48073	TX	Cherokee, TX	R	WT	41049	42531	49341	57590	394.561	430.265	556.866	715.372
48	75	48075	TX	Childress, TX	U2	WT	5953	7390	8574	10007	44.284	21.138	27.242	34.905
48	77	48077	TX	Clay, TX	R	WT	10024	10352	12010	14018	110.412	125.804	162.877	209.297
48	79	48079	TX	Cochran, TX	U2	WT	4377	4035	4681	5464	44.564	33.599	43.451	55.805
48	81	48081	TX	Coke, TX	R	WT	3424	3426	3974	4639	47.466	58.906	76.303	98.063
48	83	48083	TX	Coleman, TX	U2	WT	9710	9607	11145	13009	94.650	79.909	103.360	132.736
48	85	48085	TX	Collin, TX	U1	HS	264036	381735	442856	516899	1793.572	3087.344	4022.341	5226.719
48	87	48087	TX	Collingsworth, TX	R	WT	3573	3365	3903	4556	38.202	61.469	79.622	102.345
48	89	48089	TX	Colorado, TX	R	WT	18383	18809	21821	25469	295.010	204.826	265.129	340.631
48	91	48091	TX	Comal, TX	U1	WT	51832	67989	78875	92062	447.185	293.237	382.847	497.856
48	93	48093	TX	Comanche, TX	R	WT	13381	13564	15736	18367	146.104	164.372	212.806	273.430
48	95	48095	TX	Concho, TX	R	WT	3044	3095	3591	4191	43.293	52.366	67.834	87.186
48	97	48097	TX	Cooke, TX	R	WT	30777	32673	37904	44242	389.940	299.858	388.023	498.428
48	99	48099	TX	Coryell, TX	U1	WT	64226	75551	87647	102301	452.761	487.769	610.903	764.550
48	101	48101	TX	Cottle, TX	R	WT	2247	1998	2318	2706	43.767	38.657	50.073	64.363
48	103	48103	TX	Crane, TX	U2	WT	4652	4571	5302	6189	43.090	24.687	31.884	40.919
48	105	48105	TX	Crockett, TX	U2	WT	4078	4455	5168	6033	40.814	18.744	24.191	31.021
48	107	48107	TX	Crosby, TX	R	WT	7304	7365	8544	9973	131.573	125.655	162.765	209.209
48	109	48109	TX	Culberson, TX	U2	WT	3407	3175	3683	4299	28.295	11.630	14.983	19.199
48	111	48111	TX	Dallam, TX	U2	WT	5461	6232	7230	8439	50.685	29.506	38.110	48.892
48	113	48113	TX	Dallas, TX	U1	HS	1852810	1998807	2318839	2706536	18180.498	23030.445	29864.437	38697.383
48	115	48115	TX	Dawson, TX	U2	WT	14349	14730	17088	19945	120.923	72.693	93.863	120.408
48	117	48117	TX	Deaf Smith, TX	U2	WT	19153	19406	22513	26277	212.041	92.006	118.772	152.352
48	119	48119	TX	Delta, TX	R	WT	4857	4929	5718	6674	71.864	83.557	108.235	139.118
48	121	48121	TX	Denton, TX	U1	HS	273525	351982	408338	476610	2069.761	3203.643	4171.315	5418.327
48	123	48123	TX	DeWitt, TX	R	WT	18840	19555	22686	26479	185.011	181.508	234.867	301.688
48	125	48125	TX	Dickens, TX	R	WT	2571	2299	2667	3113	52.558	44.231	57.294	73.633
48	127	48127	TX	Dimmit, TX	U2	WT	10433	10478	12156	14189	99.051	86.953	112.474	144.435
48	129	48129	TX	Donley, TX	R	WT	3696	3794	4401	5137	92.754	63.584	82.363	105.859
48	131	48131	TX	Duval, TX	U2	WT	12918	13509	15671	18292	109.463	103.369	133.693	171.670
48	133	48133	TX	Eastland, TX	U2	WT	18488	17947	20821	24302	249.349	152.065	196.689	252.588
48	135	48135	TX	Ector, TX	U2	WT	118934	123899	143737	167769	981.787	1017.039	1218.580	1466.007
48	137	48137	TX	Edwards, TX	R	WT	2266	3528	4093	4777	30.193	38.982	50.495	64.914
48	139	48139	TX	Ellis, TX	U1	WT	85167	98418	114176	133266	853.024	820.795	1084.360	1420.726
48	141	48141	**TX**	El Paso, TX	**U1**	WT	**591610**	685867	795682	928715	4947.720	4857.838	6211.033	7932.645
48	143	48143	TX	Erath, TX	U2	WT	27991	30806	35738	41713	265.046	212.692	275.046	353.163
48	145	48145	TX	Falls, TX	R	WT	17712	17742	20583	24024	287.708	201.851	261.290	335.697
48	147	48147	TX	Fannin, TX	R	WT	24804	27248	31610	36895	286.328	319.027	413.065	530.764
48	149	48149	TX	Fayette, TX	R	WT	20095	20957	24313	28378	364.555	282.066	365.266	469.378

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48	151	48151	TX	Fisher, TX	R	WT	4842	4422	5130	5988	87.491	83.299	107.900	138.693
48	153	48153	TX	Floyd, TX	R	WT	8497	8254	9575	11176	103.567	83.427	107.957	138.680
48	155	48155	TX	Foard, TX	R	WT	1794	1736	2014	2350	32.047	30.863	39.978	51.379
48	157	48157	TX	Fort Bend, TX	U1	HS	225421	307474	356704	416342	1558.441	2269.286	2966.731	3845.761
48	159	48159	TX	Franklin, TX	R	WT	7802	9334	10828	12639	142.230	124.477	161.223	207.222
48	161	48161	TX	Freestone, TX	R	WT	15818	17294	20063	23417	220.255	167.400	216.660	278.342
48	163	48163	TX	Frio, TX	U2	WT	13472	15532	18019	21031	144.285	77.853	100.579	129.067
48	165	48165	TX	Gaines, TX	R	WT	14123	14862	17241	20124	107.393	140.817	182.230	234.093
48	167	48167	TX	Galveston, TX	U1	HS	217396	239324	277643	324063	1236.070	2372.103	2916.452	3615.299
48	169	48169	TX	Garza, TX	U2	WT	5143	4705	5458	6371	39.117	28.015	36.183	46.431
48	171	48171	TX	Gillespie, TX	R	WT	17204	19523	22648	26435	198.920	184.286	238.522	306.422
48	173	48173	TX	Glasscock, TX	R	WT	1447	1453	1686	1967	19.366	24.893	32.247	41.450
48	175	48175	TX	Goliad, TX	R	WT	5980	6662	7729	9021	77.122	102.877	133.261	171.276
48	177	48177	TX	Gonzales, TX	R	WT	17205	17517	20322	23719	262.616	190.858	247.047	317.391
48	179	48179	TX	Gray, TX	U2	WT	23967	23754	27558	32165	236.578	90.846	117.123	150.114
48	181	48181	TX	Grayson, TX	U2	WT	95019	100609	116718	136233	944.764	1350.656	1637.947	1988.078
48	183	48183	TX	Gregg, TX	U2	WT	104948	111976	129904	151624	1039.258	1081.520	1324.674	1629.577
48	185	48185	TX	Grimes, TX	R	WT	18828	22272	25838	30158	141.197	222.501	288.041	370.088
48	187	48187	TX	Guadalupe, TX	U1	WT	64873	76093	88276	103036	648.853	724.331	944.214	1226.727
48	189	48189	TX	Hale, TX	U2	WT	34671	36327	42143	49190	440.678	214.222	276.833	355.304
48	191	48191	TX	Hall, TX	R	WT	3905	3734	4331	5056	49.119	67.179	87.020	111.851
48	193	48193	TX	Hamilton, TX	R	WT	7733	7626	8847	10326	90.912	85.728	110.967	142.561
48	195	48195	TX	Hansford, TX	U2	WT	5848	5461	6335	7394	57.636	49.114	63.531	81.581
48	197	48197	TX	Hardeman, TX	U2	WT	5283	4784	5550	6478	55.161	35.914	46.426	59.605
48	199	48199	TX	Hardin, TX	U1	WT	41320	47391	54979	64171	352.070	561.027	672.672	806.949
48	201	48201	TX	Harris, TX	U1	HS	2818101	3109524	3607395	4210531	17466.897	31520.304	41040.583	53069.062
48	203	48203	TX	Harrison, TX	R	WT	57483	59372	68878	80394	740.793	595.689	738.890	915.791
48	205	48205	TX	Hartley, TX	U2	WT	3634	4909	5694	6647	36.077	26.456	34.206	43.911
48	207	48207	TX	Haskell, TX	R	WT	6820	6209	7203	8407	75.953	62.984	81.493	104.667
48	209	48209	TX	Hays, TX	U1	WT	65614	83331	96673	112837	525.542	665.838	924.101	1257.962
48	211	48211	TX	Hemphill, TX	R	WT	3720	3633	4214	4919	43.403	63.998	82.899	106.548
48	213	48213	TX	Henderson, TX	R	WT	58543	66089	76671	89490	529.462	773.340	1022.325	1339.954
48	215	48215	TX	Hidalgo, TX	U1	WT	383545	492725	571616	667187	2514.652	4213.360	5756.543	7785.251
48	217	48217	TX	Hill, TX	R	WT	27146	29621	34363	40108	443.752	353.099	457.190	587.476
48	219	48219	TX	Hockley, TX	U2	WT	24199	23971	27809	32459	205.093	191.041	247.076	317.277
48	221	48221	TX	Hood, TX	R	WT	28981	35173	40805	47627	229.334	433.422	576.261	760.616
48	223	48223	TX	Hopkins, TX	R	WT	28833	30292	35142	41017	356.832	269.538	348.755	447.954
48	225	48225	TX	Houston, TX	R	WT	21375	21811	25304	29534	256.160	254.592	329.590	423.472
48	227	48227	TX	Howard, TX	U2	WT	32343	32531	37739	44049	332.374	184.465	238.304	305.806
48	229	48229	**TX**	Hudspeth, TX	**R**	WT	**2915**	3269	3792	4426	62.098	50.149	64.959	83.494
48	231	48231	TX	Hunt, TX	R	WT	64343	68600	79583	92889	742.101	625.403	826.242	1082.555
48	233	48233	TX	Hutchinson, TX	U2	WT	25689	24218	28096	32793	230.200	189.471	244.994	314.560
48	235	48235	TX	Irion, TX	R	WT	1629	1686	1956	2284	20.586	28.024	36.301	46.661
48	237	48237	TX	Jack, TX	R	WT	6981	7266	8430	9839	69.495	66.142	85.582	109.928

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48	239	48239	TX	Jackson, TX	R	WT	13039	13568	15740	18372	141.056	138.259	178.944	229.896
48	241	48241	TX	Jasper, TX	R	WT	31102	32903	38171	44553	386.640	422.976	547.708	703.830
48	243	48243	TX	Jeff Davis, TX	R	WT	1946	2193	2544	2969	37.485	33.478	43.365	55.742
48	245	48245	TX	Jefferson, TX	U1	WT	239389	241576	280255	327112	2367.012	2475.468	2926.875	3482.055
48	247	48247	TX	Jim Hogg, TX	U2	WT	5109	4951	5744	6704	29.301	16.945	21.825	27.955
48	249	48249	TX	Jim Wells, TX	U2	WT	37679	39533	45863	53531	290.433	268.886	347.645	446.334
48	251	48251	TX	Johnson, TX	U1	WT	97165	111640	129514	151168	934.742	906.146	1203.660	1587.853
48	253	48253	TX	Jones, TX	U2	WT	16490	18473	21430	25013	145.829	129.587	167.401	214.807
48	255	48255	TX	Karnes, TX	U2	WT	12455	12494	14495	16918	124.349	106.693	138.019	177.260
48	257	48257	TX	Kaufman, TX	U1	WT	52220	62195	72153	84216	586.565	547.163	723.000	947.374
48	259	48259	TX	Kendall, TX	R	WT	14589	19565	22697	26492	187.143	182.142	235.819	303.007
48	261	48261	TX	Kenedy, TX	R	WT	460	432	501	585	8.062	7.915	10.251	13.172
48	263	48263	TX	Kent, TX	R	WT	1010	884	1026	1197	17.004	17.377	22.507	28.932
48	265	48265	TX	Kerr, TX	R	WT	36304	41720	48400	56492	395.198	344.559	445.842	572.671
48	267	48267	TX	Kimble, TX	U2	WT	4122	4188	4859	5671	48.369	29.455	38.084	48.887
48	269	48269	TX	King, TX	R	WT	354	349	405	472	6.314	6.090	7.889	10.141
48	271	48271	TX	Kinney, TX	R	WT	3119	3429	3978	4644	33.849	53.658	69.506	89.331
48	273	48273	TX	Kleberg, TX	U2	WT	30274	30224	35064	40926	203.539	113.711	146.592	187.883
48	275	48275	TX	Knox, TX	R	WT	4837	4384	5086	5937	79.143	83.213	107.790	138.538
48	277	48277	TX	Lamar, TX	U2	WT	43949	45512	52799	61626	367.739	358.213	463.323	594.986
48	279	48279	TX	Lamb, TX	R	WT	15072	14881	17263	20150	202.206	154.775	200.306	257.317
48	281	48281	TX	Lampasas, TX	R	WT	13521	16924	19634	22916	115.829	129.817	167.980	215.774
48	283	48283	TX	La Salle, TX	U2	WT	5254	5838	6772	7905	58.948	30.616	39.555	50.758
48	285	48285	TX	Lavaca, TX	R	WT	18690	18678	21669	25291	214.481	221.737	287.055	368.820
48	287	48287	TX	Lee, TX	R	WT	12854	14515	16839	19655	122.639	155.209	200.936	258.176
48	289	48289	TX	Leon, TX	R	WT	12665	14195	16468	19221	218.382	217.882	282.232	362.757
48	291	48291	TX	Liberty, TX	U1	HS	52726	62345	72327	84420	593.455	587.406	778.651	1017.832
48	293	48293	TX	Limestone, TX	R	WT	20946	21043	24412	28494	194.308	197.376	255.393	328.038
48	295	48295	TX	Lipscomb, TX	R	WT	3143	3044	3531	4121	55.935	54.070	70.040	90.018
48	297	48297	TX	Live Oak, TX	R	WT	9556	10071	11684	13637	173.957	122.745	158.925	204.217
48	299	48299	TX	Llano, TX	R	WT	11631	12894	14958	17459	119.541	104.888	135.702	174.299
48	301	48301	TX	Loving, TX	R	WT	107	106	123	144	1.352	1.842	2.385	3.058
48	303	48303	TX	Lubbock, TX	U2	WT	222636	229524	266273	310793	2289.137	2416.998	2912.905	3525.142
48	305	48305	TX	Lynn, TX	R	WT	6758	6615	7674	8957	94.749	70.084	90.704	116.513
48	307	48307	TX	McCulloch, TX	U2	WT	8778	8778	10183	11886	69.261	55.242	71.393	91.643
48	309	48309	TX	McLennan, TX	U2	WT	189123	201003	233186	272173	2117.183	2331.846	2841.167	3474.106
48	311	48311	TX	McMullen, TX	R	WT	817	788	914	1067	11.716	14.058	18.206	23.408
48	313	48313	TX	Madison, TX	R	WT	10931	11789	13677	15963	180.128	130.567	169.030	217.183
48	315	48315	TX	Marion, TX	R	WT	9984	10574	12267	14318	127.085	171.758	222.488	285.965
48	317	48317	TX	Martin, TX	U2	WT	4956	5061	5871	6852	106.614	44.930	58.131	74.657
48	319	48319	TX	Mason, TX	R	WT	3423	3618	4197	4898	54.699	58.887	76.279	98.045
48	321	48321	TX	Matagorda, TX	U2	WT	36928	37770	43817	51143	333.801	269.961	349.065	448.177
48	323	48323	TX	Maverick, TX	U2	WT	36378	46234	53637	62605	249.415	293.213	379.238	487.002
48	325	48325	TX	Medina, TX	R	WT	27312	35468	41147	48026	360.319	309.665	400.849	515.000

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48	327	48327	TX	Menard, TX	R	WT	2252	2321	2693	3143	34.840	38.742	50.184	64.507
48	329	48329	TX	Midland, TX	U2	WT	106611	116940	135664	158346	889.855	1101.272	1322.301	1592.836
48	331	48331	TX	Milam, TX	R	WT	22946	24077	27933	32603	222.796	220.558	285.401	366.598
48	333	48333	TX	Mills, TX	R	WT	4531	4737	5495	6414	66.489	77.950	100.971	129.784
48	335	48335	TX	Mitchell, TX	U2	WT	8016	8661	10047	11727	114.929	61.413	79.420	101.975
48	337	48337	TX	Montague, TX	R	WT	17274	18145	21050	24570	171.427	170.994	221.279	284.249
48	339	48339	TX	Montgomery, TX	U1	HS	182201	247280	286873	334836	1713.243	2117.797	2807.551	3670.134
48	341	48341	TX	Moore, TX	U2	WT	17865	19275	22361	26100	122.615	100.034	129.220	165.810
48	343	48343	TX	Morris, TX	R	WT	13200	13287	15415	17992	281.424	185.660	240.421	308.966
48	345	48345	TX	Motley, TX	R	WT	1532	1316	1527	1782	28.963	26.357	34.139	43.882
48	347	48347	TX	Nacogdoches, TX	U2	WT	54753	56436	65472	76418	419.779	444.701	575.185	738.638
48	349	48349	TX	Navarro, TX	U2	WT	39926	41160	47751	55734	434.622	318.075	411.381	528.266
48	351	48351	TX	Newton, TX	R	WT	13569	14297	16586	19359	196.846	233.435	302.378	388.649
48	353	48353	TX	Nolan, TX	U2	WT	16594	16501	19143	22344	186.845	92.730	119.783	153.697
48	355	48355	TX	Nueces, TX	U1	WT	291145	313713	363942	424791	2622.688	2930.104	3527.356	4272.092
48	357	48357	TX	Ochiltree, TX	U2	WT	9128	8934	10365	12098	61.445	34.510	44.493	57.028
48	359	48359	TX	Oldham, TX	R	WT	2278	2227	2584	3016	51.964	39.190	50.766	65.241
48	361	48361	TX	Orange, TX	U1	WT	80509	84057	97515	113819	1057.458	656.730	789.135	947.868
48	363	48363	TX	Palo Pinto, TX	U2	WT	25055	25431	29503	34436	303.587	199.293	257.753	330.994
48	365	48365	TX	Panola, TX	R	WT	22035	22866	26528	30963	242.465	274.450	355.328	456.569
48	367	48367	TX	Parker, TX	U1	WT	64785	76807	89105	104003	799.637	861.588	1144.907	1510.693
48	369	48369	TX	Parmer, TX	R	WT	9863	10388	12051	14066	125.351	110.276	142.745	183.392
48	371	48371	TX	Pecos, TX	U2	WT	14675	15979	18537	21636	184.920	115.168	148.948	191.254
48	373	48373	TX	Polk, TX	R	WT	30687	45057	52271	61011	312.557	446.922	578.780	743.801
48	375	48375	TX	Potter, TX	U2	WT	97841	107614	124844	145718	996.069	1113.591	1344.942	1631.825
48	377	48377	TX	Presidio, TX	R	WT	6637	8300	9629	11239	77.054	63.475	82.136	105.497
48	379	48379	TX	Rains, TX	R	WT	6715	7999	9280	10831	71.864	115.522	149.641	192.331
48	381	48381	TX	Randall, TX	U2	WT	89673	97601	113228	132159	771.344	947.480	1147.110	1393.871
48	383	48383	TX	Reagan, TX	U2	WT	4514	4269	4952	5780	26.928	19.414	25.049	32.117
48	385	48385	TX	Real, TX	R	WT	2412	2647	3071	3584	36.668	41.496	53.749	69.091
48	387	48387	TX	Red River, TX	R	WT	14317	13869	16089	18779	189.321	176.867	228.983	294.226
48	389	48389	TX	Reeves, TX	U2	WT	15852	14998	17400	20309	140.956	78.320	101.116	129.715
48	391	48391	TX	Refugio, TX	R	WT	7976	7895	9160	10691	98.464	86.351	111.767	143.590
48	393	48393	TX	Roberts, TX	R	WT	1025	993	1152	1345	17.628	17.633	22.842	29.353
48	395	48395	TX	Robertson, TX	R	WT	15511	15531	18017	21030	162.738	184.184	238.440	306.363
48	397	48397	TX	Rockwall, TX	U1	WT	25604	34449	39965	46646	217.536	369.694	484.240	631.239
48	399	48399	TX	Runnels, TX	U2	WT	11294	11434	13264	15482	102.687	83.484	107.949	138.609
48	401	48401	TX	Rusk, TX	R	WT	43735	45364	52628	61427	472.585	526.902	682.132	876.451
48	403	48403	TX	Sabine, TX	R	WT	9586	10425	12094	14116	129.238	164.913	213.619	274.556
48	405	48405	TX	San Augustine, TX	R	WT	7999	8158	9464	11046	100.793	137.609	178.254	229.105
48	407	48407	TX	San Jacinto, TX	R	WT	16372	20219	23456	27378	169.816	281.655	364.840	468.938
48	409	48409	TX	San Patricio, TX	U1	WT	58749	68072	78971	92175	647.853	503.455	613.275	748.081
48	411	48411	TX	San Saba, TX	R	WT	5401	6278	7283	8501	63.294	49.830	64.473	82.822
48	413	48413	TX	Schleicher, TX	R	WT	2990	3039	3525	4115	41.882	51.439	66.631	85.633

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
48	415	48415	TX	Scurry, TX	U2	WT	18634	18249	21171	24711	141.455	124.150	160.480	206.006
48	417	48417	TX	Shackelford, TX	R	WT	3316	3332	3866	4512	58.147	57.046	73.895	94.977
48	419	48419	TX	Shelby, TX	R	WT	22034	22564	26176	30553	283.809	299.335	387.605	498.074
48	421	48421	TX	Sherman, TX	R	WT	2858	2898	3362	3924	47.139	49.168	63.688	81.859
48	423	48423	TX	Smith, TX	U2	WT	151309	164521	190863	222774	2029.430	2139.586	2728.758	3479.872
48	425	48425	TX	Somervell, TX	R	WT	5360	6110	7088	8273	61.697	92.211	119.446	153.517
48	427	48427	TX	Starr, TX	R	WT	40518	53411	61963	72323	280.183	407.938	527.923	678.157
48	429	48429	TX	Stephens, TX	U2	WT	9010	9775	11340	13236	77.301	63.761	82.433	105.843
48	431	48431	TX	Sterling, TX	R	WT	1438	1393	1616	1886	17.909	24.739	32.046	41.186
48	433	48433	TX	Stonewall, TX	R	WT	2013	1836	2130	2487	35.733	34.632	44.859	57.651
48	435	48435	TX	Sutton, TX	U2	WT	4135	4394	5097	5950	51.169	25.265	32.647	41.907
48	437	48437	TX	Swisher, TX	U2	WT	8133	8316	9648	11261	135.689	64.230	83.071	106.679
48	439	48439	TX	Tarrant, TX	U1	HS	1170103	1304871	1513796	1766894	10775.681	14286.632	18633.174	24309.668
48	441	48441	TX	Taylor, TX	U2	WT	119655	121199	140604	164112	1153.661	1290.338	1540.172	1839.628
48	443	48443	TX	Terrell, TX	R	WT	1410	1221	1416	1653	23.688	24.258	31.421	40.385
48	445	48445	TX	Terry, TX	U2	WT	13218	13034	15121	17649	111.335	73.418	94.835	121.699
48	447	48447	TX	Throckmorton, TX	R	WT	1880	1729	2006	2341	30.491	32.342	41.895	53.852
48	449	48449	TX	Titus, TX	U2	WT	24009	25068	29082	33945	300.863	215.073	278.253	357.377
48	451	48451	TX	Tom Green, TX	U2	WT	98458	102049	118389	138183	635.453	856.491	1047.125	1292.411
48	453	48453	TX	Travis, TX	U1	WT	576407	676863	785237	916524	5507.772	7058.161	9637.202	12991.045
48	455	48455	TX	Trinity, TX	R	WT	11445	12272	14237	16617	113.801	153.004	198.116	254.590
48	457	48457	TX	Tyler, TX	R	WT	16646	19613	22753	26557	212.357	243.911	315.877	405.949
48	459	48459	TX	Upshur, TX	R	WT	31370	34838	40416	47173	349.672	425.250	528.032	654.863
48	461	48461	TX	Upton, TX	R	WT	4447	3905	4531	5288	68.602	76.503	99.099	127.371
48	463	48463	TX	Uvalde, TX	U2	WT	23340	25293	29343	34249	189.633	164.297	212.411	272.710
48	465	48465	TX	Val Verde, TX	U2	WT	38721	42487	49290	57531	198.681	130.419	168.012	215.244
48	467	48467	TX	Van Zandt, TX	R	WT	37944	42276	49045	57245	576.056	515.798	667.902	858.267
48	469	48469	TX	Victoria, TX	U2	WT	74361	80929	93887	109584	609.800	759.649	966.915	1230.338
48	471	48471	TX	Walker, TX	U2	WT	50917	54012	62660	73137	543.965	426.174	551.268	707.962
48	473	48473	TX	Waller, TX	U1	HS	23389	26306	30518	35620	330.452	228.653	302.771	395.525
48	475	48475	TX	Ward, TX	U2	WT	13115	12066	13998	16338	175.328	95.145	123.020	157.946
48	477	48477	TX	Washington, TX	R	WT	26154	28622	33204	38756	215.606	257.434	333.134	427.930
48	479	48479	TX	Webb, TX	U2	WT	133239	176079	204271	238424	556.676	1000.148	1352.430	1801.482
48	481	48481	TX	Wharton, TX	R	WT	39955	40119	46542	54324	400.144	373.352	483.079	620.494
48	483	48483	TX	Wheeler, TX	R	WT	5879	5390	6253	7299	114.236	101.140	131.009	168.399
48	485	48485	TX	Wichita, TX	U2	WT	122378	127906	148385	173194	1083.875	1105.382	1275.680	1467.521
48	487	48487	TX	Wilbarger, TX	U2	WT	15121	14278	16565	19334	107.978	66.840	86.247	110.601
48	489	48489	TX	Willacy, TX	U2	WT	17705	19382	22486	26245	163.647	160.902	208.176	267.376
48	491	48491	TX	Williamson, TX	U1	WT	139551	200345	232422	271282	1036.174	1108.648	1524.643	2064.152
48	493	48493	TX	Wilson, TX	R	WT	22650	29116	33778	39426	204.467	305.147	399.366	520.084
48	495	48495	TX	Winkler, TX	U2	WT	8626	8121	9421	10997	66.431	36.811	47.491	60.897
48	497	48497	TX	Wise, TX	R	WT	34679	41286	47896	55904	315.255	455.006	589.146	757.053
48	499	48499	TX	Wood, TX	R	WT	29380	33486	38847	45342	296.455	401.630	520.072	668.311
48	501	48501	TX	Yoakum, TX	U2	WT	8786	8257	9579	11181	75.592	67.671	87.510	112.380

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48	503	48503	TX	Young, TX	U2	WT	18126	17654	20480	23904	149.368	110.419	142.682	183.126
48	505	48505	TX	Zapata, TX	U2	WT	9279	10982	12741	14871	59.627	43.906	56.674	72.690
48	507	48507	TX	Zavala, TX	U2	WT	12162	11985	13903	16228	88.817	78.491	101.450	130.218
49	1	49001	UT	Beaver, UT	R	UT	4765	5704	7017	7910	109.281	155.821	217.260	298.501
49	3	49003	UT	Box Elder, UT	U2	UT	36485	40442	49746	56083	446.779	554.486	772.830	1061.586
49	5	49005	UT	Cache, UT	U2	UT	70183	82727	101758	114720	655.310	899.371	1242.795	1698.415
49	7	49007	UT	Carbon, UT	R	UT	20228	20831	25624	28887	316.620	380.741	530.740	729.093
49	9	49009	UT	Daggett, UT	R	UT	690	745	916	1033	19.193	22.564	31.461	43.225
49	11	49011	UT	Davis, UT	U1	UT	187941	220616	271368	305934	1132.947	1738.692	2368.978	3206.980
49	13	49013	UT	Duchesne, UT	R	UT	12645	14185	17449	19671	236.542	287.565	400.895	550.752
49	15	49015	UT	Emery, UT	R	UT	10332	10797	13281	14973	285.835	337.867	471.088	647.246
49	17	49017	UT	Garfield, UT	R	UT	3980	4173	5133	5787	91.683	130.152	181.468	249.323
49	19	49019	UT	Grand, UT	U2	UT	6620	7904	9722	10961	98.685	88.740	123.671	169.874
49	21	49021	UT	Iron, UT	U2	UT	20789	26753	32907	37099	212.875	247.381	344.725	473.462
49	23	49023	UT	Juab, UT	U2	UT	5817	7044	8664	9767	72.112	77.149	107.518	147.685
49	25	49025	UT	Kane, UT	U2	UT	5169	5734	7053	7951	100.446	67.766	92.585	124.753
49	27	49027	UT	Millard, UT	R	UT	11333	12179	14981	16889	223.907	274.161	382.217	525.106
49	29	49029	UT	Morgan, UT	R	UT	5528	6708	8252	9303	122.737	180.771	252.048	346.307
49	31	49031	UT	Piute, UT	R	UT	1277	1375	1691	1906	33.172	41.759	58.225	79.995
49	33	49033	UT	Rich, UT	R	UT	1725	1803	2218	2500	52.420	56.409	78.651	108.065
49	35	49035	UT	Salt Lake, UT	U1	UT	725956	823619	1013090	1142133	5177.618	6721.859	9157.870	12396.821
49	37	49037	UT	San Juan, UT	R	UT	12621	13536	16649	18770	243.284	311.003	433.586	595.681
49	39	49039	UT	Sanpete, UT	R	UT	16259	20231	24885	28055	308.545	423.504	590.440	811.191
49	41	49041	UT	Sevier, UT	R	UT	15431	17688	21757	24528	257.600	324.691	452.636	621.809
49	43	49043	UT	Summit, UT	R	UT	15518	24290	29878	33684	197.908	363.726	507.077	696.633
49	45	49045	UT	Tooele, UT	U2	UT	26601	30723	37791	42604	273.470	285.248	397.456	545.861
49	47	49047	UT	Uintah, UT	R	UT	22211	25041	30802	34725	379.416	429.022	598.049	821.561
49	49	49049	UT	Utah, UT	U1	UT	263590	318920	392287	442255	1765.408	2761.731	3880.810	5358.051
49	51	49051	UT	Wasatch, UT	R	UT	10089	12402	15256	17199	125.214	176.091	245.452	337.190
49	53	49053	UT	Washington, UT	U2	UT	48560	74321	91418	103062	360.804	433.173	603.450	828.671
49	55	49055	UT	Wayne, UT	R	UT	2177	2341	2879	3246	47.699	71.190	99.261	136.382
49	57	49057	UT	Weber, UT	U1	UT	158330	178272	219283	247215	1298.110	1644.694	2249.638	3052.610
50	1	50001	VT	Addison, VT	R	NN	32953	34672	37685	39280	264.409	321.964	409.463	522.098
50	3	50003	VT	Bennington, VT	R	NN	35845	35939	39063	40716	290.073	348.669	443.405	565.370
50	5	50005	VT	Caledonia, VT	R	NN	27846	28571	31054	32368	313.083	278.716	354.560	452.162
50	7	50007	VT	Chittenden, VT	U2	NN	131761	140012	152181	158620	1479.732	2000.298	2568.959	3318.293
50	9	50009	VT	Essex, VT	R	NN	6405	6528	7096	7396	60.659	75.939	96.773	123.532
50	11	50011	VT	Franklin, VT	R	NN	39980	43001	46739	48717	420.645	415.253	540.359	703.443
50	13	50013	VT	Grand Isle, VT	R	NN	5318	6071	6598	6877	44.329	63.050	82.157	107.037
50	15	50015	VT	Lamoille, VT	R	NN	19735	21198	23041	24015	161.100	233.983	298.172	380.660
50	17	50017	VT	Orange, VT	R	NN	26149	27562	29958	31226	319.955	310.030	395.079	504.375
50	19	50019	VT	Orleans, VT	R	NN	24053	25136	27320	28476	296.504	249.677	317.748	405.308
50	21	50021	VT	Rutland, VT	R	NN	62142	62628	68071	70952	500.834	590.811	751.140	957.592
50	23	50023	VT	Washington, VT	R	NN	54928	56257	61146	63733	610.656	509.292	647.305	825.069

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50	25	50025	VT	Windham, VT	R	NN	41588	42664	46372	48334	415.667	372.498	473.242	603.052
50	27	50027	VT	Windsor, VT	R	NN	54055	54994	59773	62302	660.700	587.262	747.724	954.072
51	1	51001	VA	Accomack, VA	R	NN	31703	32040	35628	39218	361.252	465.876	595.263	766.597
51	3	51003	VA	Albemarle, VA	R	NN	68172	76183	84714	93251	671.115	772.998	991.617	1282.608
51	5	51005	VA	Alleghany, VA	R	NN	12969	12404	13793	15183	223.123	161.831	207.102	266.694
51	7	51007	VA	Amelia, VA	R	NN	8787	10053	11179	12305	97.108	144.967	185.242	238.575
51	9	51009	VA	Amherst, VA	R	NN	28578	29767	33100	36436	312.749	385.625	477.612	597.294
51	11	51011	VA	Appomattox, VA	R	NN	12298	12851	14290	15730	138.306	202.891	259.260	333.898
51	13	51013	VA	Arlington, VA	U1	PA	170897	172340	191639	210951	1579.832	1820.850	2352.201	3062.762
51	15	51015	VA	Augusta, VA	R	NN	54677	60794	67602	74415	704.374	438.225	559.743	720.588
51	17	51017	VA	Bath, VA	R	NN	4799	4905	5455	6004	67.704	79.173	101.170	130.298
51	19	51019	VA	Bedford, VA	R	NN	45552	54217	60288	66364	384.407	643.289	800.692	1003.904
51	21	51021	VA	Bland, VA	R	NN	6514	6811	7573	8336	123.074	107.469	137.323	176.862
51	23	51023	VA	Botetourt, VA	R	NN	24992	27797	30909	34024	449.883	366.975	442.450	538.746
51	25	51025	VA	Brunswick, VA	R	NN	15987	16698	18567	20439	303.015	263.753	337.030	434.049
51	27	51027	VA	Buchanan, VA	R	NN	31333	29643	32962	36284	419.050	516.930	660.544	850.719
51	29	51029	VA	Buckingham, VA	R	NN	12873	14329	15934	17540	135.766	212.378	271.381	349.512
51	31	51031	VA	Campbell, VA	R	NN	47572	49804	55381	60962	493.932	544.226	671.367	836.610
51	33	51033	VA	Caroline, VA	R	NN	19217	21364	23757	26151	347.056	317.041	405.122	521.759
51	35	51035	VA	Carroll, VA	R	NN	26565	27774	30885	33997	449.683	354.733	453.246	583.676
51	36	51036	VA	Charles City, VA	U1	PA	6282	6871	7640	8410	77.316	103.640	130.698	166.286
51	37	51037	VA	Charlotte, VA	R	NN	11688	12102	13457	14813	141.717	192.828	246.399	317.344
51	41	51041	VA	Chesterfield, VA	U1	PA	209564	238212	264888	291582	1702.541	2544.884	3159.104	3980.906
51	43	51043	VA	Clarke, VA	R	NN	12101	12794	14227	15661	115.130	150.083	197.707	260.471
51	45	51045	VA	Craig, VA	R	NN	4372	4813	5352	5892	45.614	72.129	92.169	118.688
51	47	51047	VA	Culpeper, VA	R	NN	27791	31897	35469	39043	212.811	321.183	423.071	557.377
51	49	51049	VA	Cumberland, VA	R	NN	7825	7823	8699	9576	88.205	123.545	157.863	203.311
51	51	51051	VA	Dickenson, VA	R	NN	17620	17256	19188	21122	228.827	290.694	371.455	478.398
51	53	51053	VA	Dinwiddie, VA	U1	NN	22319	24045	26738	29432	297.861	501.954	624.829	787.760
51	57	51057	VA	Essex, VA	R	NN	8689	9148	10173	11198	102.403	143.351	183.177	235.912
51	59	51059	VA	Fairfax, VA	U1	PA	818358	900559	1001407	1102323	6308.666	8772.369	11340.310	14772.631
51	61	51061	VA	Fauquier, VA	R	NN	48860	52552	58437	64326	638.962	726.838	957.597	1261.732
51	63	51063	VA	Floyd, VA	R	NN	11965	12903	14348	15793	133.591	198.058	253.083	325.951
51	65	51065	VA	Fluvanna, VA	R	NN	12429	17005	18910	20815	198.573	205.051	265.322	345.001
51	67	51067	VA	Franklin, VA	R	NN	39549	43673	48563	53457	382.150	586.902	749.905	965.769
51	69	51069	VA	Frederick, VA	R	NN	45723	53412	59393	65378	469.450	542.540	693.248	892.687
51	71	51071	VA	Giles, VA	R	NN	16366	16200	18014	19829	187.322	270.005	345.019	444.350
51	73	51073	VA	Gloucester, VA	U1	NN	30131	33838	37627	41419	211.045	432.964	540.894	688.040
51	75	51075	VA	Goochland, VA	U1	NN	14163	17106	19022	20939	227.977	233.660	294.664	374.886
51	77	51077	VA	Grayson, VA	R	NN	16278	16179	17991	19804	191.545	268.554	343.163	441.963
51	79	51079	VA	Greene, VA	R	NN	10297	12980	14433	15888	88.095	169.880	219.809	285.829
51	81	51081	VA	Greensville, VA	R	NN	8630	11033	12268	13504	158.357	100.226	128.037	164.868
51	83	51083	VA	Halifax, VA	R	NN	36030	36945	41082	45222	383.481	482.455	616.408	793.796
51	85	51085	VA	Hanover, VA	U1	PA	63306	76706	85296	93891	795.011	809.135	1014.387	1285.975

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51	87	51087	VA	Henrico, VA	U1	PA	217849	240128	267018	293927	1999.504	2363.859	2929.456	3687.835
51	89	51089	VA	Henry, VA	R	NN	56942	56135	62422	68712	515.513	647.898	827.682	1065.794
51	91	51091	VA	Highland, VA	R	NN	2635	2541	2825	3110	33.931	43.472	55.551	71.535
51	93	51093	VA	Isle of Wight, VA	R	NN	25053	28051	31193	34336	222.337	338.339	424.207	540.772
51	95	51095	VA	James City, VA	U1	PA	34970	41735	46408	51085	351.038	441.264	546.871	693.421
51	97	51097	VA	King and Queen, VA	R	NN	6289	6501	7229	7957	68.950	103.757	132.583	170.743
51	99	51099	VA	King George, VA	R	NN	13527	16454	18297	20141	121.810	223.168	294.039	387.442
51	101	51101	VA	King William, VA	R	NN	10913	12248	13620	14993	87.858	133.029	169.951	218.851
51	103	51103	VA	Lancaster, VA	R	NN	10896	11229	12487	13745	117.027	179.761	229.704	295.830
51	105	51105	VA	Lee, VA	R	NN	24496	24116	26817	29519	299.884	404.134	516.411	665.090
51	107	51107	VA	Loudoun, VA	U1	PA	86129	126727	140918	155119	490.989	874.550	1141.075	1494.769
51	109	51109	VA	Louisa, VA	R	NN	20325	23338	25951	28567	345.525	335.320	428.479	551.853
51	111	51111	VA	Lunenburg, VA	R	NN	11419	12073	13425	14778	140.076	188.390	240.728	310.042
51	113	51113	VA	Madison, VA	R	NN	11949	12420	13810	15202	118.213	197.134	251.902	324.420
51	115	51115	VA	Mathews, VA	R	NN	8348	9003	10011	11020	92.370	137.724	172.700	220.178
51	117	51117	VA	Mecklenburg, VA	R	NN	29241	30696	34134	37574	467.719	414.937	530.164	682.752
51	119	51119	VA	Middlesex, VA	R	NN	8653	9425	10481	11537	89.183	142.756	182.417	234.937
51	121	51121	VA	Montgomery, VA	U2	NN	73913	75721	84200	92685	582.996	360.068	459.419	591.163
51	125	51125	VA	Nelson, VA	R	NN	12778	13616	15141	16667	236.562	210.811	269.379	346.925
51	127	51127	VA	New Kent, VA	U1	NN	10445	12002	13346	14690	170.218	172.320	217.311	276.470
51	131	51131	VA	Northampton, VA	R	NN	13061	12829	14265	15703	168.967	215.480	275.344	354.619
51	133	51133	VA	Northumberland, VA	R	NN	10524	11301	12567	13833	113.546	173.625	221.861	285.734
51	135	51135	VA	Nottoway, VA	R	NN	14993	15017	16699	18381	142.873	191.395	244.526	314.904
51	137	51137	VA	Orange, VA	R	NN	21421	24459	27198	29939	189.407	312.086	398.758	513.536
51	139	51139	VA	Page, VA	R	NN	21690	22688	25228	27771	197.876	284.440	363.407	467.993
51	141	51141	VA	Patrick, VA	R	NN	17473	18063	20085	22110	203.881	288.269	368.357	474.400
51	143	51143	VA	Pittsylvania, VA	R	NN	55672	57314	63733	70155	555.960	621.054	713.636	838.476
51	145	51145	VA	Powhatan, VA	U1	NN	15328	20374	22656	24939	150.911	252.880	318.902	405.717
51	147	51147	VA	Prince Edward, VA	R	NN	17320	18661	20750	22841	148.500	195.543	249.798	321.672
51	149	51149	VA	Prince George, VA	U1	NN	27394	29406	32699	35994	329.212	580.200	722.004	910.751
51	153	51153	VA	Prince William, VA	U1	PA	215677	248923	276798	304692	1423.126	2346.798	3046.402	3978.654
51	155	51155	VA	Pulaski, VA	R	NN	34496	34404	38257	42112	536.157	409.336	522.934	673.388
51	157	51157	VA	Rappahannock, VA	R	NN	6622	6990	7772	8556	70.396	109.249	139.601	179.791
51	159	51159	VA	Richmond, VA	R	NN	7273	8389	9328	10268	80.320	119.990	153.326	197.468
51	161	51161	VA	Roanoke, VA	U2	NN	79294	81031	90105	99185	767.678	880.771	1043.574	1258.157
51	163	51163	VA	Rockbridge, VA	R	NN	18350	19261	21418	23576	246.285	183.314	234.312	301.693
51	165	51165	VA	Rockingham, VA	R	NN	57482	62866	69906	76950	755.413	590.379	753.734	970.525
51	167	51167	VA	Russell, VA	R	NN	28667	28966	32210	35456	341.219	411.980	526.390	677.897
51	169	51169	VA	Scott, VA	U1	NN	23204	22762	25311	27861	289.790	404.866	507.841	639.987
51	171	51171	VA	Shenandoah, VA	R	NN	31636	33902	37699	41498	496.080	409.310	522.937	673.417
51	173	51173	VA	Smyth, VA	R	NN	32370	32832	36509	40188	544.760	427.948	546.757	704.114
51	175	51175	VA	Southampton, VA	R	NN	17550	17660	19637	21616	165.016	195.898	250.170	322.145
51	177	51177	VA	Spotsylvania, VA	R	NN	57403	77674	86372	95076	498.164	712.834	929.772	1217.526
51	179	51179	VA	Stafford, VA	U1	PA	61236	84054	93467	102886	690.430	862.405	1131.824	1487.871

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
51	181	51181	VA	Surry, VA	R	NN	6145	6391	7107	7823	69.851	101.380	129.546	166.836
51	183	51183	VA	Sussex, VA	R	NN	10248	10107	11239	12372	210.783	169.072	216.042	278.246
51	185	51185	VA	Tazewell, VA	R	NN	45960	46737	51970	57208	437.660	496.744	634.548	817.082
51	187	51187	VA	Warren, VA	R	NN	26142	29456	32754	36055	249.410	241.188	317.630	418.404
51	191	51191	VA	Washington, VA	U1	NN	45887	48386	53804	59226	736.150	704.504	883.075	1111.460
51	193	51193	VA	Westmoreland, VA	R	NN	15480	16180	17992	19805	162.224	206.664	264.041	340.031
51	195	51195	VA	Wise, VA	R	NN	39573	39329	43733	48140	400.638	476.487	608.157	783.139
51	197	51197	VA	Wythe, VA	R	NN	25471	26183	29115	32049	391.138	291.514	372.404	479.546
51	199	51199	VA	York, VA	U1	PA	42434	55020	61182	67347	461.844	481.731	596.632	754.633
51	510	51510	VA	Alexandria city, VA	U1	PA	111182	115659	128611	141571	1068.085	1184.947	1530.731	1993.147
51	515	51515	VA	Bedford city, VA	U2	NN	6177	6279	6982	7686	43.260	72.838	90.108	112.976
51	520	51520	VA	Bristol city, VA	U1	NN	18426	17458	19413	21370	259.669	249.853	311.496	392.056
51	530	51530	VA	Buena Vista city, VA	U2	NN	6406	6175	6866	7558	77.921	57.936	74.133	95.451
51	540	51540	VA	Charlottesville city, VA	U2	NN	40475	38271	42557	46846	327.814	377.907	484.367	626.505
51	550	51550	VA	Chesapeake City, VA	U1	PA	151982	189383	210590	231812	1182.672	1456.883	1793.353	2261.053
51	560	51560	VA	Clifton Forge city, VA	U2	NN	4679	4442	4940	5438	79.267	57.868	73.576	94.747
51	570	51570	VA	Colonial Heights city, VA	U1	PA	16064	16592	18450	20309	117.812	176.654	218.602	275.469
51	580	51580	VA	Covington city, VA	U2	NN	7198	6989	7771	8555	105.540	157.335	195.831	246.774
51	590	51590	VA	Danville city, VA	U2	NN	53056	51306	57051	62800	496.087	550.133	636.783	748.179
51	595	51595	VA	Emporia city, VA	U2	NN	5479	5513	6131	6748	76.552	48.464	61.895	79.699
51	600	51600	VA	Fairfax city, VA	U1	PA	19894	20298	22571	24845	200.631	209.109	270.129	351.731
51	610	51610	VA	Falls Church city, VA	U1	PA	9522	9828	10929	12030	68.337	94.793	122.842	160.022
51	620	51620	VA	Franklin city, VA	U2	NN	7864	8671	9642	10614	82.252	97.543	124.698	160.574
51	630	51630	VA	Fredericksburg city, VA	U2	NN	19027	20794	23122	25452	243.879	349.272	455.174	596.045
51	640	51640	VA	Galax city, VA	U2	NN	6699	6859	7627	8396	110.664	87.324	111.541	143.639
51	650	51650	VA	Hampton city, VA	U1	PA	133811	137877	153317	168768	1303.363	1247.359	1533.551	1932.060
51	660	51660	VA	Harrisonburg city, VA	U2	NN	30707	33112	36820	40531	398.167	310.722	397.282	511.549
51	670	51670	VA	Hopewell city, VA	U1	PA	23101	22301	24799	27298	244.995	432.602	537.305	677.768
51	678	51678	VA	Lexington city, VA	U2	NN	6959	7161	7963	8766	91.139	68.120	86.709	111.643
51	680	51680	VA	Lynchburg city, VA	U2	NN	66049	65431	72758	80090	641.302	709.207	871.676	1086.221
51	683	51683	VA	Manassas city, VA	U1	PA	27957	33390	37130	40871	192.009	316.269	411.022	536.803
51	685	51685	VA	Manassas Park city, VA	U1	PA	6734	8221	9142	10063	47.296	78.071	101.245	132.227
51	690	51690	VA	Martinsville city, VA	U2	NN	16162	15846	17620	19396	145.363	182.705	233.387	300.529
51	700	51700	VA	Newport News city, VA	U1	PA	171439	175210	194831	214465	1540.145	1585.414	1949.168	2455.675
51	710	51710	VA	Norfolk city, VA	U1	PA	261250	233938	260135	286350	2574.639	2436.663	2995.728	3774.179
51	720	51720	VA	Norton city, VA	U2	NN	4247	4241	4716	5191	43.656	51.423	66.268	85.335
51	730	51730	VA	Petersburg city, VA	U1	NN	37027	34551	38420	42292	416.440	704.190	873.575	1101.370
51	735	51735	VA	Poquoson city, VA	U1	PA	11005	11386	12662	13937	94.041	98.598	121.486	153.658
51	740	51740	VA	Portsmouth city, VA	U1	PA	103910	100133	111346	122567	1008.596	968.535	1190.754	1500.181
51	750	51750	VA	Radford city, VA	U2	NN	15940	15409	17134	18861	117.519	72.575	92.609	119.166
51	760	51760	VA	Richmond city, VA	U1	PA	202798	193881	215593	237319	2305.617	2109.423	2608.156	3278.751
51	770	51770	VA	Roanoke city, VA	U2	NN	96509	94490	105071	115659	889.216	1019.816	1208.792	1457.349
51	775	51775	VA	Salem city, VA	U2	NN	23797	24654	27415	30178	234.396	268.543	318.636	384.155
51	790	51790	VA	Staunton City, VA	U2	NN	24461	23489	26119	28752	266.013	165.507	211.392	272.137

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51	800	51800	VA	Suffolk City, VA	U1	PA	52143	59763	66456	73152	576.949	580.700	719.219	910.169
51	810	51810	VA	Virginia Beach City, VA	U1	PA	393089	426908	474715	522554	2575.803	3690.573	4538.765	5719.278
51	820	51820	VA	Waynesboro city, VA	U2	NN	18549	18553	20631	22710	211.687	131.534	168.221	216.560
51	830	51830	VA	Williamsburg city, VA	U1	PA	11409	11744	13059	14375	98.630	122.499	153.652	194.828
51	840	51840	VA	Winchester city, VA	U2	NN	21947	22364	24868	27374	192.522	222.685	284.302	366.092
53	1	53001	WA	Adams, WA	R	SP	13603	15264	17759	20567	154.265	127.209	169.779	226.414
53	3	53003	WA	Asotin, WA	U2	SP	17605	20662	24038	27840	141.481	66.147	88.083	117.309
53	5	53005	WA	Benton, WA	U2	SP	112560	132456	154105	178476	922.165	1051.132	1437.063	1951.422
53	7	53007	WA	Chelan, WA	U2	SP	52250	58650	68236	79028	469.908	363.501	484.890	646.455
53	9	53009	WA	Clallam, WA	R	WA	56210	62765	73023	84571	503.758	428.751	572.028	762.698
53	11	53011	WA	Clark, WA	U1	WA	238053	305316	355216	411393	1915.024	2578.919	3381.502	4430.561
53	13	53013	WA	Columbia, WA	R	SP	4024	4241	4934	5714	33.986	55.657	74.320	99.145
53	15	53015	WA	Cowlitz, WA	U2	WA	82119	89589	104231	120716	719.387	816.989	1078.560	1429.016
53	17	53017	WA	Douglas, WA	U2	SP	26205	32444	37747	43716	213.906	162.208	216.322	288.351
53	19	53019	WA	Ferry, WA	R	SP	6295	7119	8282	9592	88.958	87.069	116.262	155.093
53	21	53021	WA	Franklin, WA	U2	SP	37473	45662	53125	61527	326.710	400.857	549.811	748.082
53	23	53023	WA	Garfield, WA	R	SP	2248	2275	2646	3065	37.783	31.092	41.518	55.384
53	25	53025	WA	Grant, WA	R	SP	54798	67587	78634	91070	492.169	442.050	589.837	786.495
53	27	53027	WA	Grays Harbor, WA	U2	WA	64175	67406	78423	90826	608.074	437.200	583.177	777.467
53	29	53029	WA	Island, WA	R	WA	60195	69168	80473	93200	511.786	557.038	758.489	1032.885
53	31	53031	WA	Jefferson, WA	R	WA	20406	25154	29265	33893	177.886	150.631	200.962	267.942
53	33	53033	WA	King, WA	U1	WA	1507305	1614917	1878859	2175998	14012.863	16253.224	21741.577	29294.662
53	35	53035	WA	Kitsap, WA	U2	WA	189731	228197	265494	307481	2088.975	2037.180	2748.579	3674.579
53	37	53037	WA	Kittitas, WA	R	SP	26725	30718	35738	41390	251.990	207.228	276.491	368.656
53	39	53039	WA	Klickitat, WA	R	SP	16616	18719	21778	25222	204.779	186.215	248.592	331.568
53	41	53041	WA	Lewis, WA	R	WA	59358	66410	77264	89483	635.787	573.947	766.054	1021.627
53	43	53043	WA	Lincoln, WA	R	SP	8864	9668	11248	13027	147.015	122.603	163.710	218.392
53	45	53045	WA	Mason, WA	R	WA	38341	47886	55713	64524	393.741	435.169	580.952	774.872
53	47	53047	WA	Okanogan, WA	R	SP	33350	37895	44088	51061	425.099	407.183	543.639	725.155
53	49	53049	WA	Pacific, WA	R	WA	18882	20797	24196	28022	231.077	223.048	297.783	397.203
53	51	53051	WA	Pend Oreille, WA	R	SP	8915	10934	12722	14733	131.341	123.308	164.653	219.645
53	53	53053	WA	Pierce, WA	U1	WA	586203	653551	760368	880619	5542.380	5998.781	7824.079	10248.697
53	55	53055	WA	San Juan, WA	R	WA	10035	11943	13895	16092	119.984	138.801	185.339	247.232
53	57	53057	WA	Skagit, WA	R	WA	79545	95111	110656	128156	630.763	581.644	775.957	1034.554
53	59	53059	WA	Skamania, WA	R	WA	8289	9449	10993	12732	121.228	114.648	153.090	204.224
53	61	53061	WA	Snohomish, WA	U1	WA	465628	550470	640438	741723	3964.507	4941.636	6635.568	8961.314
53	63	53063	WA	Spokane, WA	U1	SP	361333	398462	463586	536902	2805.275	3300.009	4134.621	5227.650
53	65	53065	WA	Stevens, WA	R	SP	30948	38058	44278	51281	394.171	370.768	495.008	660.280
53	67	53067	WA	Thurston, WA	U2	WA	161238	194773	226607	262444	1730.416	2112.037	2989.073	4157.447
53	69	53069	WA	Wahkiakum, WA	R	WA	3327	3814	4437	5139	58.660	46.017	61.447	81.966
53	71	53071	WA	Walla Walla, WA	U2	SP	48439	52778	61404	71115	346.041	200.314	266.834	355.447
53	73	53073	WA	Whatcom, WA	U2	WA	127780	150468	175060	202746	1165.247	1314.419	1786.154	2406.321
53	75	53075	WA	Whitman, WA	U2	SP	38775	39243	45657	52877	324.952	192.168	256.130	341.290
53	77	53077	WA	Yakima, WA	U2	SP	188823	214104	249098	288492	1650.723	1632.471	2060.912	2601.290

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54	1	54001	WV	Barbour, WV	R	ON	15699	16134	16300	16288	104.045	146.796	174.629	210.793
54	3	54003	WV	Berkeley, WV	R	ON	59253	67669	68364	68312	416.786	528.311	695.148	915.236
54	5	54005	WV	Boone, WV	R	ON	25870	26343	26614	26594	197.104	260.166	309.635	373.839
54	7	54007	WV	Braxton, WV	R	ON	12998	13256	13392	13382	145.959	143.984	171.456	207.088
54	9	54009	WV	Brooke, WV	U2	ON	26992	26346	26616	26596	189.586	257.795	292.849	337.087
54	11	54011	WV	Cabell, WV	U1	ON	96827	95313	96292	96219	895.057	1025.348	1220.697	1467.679
54	13	54013	WV	Calhoun, WV	R	ON	7885	7903	7984	7978	55.650	87.344	104.013	125.614
54	15	54015	WV	Clay, WV	R	ON	9983	10437	10544	10536	118.341	110.585	131.687	159.042
54	17	54017	WV	Doddridge, WV	R	ON	6994	7328	7404	7398	50.138	77.474	92.258	111.431
54	19	54019	WV	Fayette, WV	R	ON	47952	48358	48855	48818	554.532	472.223	561.945	678.425
54	21	54021	WV	Gilmer, WV	R	ON	7669	7249	7323	7318	87.549	84.952	101.162	122.181
54	23	54023	WV	Grant, WV	R	ON	10428	10993	11106	11097	68.866	115.515	137.556	166.133
54	25	54025	WV	Greenbrier, WV	R	ON	34693	35386	35750	35723	358.924	329.112	391.554	472.646
54	27	54027	WV	Hampshire, WV	R	ON	16498	18553	18744	18730	100.280	182.753	217.625	262.842
54	29	54029	WV	Hancock, WV	U2	ON	35233	34582	34937	34910	246.336	345.418	391.684	450.370
54	31	54031	WV	Hardy, WV	R	ON	10977	11683	11803	11794	67.657	121.597	144.798	174.886
54	33	54033	WV	Harrison, WV	R	ON	69371	70541	71265	71211	617.974	531.693	631.603	761.725
54	35	54035	WV	Jackson, WV	R	ON	25938	27323	27604	27583	227.634	224.904	267.412	322.686
54	37	54037	WV	Jefferson, WV	R	ON	35926	39484	39889	39859	197.081	345.931	455.412	599.796
54	39	54039	WV	Kanawha, WV	U1	ON	207619	204214	206311	206155	2368.797	2455.056	2903.438	3504.406
54	41	54041	WV	Lewis, WV	R	ON	17223	17500	17680	17666	161.945	147.563	175.437	211.699
54	43	54043	WV	Lincoln, WV	R	ON	21382	22100	22327	22310	159.697	236.855	282.050	340.654
54	45	54045	WV	Logan, WV	R	ON	43032	41541	41968	41936	322.913	448.162	533.489	644.212
54	47	54047	WV	McDowell, WV	R	ON	35233	31273	31594	31570	326.631	363.726	432.955	522.794
54	49	54049	WV	Marion, WV	R	ON	57249	56929	57514	57470	537.513	459.252	545.742	658.315
54	51	54051	WV	Marshall, WV	R	ON	37356	35937	36306	36278	210.836	401.480	457.799	530.542
54	53	54053	WV	Mason, WV	R	ON	25178	25858	26123	26103	167.870	235.665	280.350	338.404
54	55	54055	WV	Mercer, WV	R	ON	64980	64411	65072	65023	626.561	548.447	651.981	786.646
54	57	54057	WV	Mineral, WV	R	ON	26697	26814	27089	27068	162.398	238.987	273.320	320.830
54	59	54059	WV	Mingo, WV	R	ON	33739	32730	33066	33041	238.483	337.785	402.004	485.364
54	61	54061	WV	Monongalia, WV	U2	ON	75509	77202	77995	77936	602.613	508.353	603.211	727.025
54	63	54063	WV	Monroe, WV	R	ON	12406	13050	13184	13174	86.834	137.424	163.647	197.656
54	65	54065	WV	Morgan, WV	R	ON	12128	13284	13421	13411	72.249	134.348	159.979	193.228
54	67	54067	WV	Nicholas, WV	R	ON	26775	27465	27747	27726	172.973	248.535	295.645	356.859
54	69	54069	WV	Ohio, WV	U2	ON	50871	49146	49650	49613	400.638	536.640	608.235	702.369
54	71	54071	WV	Pendleton, WV	R	ON	8054	8010	8093	8086	53.357	89.217	106.240	128.317
54	73	54073	WV	Pleasants, WV	R	ON	7546	7495	7572	7567	55.552	83.588	99.539	120.227
54	75	54075	WV	Pocahontas, WV	R	ON	9008	9035	9127	9120	66.903	99.783	118.824	143.522
54	77	54077	WV	Preston, WV	R	ON	29037	29654	29959	29936	303.559	293.584	349.419	421.905
54	79	54079	WV	Putnam, WV	U1	ON	42835	49151	49656	49618	371.042	508.687	603.683	730.197
54	81	54081	WV	Raleigh, WV	R	ON	76819	78684	79492	79432	775.989	667.165	793.267	957.243
54	83	54083	WV	Randolph, WV	R	ON	27803	28640	28934	28912	171.940	243.764	289.857	349.798
54	85	54085	WV	Ritchie, WV	R	ON	10233	10260	10365	10357	77.183	113.355	134.983	163.033
54	87	54087	WV	Roane, WV	R	ON	15120	15285	15442	15431	151.598	167.489	199.447	240.893

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54	89	54089	WV	Summers, WV	R	ON	14204	13836	13978	13968	140.389	127.629	151.790	183.192
54	91	54091	WV	Taylor, WV	R	ON	15144	15316	15474	15462	94.322	119.946	142.522	171.904
54	93	54093	WV	Tucker, WV	R	ON	7728	7716	7795	7789	58.516	85.605	101.940	123.117
54	95	54095	WV	Tyler, WV	R	ON	9796	10025	10128	10120	73.433	100.629	119.778	144.627
54	97	54097	WV	Upshur, WV	R	ON	22867	23686	23930	23912	140.543	202.163	240.404	290.129
54	99	54099	WV	Wayne, WV	U1	ON	41636	42014	42445	42413	425.912	452.108	542.862	656.029
54	101	54101	WV	Webster, WV	R	ON	10729	10393	10500	10492	82.597	118.847	141.526	170.938
54	103	54103	WV	Wetzel, WV	R	ON	19258	18613	18805	18790	122.840	138.801	164.800	198.702
54	105	54105	WV	Wirt, WV	R	ON	5192	5597	5654	5650	33.204	57.514	68.488	82.713
54	107	54107	WV	Wood, WV	U2	ON	86915	87013	87906	87840	663.704	823.294	976.077	1173.257
54	109	54109	WV	Wyoming, WV	R	ON	28990	27840	28126	28104	235.307	321.131	382.408	461.853
55	1	55001	WI	Adams, WI	R	MI	15682	17804	19039	19930	155.600	263.496	328.311	410.683
55	3	55003	WI	Ashland, WI	U2	MI	16307	16460	17602	18425	122.442	139.476	173.539	216.889
55	5	55005	WI	Barron, WI	R	MI	40750	43256	46257	48420	367.012	513.030	638.910	798.962
55	7	55007	WI	Bayfield, WI	R	MI	14008	15054	16098	16851	159.825	235.369	293.266	366.842
55	9	55009	WI	Brown, WI	U2	MI	194594	211437	226104	236677	1323.256	2252.177	2821.891	3568.593
55	11	55011	WI	Buffalo, WI	R	MI	13584	14101	15079	15784	145.463	228.245	284.390	355.739
55	13	55013	WI	Burnett, WI	R	MI	13084	14324	15318	16034	142.692	219.844	273.921	342.646
55	15	55015	WI	Calumet, WI	U1	MI	34291	37509	40111	41986	171.257	349.524	442.504	562.677
55	17	55017	WI	Chippewa, WI	R	MI	52360	53979	57724	60423	521.670	714.732	897.413	1131.597
55	19	55019	WI	Clark, WI	R	MI	31647	32802	35078	36718	358.694	489.863	610.281	763.340
55	21	55021	WI	Columbia, WI	R	MI	45088	49609	53050	55531	507.411	558.708	695.776	870.053
55	23	55023	WI	Crawford, WI	R	MI	15940	16462	17604	18427	145.409	179.385	223.349	279.264
55	25	55025	WI	Dane, WI	U1	MI	367085	393164	420438	440098	2900.194	3564.179	4557.959	5859.308
55	27	55027	WI	Dodge, WI	R	MI	76559	81584	87244	91323	495.498	743.857	925.838	1157.373
55	29	55029	WI	Door, WI	R	MI	25690	26725	28578	29915	268.448	288.243	358.880	448.726
55	31	55031	WI	Douglas, WI	U2	MI	41758	42990	45972	48122	402.798	462.579	544.346	646.003
55	33	55033	WI	Dunn, WI	R	MI	35909	38348	41009	42926	385.882	391.630	487.575	609.610
55	35	55035	WI	Eau Claire, WI	U2	MI	85183	88658	94808	99241	809.689	993.003	1237.146	1552.807
55	37	55037	WI	Florence, WI	R	MI	4590	5129	5485	5741	48.241	77.123	96.094	120.205
55	39	55039	WI	Fond du Lac, WI	U2	MI	90083	93722	100224	104910	601.656	700.781	871.675	1089.250
55	41	55041	WI	Forest, WI	R	MI	8776	9466	10123	10596	104.574	147.459	183.730	229.829
55	43	55043	WI	Grant, WI	R	MI	49266	49461	52892	55365	470.002	568.217	707.512	884.668
55	45	55045	WI	Green, WI	R	MI	30339	32753	35025	36663	243.465	300.245	373.714	467.189
55	47	55047	WI	Green Lake, WI	R	MI	18651	19338	20679	21646	170.082	230.486	287.029	358.922
55	49	55049	WI	Iowa, WI	R	MI	20150	21880	23398	24492	201.816	277.897	346.143	432.900
55	51	55051	WI	Iron, WI	R	MI	6153	6432	6879	7200	77.819	103.384	128.817	161.137
55	53	55053	WI	Jackson, WI	R	MI	16588	17470	18682	19555	222.795	224.174	279.216	349.193
55	55	55055	WI	Jefferson, WI	U2	MI	67783	72576	77611	81240	657.887	544.790	677.711	846.918
55	57	55057	WI	Juneau, WI	R	MI	21650	23657	25298	26481	290.441	310.026	386.186	483.002
55	59	55059	WI	Kenosha, WI	U1	CH	128181	140773	150539	157578	766.488	1174.055	1465.923	1843.452
55	61	55061	WI	Kewaunee, WI	R	MI	18878	19564	20921	21899	115.924	221.812	276.199	345.357
55	63	55063	WI	La Crosse, WI	U2	MI	97904	101654	108706	113789	940.320	1038.851	1310.967	1661.121
55	65	55065	WI	Lafayette, WI	R	MI	16074	16331	17464	18281	201.333	270.117	336.561	420.999

State No.	County No.	FIPS	State Code	County	Urban/ Rural	Mapped Area	Population 1990	1996	2007	2020	Annual VMT (Millions) 1990	1996	2007	2020
55	67	55067	WI	Langlade, WI	R	MI	19505	20412	21828	22849	149.107	198.385	246.946	308.725
55	69	55069	WI	Lincoln, WI	R	MI	26993	29256	31285	32748	204.082	247.428	307.915	384.883
55	71	55071	WI	Manitowoc, WI	U2	MI	80421	81964	87650	91748	638.261	599.753	745.903	932.012
55	73	55073	WI	Marathon, WI	U2	MI	115400	121443	129867	135940	1287.295	1382.585	1738.158	2192.646
55	75	55075	WI	Marinette, WI	R	MI	40548	42664	45624	47757	369.638	446.915	556.416	695.704
55	77	55077	WI	Marquette, WI	R	MI	12321	14450	15453	16175	182.706	207.024	257.949	322.659
55	78	55078	WI	Menominee, WI	R	MI	3890	4648	4970	5203	28.707	65.362	81.439	101.876
55	79	55079	WI	Milwaukee, WI	U1	CH	959275	916131	979683	1025493	4819.287	9886.937	11749.854	14236.577
55	81	55081	WI	Monroe, WI	R	MI	36633	38966	41669	43618	381.562	375.490	467.415	584.354
55	83	55083	WI	Oconto, WI	R	MI	30226	32933	35217	36864	297.596	397.561	495.151	619.215
55	85	55085	WI	Oneida, WI	R	MI	31679	35123	37559	39316	299.097	416.208	518.373	648.273
55	87	55087	WI	Outagamie, WI	U1	MI	140510	152223	162783	170394	848.046	1560.972	1964.817	2489.699
55	89	55089	WI	Ozaukee, WI	U1	CH	72831	79608	85130	89111	1237.182	747.387	895.298	1089.948
55	91	55091	WI	Pepin, WI	R	MI	7107	7179	7677	8036	86.459	119.414	148.789	186.116
55	93	55093	WI	Pierce, WI	R	MN	32765	34847	37264	39007	280.221	319.376	409.420	522.207
55	95	55095	WI	Polk, WI	R	MI	34773	37776	40396	42285	374.075	542.746	676.174	845.759
55	97	55097	WI	Portage, WI	U2	MI	61405	64270	68729	71943	563.831	544.403	677.424	846.704
55	99	55099	WI	Price, WI	R	MI	15600	15704	16793	17578	157.478	213.605	266.060	332.736
55	101	55101	WI	Racine, WI	U1	CH	175034	183913	196671	205868	919.839	1435.744	1741.203	2140.057
55	103	55103	WI	Richland, WI	R	MI	17521	17863	19102	19995	162.827	215.969	268.949	336.312
55	105	55105	WI	Rock, WI	U2	MI	139510	148786	159107	166547	1150.688	1392.937	1670.320	2028.154
55	107	55107	WI	Rusk, WI	R	MI	15079	15280	16340	17104	150.196	191.816	238.886	298.749
55	109	55109	WI	St. Croix, WI	U1	MN	50251	56302	60207	63023	543.905	589.819	756.434	965.070
55	111	55111	WI	Sauk, WI	R	MI	46975	52128	55744	58351	490.847	506.954	631.137	789.092
55	113	55113	WI	Sawyer, WI	R	MI	14181	15726	16817	17604	148.502	238.276	296.887	371.376
55	115	55115	WI	Shawano, WI	R	MI	37157	38304	40961	42876	327.730	505.579	629.724	787.545
55	117	55117	WI	Sheboygan, WI	U2	CH	103877	109036	116600	122052	723.894	1028.577	1268.925	1571.938
55	119	55119	WI	Taylor, WI	R	MI	18901	19216	20549	21509	185.882	250.644	312.175	390.407
55	121	55121	WI	Trempealeau, WI	R	MI	25263	26198	28016	29326	409.469	424.482	528.896	661.589
55	123	55123	WI	Vernon, WI	R	MI	25617	26955	28825	30173	267.299	369.131	459.817	575.108
55	125	55125	WI	Vilas, WI	R	MI	17707	20630	22061	23093	191.193	297.523	370.707	463.703
55	127	55127	WI	Walworth, WI	R	MI	75000	83061	88823	92976	618.529	786.165	978.678	1223.565
55	129	55129	WI	Washburn, WI	R	MI	13772	15077	16123	16877	152.327	231.403	288.324	360.672
55	131	55131	WI	Washington, WI	U1	CH	95328	110213	117859	123370	728.899	971.022	1172.701	1434.565
55	133	55133	WI	Waukesha, WI	U1	CH	304715	342509	366269	383396	2254.078	3287.476	3933.573	4785.514
55	135	55135	WI	Waupaca, WI	R	MI	46104	49479	52911	55385	342.699	546.021	679.913	850.177
55	137	55137	WI	Waushara, WI	R	MI	19385	21204	22675	23735	288.923	324.452	404.256	505.674
55	139	55139	WI	Winnebago, WI	U1	MI	140320	148561	158866	166295	547.615	1379.208	1732.586	2192.786
55	141	55141	WI	Wood, WI	U2	MI	73605	75468	80704	84477	538.730	616.639	767.183	958.805
56	1	56001	WY	Albany, WY	U2	ID	30797	29864	35581	40766	217.513	236.093	293.638	365.138
56	3	56003	WY	Big Horn, WY	R	ID	10525	10959	13056	14959	304.582	352.666	442.229	552.604
56	5	56005	WY	Campbell, WY	U2	ID	29370	31699	37766	43270	362.122	458.219	572.994	714.815
56	7	56007	WY	Carbon, WY	U2	ID	16659	15961	19016	21788	311.523	278.510	348.391	434.714
56	9	56009	WY	Converse, WY	R	ID	11128	12128	14450	16555	171.116	221.500	277.292	346.159

State	County		State		Urban/	Mapped	Population				Annual VMT (Millions)			
No.	No.	FIPS	Code	County	Rural	Area	1990	1996	2007	2020	1990	1996	2007	2020
56	11	56011	WY	Crook, WY	R	ID	5294	5723	6818	7811	135.909	177.388	222.439	277.952
56	13	56013	WY	Fremont, WY	R	ID	33662	35570	42378	48554	621.796	644.081	806.185	1006.311
56	15	56015	WY	Goshen, WY	R	ID	12373	12771	15215	17432	190.894	246.068	308.049	384.567
56	17	56017	WY	Hot Springs, WY	U2	ID	4809	4699	5599	6415	63.097	64.310	80.345	100.184
56	19	56019	WY	Johnson, WY	U2	ID	6145	6694	7976	9138	89.591	107.434	134.419	167.753
56	21	56021	WY	Laramie, WY	U2	ID	73142	77711	92586	106078	579.854	976.069	1195.644	1473.074
56	23	56023	WY	Lincoln, WY	R	ID	12625	13693	16314	18691	241.170	333.123	417.448	521.436
56	25	56025	WY	Natrona, WY	U2	ID	61226	63293	75408	86397	643.744	927.356	1101.201	1325.467
56	27	56027	WY	Niobrara, WY	R	ID	2499	2601	3099	3550	74.863	83.735	105.001	131.210
56	29	56029	WY	Park, WY	U2	ID	23178	25315	30160	34556	293.014	383.355	479.520	598.308
56	31	56031	WY	Platte, WY	R	ID	8145	8484	10107	11580	181.144	175.374	219.615	274.213
56	33	56033	WY	Sheridan, WY	U2	ID	23562	24965	29744	34078	314.582	374.989	468.965	585.085
56	35	56035	WY	Sublette, WY	R	ID	4843	5574	6641	7609	116.446	162.278	203.488	254.280
56	37	56037	WY	Sweetwater, WY	U2	ID	38823	39607	47189	54065	372.229	355.321	442.692	551.061
56	39	56039	WY	Teton, WY	R	ID	11173	13531	16121	18470	142.210	241.582	302.531	377.745
56	41	56041	WY	Uinta, WY	U2	ID	18705	20061	23901	27384	194.868	301.617	377.229	470.653
56	43	56043	WY	Washakie, WY	U2	ID	8388	8595	10241	11733	105.259	109.828	137.200	171.059
56	45	56045	WY	Weston, WY	R	ID	6518	6507	7752	8882	104.364	127.656	159.800	199.477