EPA-AA-TEB-EF-85-2

MOBILE3 Fuel Consumption Model

February 1985

Mark A. Wolcott
U.S. Environmental Protection Agency
Ann Arbor, Michigan

Dennis F. Kahlbaum
Computer Sciences Corporation
Ann Arbor, Michigan

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The MOBILE3 Fuel Consumption Model

I. Background

The MOBILE3 Fuel Consumption (M3FC) model was developed to estimate gasoline and diesel fuel used by motor vehicles. It is based on the MOBILE3 mobile source emissions model[1] and predicts the amount of leaded, unleaded, and diesel fuels consumed for each of fourteen vehicle classes.

Several such fuel consumption models have been developed over the years[2,3,4]. None, however, is consistent with MOBILE3. Since MOBILE3 is the emission model used to evaluate present and potential motor vehicle regulations, it is desirable to estimate the benefits from these regulations with a model for which the underlying assumptions are the same.

While the primary concern behind the Agency's regulations are the public's health and welfare, these quantities are difficult to measure. Tons of pollutants eliminated and ambient concentrations reduced tend to be easier to estimate. In the past, MOBILE3, in combination with Rollback and EKMA,[5] were sufficient to estimate the surrogates to health and welfare.

MOBILE3 itself estimates grams of carbon monoxide (CO), hydrocarbons (HC) and oxides of nitrogen (NO_x) emitted for each mile a vehicle travels. In general, these pollution estimates are not particularly sensitive to fuel economy. This is particularly true with respect to light duty vehicles (LDV) and light duty trucks (LDT).

Refueling emission losses, however, depend on total vehicle miles traveled (VMT) and fuel economy (MPG), as well as many other factors. Further, the benefits from controlling fuel volatility are in part a function of the total volume of gasoline consumed. Also, the amount of lead emitted into the atmosphere is a function of gasoline volume. A fuel consumption model based on MOBILE3 lends itself to calculating the information required more readily than MOBILE3 used by itself.

The principle of computing fuel consumption is basically simple. Total fuel consumed is a function of the total number of vehicles, the number of miles each vehicle travels, and each vehicle's fuel economy. Therefore, the more vehicles there are and the more miles they travel, the more fuel they will consume. On the other hand, the greater the fuel economy these vehicles obtain, the less fuel they

will consume. In practice, these basic inputs are refined in most models to calculate what their authors believe to be more accurate estimates.

This author is no exception. Accordingly, after a brief summary, a detailed description of each model input is presented. Registrations, VMT, and MPG for each vehicle class are presented. In addition, leaded and diesel market penetration rates and fuel switching rates are included. This discussion of inputs is followed by a presentation of the model's outputs. These outputs are used to validate the model by benchmarking it against published results for the years 1975-1983. The model's predictions are also compared with estimates from three other models. Differences with one of the models are addressed by describing the effect of four major input assumptions. Finally, the appendixes contain all of the input data, the program computer code, and the detailed output tables.

II. Summary

Total gasoline consumed by all motor vehicles peaked in 1978 at 7.41 million barrels per day (MBL/Day).[6] Since that time, gasoline consumption has declined. By the year 2000, according to M3FC, gasoline use will be only 4.87 MBL/Day. On the other hand, diesel fuel consumed by highway motor vehicles* has increased every year for each of the last ten years[7] and is expected to continue to increase through the year 2000. However, since gasoline use will at first decline more quickly than diesel fuel use will increase, total fuel consumed will decline until 1994 and then very slowly increase. Also, leaded fuel use will decline as older, pre-catalyst vehicles are scrapped and replaced by newer vehicles designed to run on unleaded fuel. [Figure 1]

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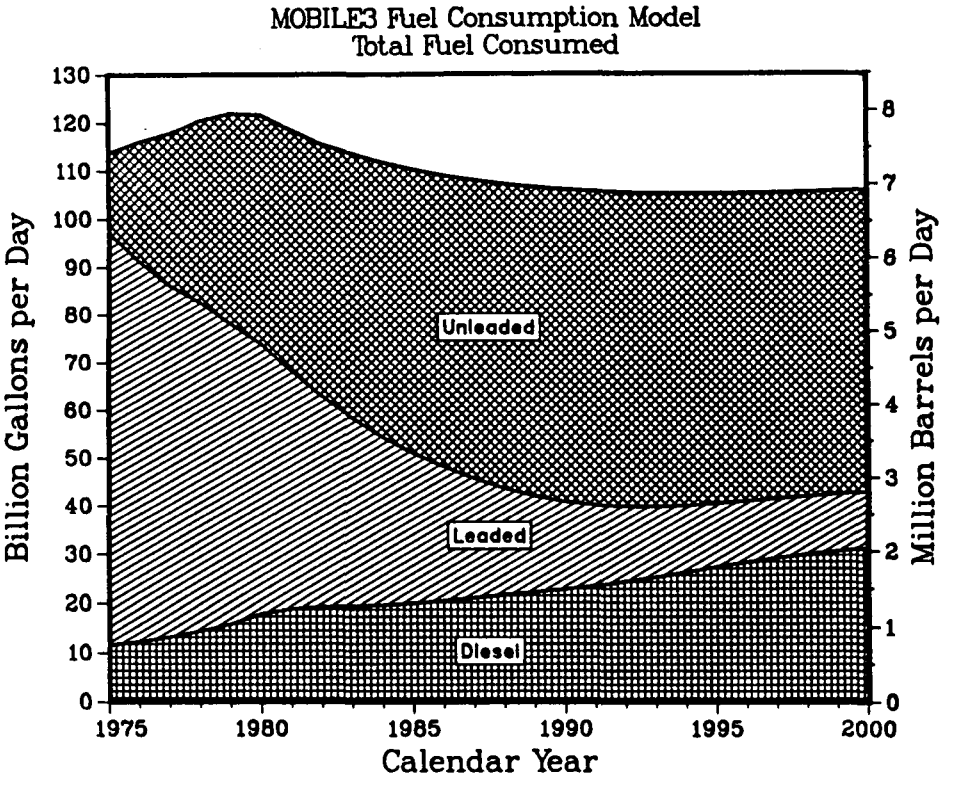
* Estimating diesel fuel consumed by off-highway motor vehicles, such as farm and construction equipment, is beyond the scope of this report.

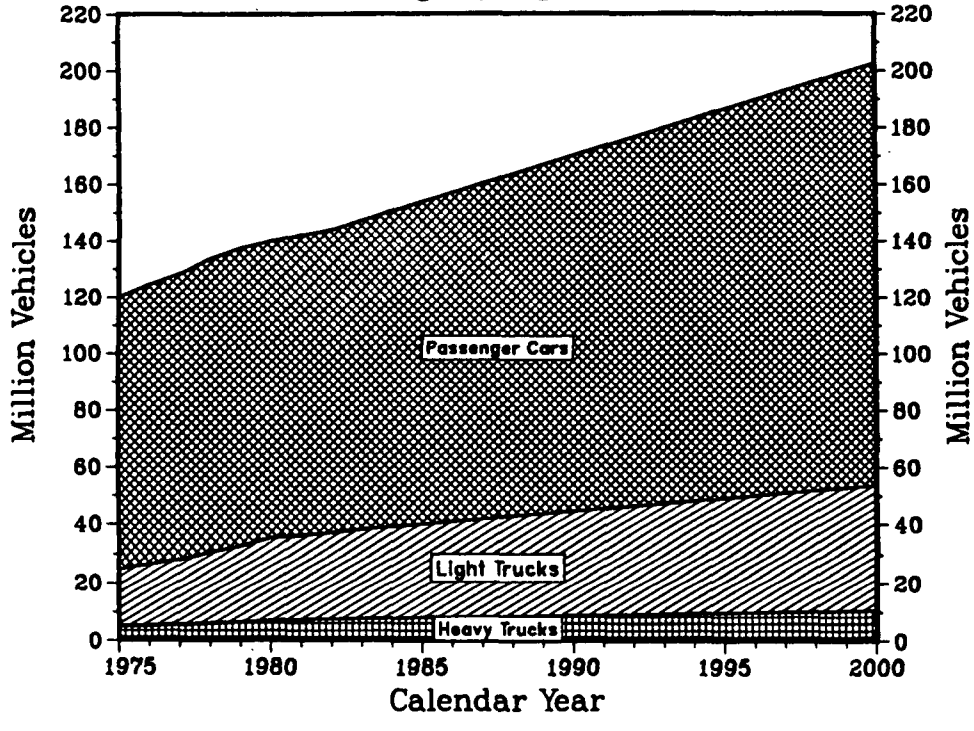
Figure 1



Underlying these total fuel consumption curves are the total number of vehicles registered, total vehicle miles traveled, and the average on road fuel economy.

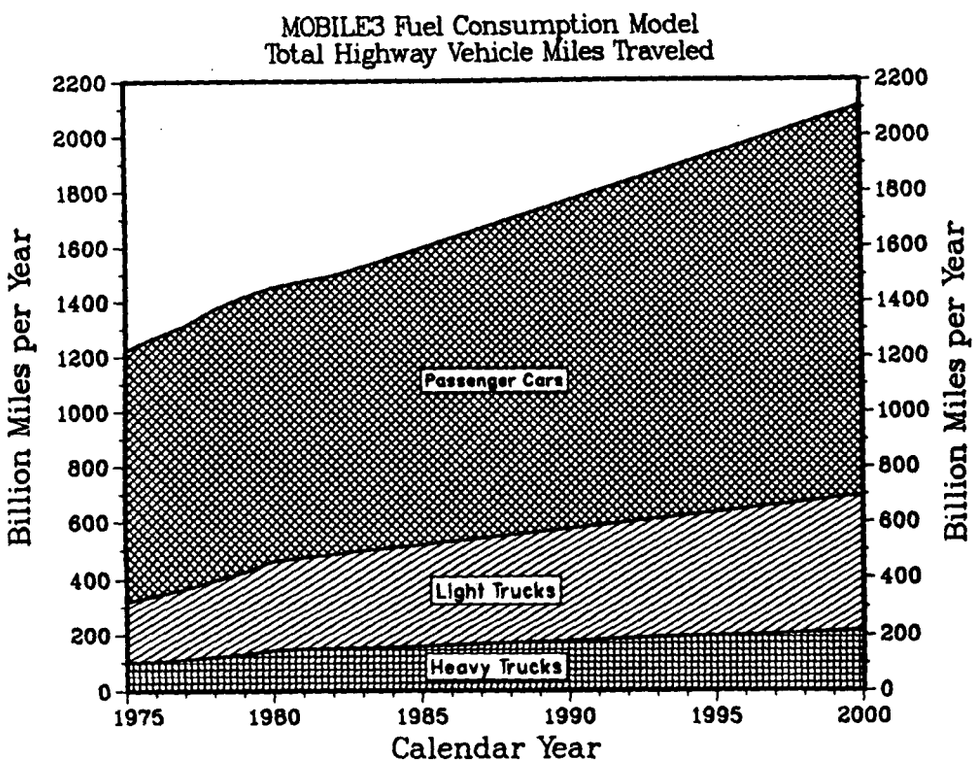
The total number of vehicles registered is expected to increase from 120 million in 1975[8] to 203 million in the year 2000. The compound annual growth rate of this increase is 2.1 percent per year (as compared to the historical growth rate of 4.0 percent per year between 1952 and 1975). [Figure 2]

Figure 2



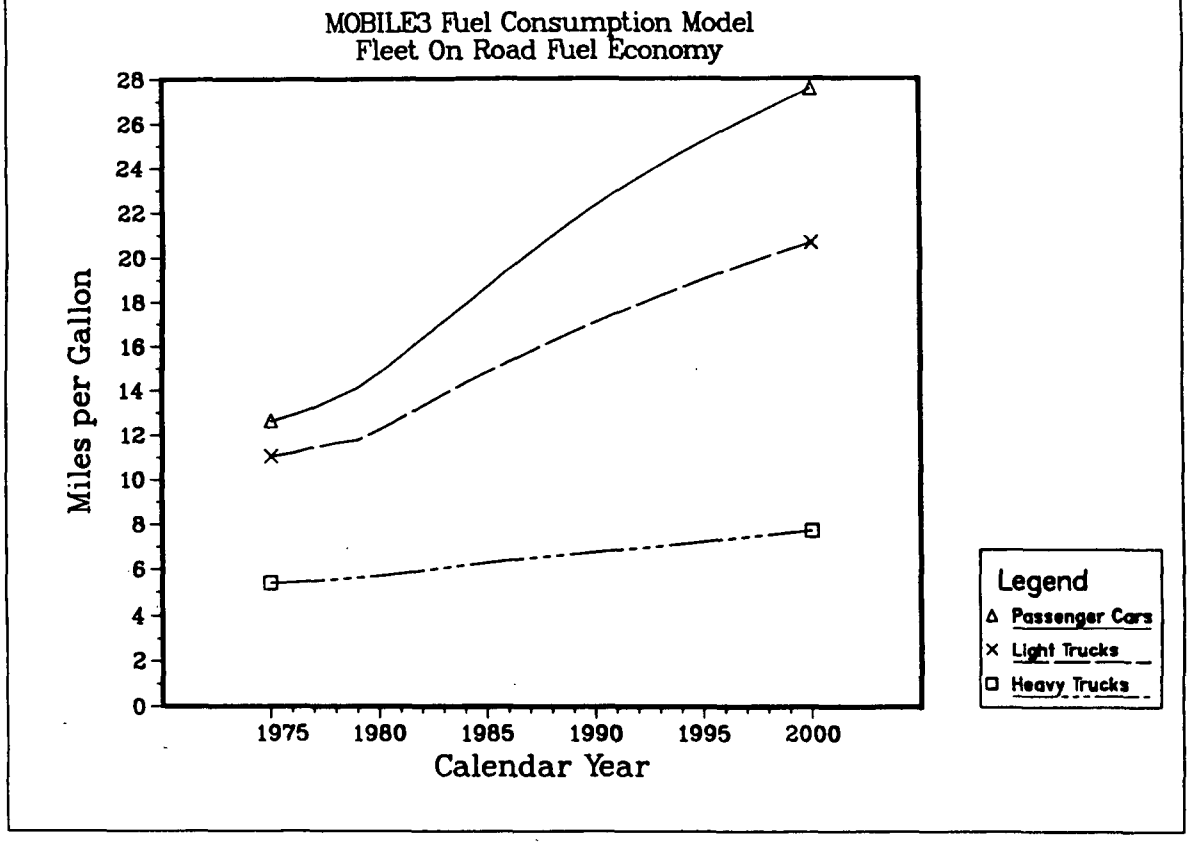
A larger vehicle stock naturally results in a greater fleet VMT. Both the number of passenger cars and the total miles they travel will increase at a compound annual rate of 1.8 percent per year from 1975 to the year 2000. Light trucks will increase at an annual rate of 3.2 percent per year and heavy trucks will increase at a rate of 3.0 percent per year. [Figure 3]

Figure 3



Since fuel economy also improves during this same time, total fuel consumption will decline. The average passenger car fuel economy will improve from 12.6 mpg in 1975[9] to 27.6 mpg by the end of the century, for an annual improvement rate of 3.2 percent. Similarly, light truck fuel economy will improve at a rate of 2.5 percent per year, from 11.0 mpg (1975)[9] to 20.7 mpg (2000). Finally, heavy truck fuel economy will improve from 5.4 mpg (1975)[10] to 7.7 mpg (2000), a 1.5 percent annual improvement. [Figure 4]

Figure 4



The interactions of these changes in number of vehicles, vehicle miles traveled, and fuel economy mean that passenger car fuel use will decline relative to truck fuel use. In 1975 passenger cars used 62.8 percent of all motor vehicle fuel. By the end of the century that use is expected to drop to 48.3 percent. At the same time the light truck share will increase moderately, from 17.5 percent to 21.8 percent, while the heavy truck share will increase somewhat more, from 16.5 percent to 26.4 percent.* [Figure 5]

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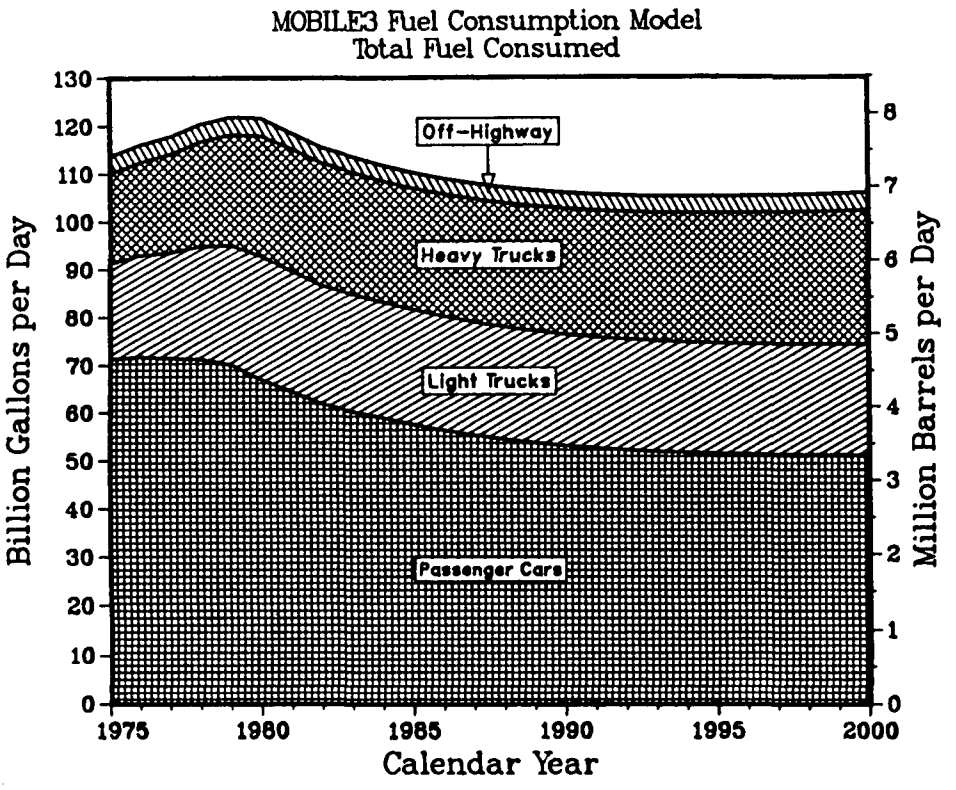
* These numbers do not add up to 100 percent. Off-highway consumption accounts for the difference.

Figure 5



III. Inputs

As noted in the introduction, the principle of computing fuel consumption is basically simple. Total fuel consumed is a function of the total number of vehicles, the number of miles each vehicle travels and each vehicle's fuel economy. In mathematical notation it is represented by the following equation:

Fuel Consumption=[Number of Vehicles]*[VMT]/[Fuel Economy]

However, this equation assumes that all vehicles have the same age, VMT, and fuel economy. In reality, the vehicles operating in any given calendar year are a mixture of model years. Different model years have different fuel economy

characteristics and vehicles of different ages have different travel characteristics. Since diesel fuel has a higher heating value than gasoline fuel, fuel type also is a factor in fuel economy estimates. Thus, a more accurate equation is

$$\text{Fuel Consumption}(i,j,k)=[\text{Number of Vehicles}(i,j,k)]*[\text{VMT}(i,j,k)]/[\text{Fuel Economy}(i,j,k)]$$

where i=age, j=fuel type, and k=vehicle class. This is the form of the equation used by the M3FC model. In M3FC age (i) ranges from 1 to 30 years; fuel type (j) represents either unleaded gasoline, leaded gasoline, or diesel fuel, and (k) represent one of fourteen vehicle classes.

Further, M3FC is capable of computing fuel consumption estimates from 1975 to 2020. Since at least a few vehicles are assumed to remain operational for up to 30 years, most input data must be available from 1946 through 2020. Operationally this has often meant that the time series of a variable remains constant at one level for some very early years and, in most cases, remains constant at a different level for all years beyond the year 2000.

III.A. Vehicle Stock

The first element of the fuel consumption equation is referred to as the vehicle stock, the total number of vehicles operating in a given calendar year. Vehicle stock estimates are required for each vehicle class for every projection year from 1975 through the year 2020.

The initial step of estimating vehicle stock is to obtain historical total stock estimates. Historical estimates are available principally from two sources, the R.L. Polk Company[8] and the Federal Highway Administration (FHWA)[11]

Although the truck stock estimates from these two sources are similar for all years, car registrations differ markedly. Figures A-1 and A-2 and Table B-1 show the vehicle stock estimates from these two sources.

According to Oak Ridge National Laboratories (ORNL),[12] there are several reasons for these differences:

1. The FHWA count includes all vehicles that have been registered throughout the calendar year. Therefore, their number includes vehicles retired during the year and double counts vehicles that have been registered twice in different or the same states. The Polk count only includes vehicles

that are registered on July 1, thus factoring in scrappage, to some degree, and avoiding double counting.

2. Polk counts are restricted to passenger cars, while FHWA figures may include light duty trucks for some states.

3. Beginning with the 1980 estimate, Polk counts vans as light trucks, rather than passenger cars. The FHWA count includes vans as passenger cars or trucks, depending on individual state classifications.

It is for these reasons that the Polk estimates appear to be a better indicator of the average automobile stock during a calendar year than are the FHWA estimates.

While these same reasons apply to estimates of truck registrations, the two groups' truck estimates are closer, probably because the scrappage rate of trucks is lower than that of cars. Also, since a truck is less likely to be reregistered in a second state within a given calendar year, double counting in the FHWA figures is reduced. The M3FC model therefore, uses the Polk values as the basis for its pre-1984 car and truck vehicle stocks.

In order to extend these estimates to the year 2020, ordinary least squares regressions were applied separately to the 1950-1983 car and truck registration time series. The slopes of these regression lines were than extrapolated from the 1983 Polk data.[8] These results are also presented in Figures A-1 and A-2 and Table B-1.

Thus, the historic and extrapolated Polk car registrations directly provide the stock estimates for LDVs. As for trucks, a method was needed to apportion the Polk numbers among the numerous M3FC truck classes. To accomplish this task, a special run was made of the Energy Environmental Analysis, Inc. (EEA) 10th Quarterly Report[13] model using 1977 calibration data. The stock obtained from that run are shown below.

1977 EEA 10th Quarterly Report Registrations

LDV	LDT1	LDT2	Class 2B
99.904	15.388	7.339	0.887
Classes 3-5	Class 6	Classes 7-8B	
1.245	1.688	1.686	

The 1977 Truck Information and Use Survey (TIUS) report[14] was then used to separate grouped Classes 3-5 and 7-8B into individual weight classes.

1977 TIUS Baseline Registration Fractions by Class

Class 3	Class 4	Class 5	Class 6
.099	.068	.122	.198
Class 7	Class8A	Class 8B	All Other Trucks
.089	.090	.172	.162

By using these functions as weighting factors, the grouped classes were split. For example, in 1977 Class 3 comprised .099/ (.099 + .068 + .122) or 34.3% of the grouped Classes 3-5 registration total or 0.427 million vehicles. Applying this procedure to the remaining classes yields the baseline registration distribution used in the M3FC model.

M3FC 1977 Baseline Registration Distribution

LDV	LDT1	LDT2	Class 2B	Class 3	Class 4
99.904	15.378	7.339	0.887	0.427	0.291
Class 5	Class 6	Class 7	Class 8A	Class 8B	
0.527	1.688	0.426	0.433	0.827	

This distribution forms the basis for all past and future truck stock estimates used in the M3FC model. From this, an iterative process was used to obtain future vehicle stock estimates.

Starting with 1977 as a base year, a constant scrappage rate was applied to each vehicle class. The assumed LDV scrappage rate was 7.9 percent while that for LDT1 through Class 8B was 5.0 percent. These scrappage rates are averages from the 1969 to 1983 values published in MVMA Motor Vehicle Facts and Figures, 1984.[15] After scrappage was applied, sale projections for each class were added. The sales figures were derived from the Data Resources, Inc. (DRI) Trendlong report[5] and sales percentages consistent with other regulatory analyses.

After the scrapped vehicles were removed from the fleet and sales were added, the resulting totals for cars and trucks were compared to the projected Polk figures. By renormalizing these series by vehicle class, the overall totals not only reflected Polk figures but also followed

vehicle stock trends projected by DRI. This process was repeated until the year 2020 using the following recursive formulas:

Step 1

Vehicle Stock by Class(year+1)=[Stock by Class(year)]*

[Scrappage Rate]+[Modified DRI Sales(year+1)]

Remove buses from Class 6

Step 2

Compute car and truck totals

Step 3

Vehicle Stock by Class(year+1)=

[Vehicle Stock by Class(year+1)]*[Polk Sum]/Computer Sum]

Go to Step 1

The resulting vehicle stock by class estimates are shown in Table B-2.

III.B. Registration Distribution

In any calendar year, the total vehicle stock consists of vehicles of different vintages. Since each vintage has its own unique blend of fuel economy and VMT, it is necessary to know how many vehicles there are of each age. The MOBILE3 registration distributions form the basis upon which these estimates were made for M3FC. (For an explanation of these distributions, see Fleet Characterization Data Used in MOBILE3.[16])

However, before the MOBILE3 distributions could be used in the fuel consumption model, certain modifications were needed. The MOBILE3 registration estimates are assumed to be as of July 1 of each year, before the first model year's sales are complete. In addition, all vehicles older than 19 years of age are added together and placed in the 20+ age group. To adjust for these differences the original MOBILE3 registration equations, covering ages 2 to 19 years, were extrapolated forward to a full first year and extended backward to 30 years of age. The resulting series was then renormalized so that the total adds up to 100 percent.

Since there are seven vehicle classes in MOBILE3 and essentially fourteen in the M3FC model, the following mapping scheme was used:

M3FC Vehicle Class	MOBILE3 Registration Distribution Used	
	Gas	Diesel
LDV	LDGV	LDDV
LDT1	LDGT1	LDDT
LDT2	LDGT2	LDDT
Class 2B	LDGT2	LDDT
Class 3	LDGT2	LDDT
Class 4	HDGV	HDGV
Class 5	HDGV	HDGV
Class 6	HDGV	HDGV
Class 7	HDDV	HDDV
Class 8A	HDDV	HDDV
Class 8B	HDDV	HDDV
School Buses	*	*
Public Buses	*	*
Off-Highway	*	*

Classes 4-6 are primarily gasoline vehicles so those fueled by diesel are assumed to be used like their gasoline counterparts. Therefore, they were assigned the adjusted MOBILE3 HDGV distributions. Also, since diesel engines predominate Class 7-8B trucks, these classes were assigned the adjusted HDDV distributions. The registration distributions used in the M3FC model are shown in Figures A-3 through A-6 and listed in Table B-3.

To actually obtain the number of vehicles of a certain age, the calendar year dependent vehicle stock was multiplied by the fraction of vehicles at that age:

Number of Vehicles (age)=[Vehicle Stock]*
[Registration Distribution(age)]

where age ranges from 1 to 30.

With the exception of buses and off-highway vehicles, this methodology was used for each year and vehicle class analyzed by the model. The data for buses and off-highway vehicles are calendar year dependent rather than age

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* The treatment of these vehicle categories is slightly different than the others. Only total VMT and fleet MPG are available for buses. Therefore, individual model year distributions are not included in the model. Further, off-highway gasoline use is entered directly into the model.

dependent and so did not require registration distributions in their calculations.

III.C. VMT

The number of miles traveled per year by a vehicle is dependent on age as well as class. M3FC uses most of the VMT age curves found in the MOBILE3 model as shown in the listing below. (For a detailed discussion of these curves, see Fleet Characterization Data Used for MOBILE3.[21]) The mapping scheme is nearly the same as that used for registration distributions.

M3FC Vehicle Class	MOBILE3 VMT Distribution Used	
	Gas	Diesel
LDV	LDGV	LDDV
LDT1	LDGT1	LDDT
LDT2	LDGT2	LDDT
Class 2B	LDGT2	LDDT
Class 3	LDGT2	LDDT
Class 4	HDGV	HDGV
Class 5	HDGV	HDGV
Class 6	HDGV	HDGV
Class 7	HDGV	--
Class 8A	HDGV	--
Class 8A	HDGV	--
Class 8B	HDGV	--

This scheme is fairly straightforward except for Classes 2B and above. The LDGT2/LDDT distributions were assigned to Class 2B because this class behaves more like LDT2 than either HDG or HDD vehicles. Since Class 3 vehicles are being slowly phased out and replaced by Class 2B vehicles, they were also assigned the LDT2 distribution.

Diesel Classes 7-8B use separate VMT distributions derived from the 1977 Truck Inventory and Use Survey.[14] While these distributions formed the basis for the single MOBILE3 HDDV distribution, using the separate distributions yields somewhat greater accuracy in calculating fuel consumption for these heavy truck classes.

For all distributions it was assumed that vehicles over 20 years of age travel annually the same distance as age 20 vehicles. Figures A-7 through A-12 and Table B-4 summarize the VMT distributions used.

III.D. Diesel Market Penetration

Each model year, a certain number of gas and diesel vehicles are produced. The fraction of diesel vehicles compared to the total produced for a given class is referred to as the diesel market penetration rate. In the M3FC model, these rates are used to estimate the number of gas and diesel vehicles operating in each model year. This is accomplished by using the following formulas:

Number of Diesel Vehicles(year)=[Number of Vehicles(year)]*
[Diesel Penetration(year)]

Number of Gas Vehicles(year)=[Number of Vehicles(year)]*
[1-Diesel Penetration(year)]

The diesel penetration rates used in the M3FC model were prepared by EPA.[17] Generally rates were available from 1960 to 1995. Because the M3FC model requires data from 1946 to 2020, it was assumed that the rates prior to 1960 were the same as those in 1960 and rates after 1995 were the same as those in 1995. The diesel penetration rates are shown in Figures A-13 through A-18 and listed in Table B-5.

At present, the future dieselization of the LDV and LDT fleets is uncertain. To allow for this uncertainty, the model has a provision to place a maximum limit on the LDV and LDT diesel penetration rates after 1983. This rate can be set in the range from 0 to 11.5 percent for LDVs and from 0 to 33.9 percent for LDTs.

III.E. Leaded Market Penetration

Similarly, in a given model year a certain number of gasoline vehicles are designed to run on leaded or unleaded fuel. The proportion of vehicles designed to run on leaded fuel is referred to as the leaded market penetration rate. In M3FC, the number of vehicles designed to use gasoline of a given type is estimated with the following two equations:

Number of Leaded Gas Vehicles(year)=
[Number of Gas Vehicles(year)]*
[Leaded Market Penetration(year)]

Number of Unleaded Gas Vehicles(year)=
[Number of Gas Vehicles(year)]*
[1-Leaded Market Penetration(year)]

The LDV through LDT2 rates used in the M3FC model were obtained from the data files used to produce EEA's 10th

Quarterly Report.[13] Classes 2B-3 were assumed to be 100 percent leaded up through 1986 and 100 percent unleaded thereafter. Classes 4-8B and buses were assumed to be 100 percent leaded for all years. Table B-6 lists the leaded market penetration rates used in the model.

III.F. Fuel Economy

Fuel economy estimates were obtained from a variety of sources. An internal EPA memorandum Fuel Consumption Model Inputs[9] provided new vehicle fleet road MPG for LDVs and LDTs. These estimates were not distinguished by fuel type but instead a diesel advantage factor was included to indicate the degree to which diesel fueled vehicles obtain fuel economy greater than their gasoline counterparts. These two estimates, along with the model year specific diesel penetration rates for each model year, were combined to estimate separate gasoline and diesel fuel economy. The two equations used are:

Gas MPG=[Fleet MPG]*([1-Diesel Penetration]
+[Diesel Penetration]/[Diesel Advantage Factor])

Diesel MPG=[Gas MPG]*[Diesel Advantage Factor]

The LDV and LDT available estimates cover the 1962 to 2000 model years. It was assumed that MPG values prior to 1962 were the same as the 1962 figure and those after the year 2000 would be the same as the year 2000 figure. No distinction was made between LDT1 and LDT2.

The Fuel Economies of Heavy Duty Vehicles report[18] provided separate gas and diesel road MPG values for 1962 to 2000 model years in Classes 2B-8B. As with the light duty classes, MPG values prior to 1962 were assigned the 1962 values. Figures A-19 through A-26 show the MPG values while Table B-7 show the MPG values and diesel advantage factors used in the model.

III.G. Fuel Switching

Unfortunately not all gasoline vehicles consistently use the type of fuel for which they were designed. Indeed, fuel switching is defined as using a type of fuel in a vehicle other than the type for which it was designed.

There are, therefore, two types of fuel switching: illegal and discretionary. Illegal fuel switching is using leaded fuel in vehicles designed for unleaded fuel. Discretionary fuel switching is using unleaded fuel in vehicles designed for leaded fuel.

The illegal fuel switching rates used in the M3FC model are based on those found in MOBILE3.[1] Two types of tampering are used to indicate illegal fuel switching. These are labeled as "fuel inlet tampering" and "other misfueling" in MOBILE3. The rates are given by the following equations:

LDV

Fuel Inlet Tampering = -0.0143*0.02022*(10K miles)
Other Misfueling = 0.0165+0.0559*(10K miles)

LDT1, LDT2, and Classes 2B-3

Fuel Inlet Tampering =0.1101+0.02022*(10K miles)
Other Misfueling = 0.0696+0.00559*(10K miles)

Since the M3FC model performs its calculations based on vehicle age, these mileage based equations were transformed to age based equations using the VMT by age distributions discussed earlier. The inlet tampering and other misfueling rates were then combined to form a single, illegal misfueling rate. These are shown in Figure A-27.

However, these rates do not reflect the amount of fuel misused but only the frequency of misuse. A multiplicative adjustment factor of 0.417 was included in the model to account for the amount of fuel misused. This factor was calculated by dividing the purchased volume misfueling rate (7.5 percent) by the vehicle involvement misfueling rate* (18.0 percent) in the Department of Energy's report, Patterns of Vehicle Misfueling in 1981 and 1982: Where, When, What Vehicles and How Often?[19]

Discretionary fuel switching rates, on the other hand, are based on the Supplementary Guidelines for Lead Implementation Plans report.[20] These rates are applied to LDV through Class 2B and depend entirely on model year. For all model years up through 1975 the rate is 7.1 percent. Thereafter, it increases to 27.5 percent. Since these

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* The purchased volume misfueling rate equals the gallons of leaded fuel used by vehicles designed to operate on unleaded gasoline divided by the total amount of fuel used by these vehicles. It is a misfueling rate based on gallons. On the other hand, the vehicle involvement misfueling rate is a rate based on frequency. It equals the number of times an owner misfuels his/her vehicle divided by the total number of times that vehicle is refueled.

values refer directly to the amount of fuel used, no adjustment factor is needed. Figure A-28 shows the discretionary misfueling rate used in the model.

The following formulas are used to calculate the total amount of fuel switched:

Number of Illegally Misfueled Vehicles=
[Number of Unleaded Vehicles]*[Illegal Misfueling Rate]*
[Misfueling Adjustment Factor]

Number of Discretionally Misfueled Vehicles =
[Number of Leaded Vehicles]*[Discretionary Rate]

III.H. Urban/Rural VMT

The amount of VMT traveled in an urban or rural environment is also dependent on vehicle class and model year. Urban VMT estimates are included in M3FC to provide one of several inputs to air quality models. The urban/rural rates used in the M3FC model are summarized in Figures A-29 through A-34 and Table B-8.[10]

IV. Outputs

The M3FC model outputs fuel consumption estimates for fourteen different vehicle classes. These classes and their composition are summarized below:

LDV	Light Duty Vehicles (passenger cars)
LDT1	Light Duty Trucks 1, 0-6000 lbs GVW
LDT2	Light Duty Trucks 2, 6001-8500 lbs GVW
Classes 2B-5	Light to Medium Duty Trucks, 8501-19500 lbs GVW
Class 6	Light Heavy Duty Trucks, 19501-26000 lbs GVW
Classes 7-8A	Heavy Heavy Duty Trucks, 26000-50000 lbs GVW
Class 8B	Heavy Heavy Duty Trucks, 50000+lbs GVW
School Buses	
Public Buses	
Off-Highway	Agricultural, industrial/commercial, construction and marine/recreation vehicles

Table 1 is a copy of the 1983 model output. Tables for all years are available in the Appendix D of this report.

For each year fuel consumption and supporting statistics are provided. The top one-half of the table lists the diesel and gasoline fuel consumed by light duty vehicles (LDV), light duty trucks (LDT1, LDT2) and by four sets of heavy duty truck classes. Also listed is consumption by

school and commercial buses. Finally, off-highway gasoline consumption is included.

Gasoline usage is divided into two parts, leaded and unleaded. Within each part, the portion consumed by vehicles designed to run on leaded fuel is distinguished from the portion consumed by vehicles designed to run on unleaded fuel.

By M3FC definition, the label "pre-control" refers to vehicles that were designed to run on leaded fuel. The label "control" refers to those vehicles that generally are equipped with catalysts and are thus designed to use unleaded fuel. Each type of usage is listed separately.

Below the fuel consumption estimates are the supporting statistics. These are new vehicle and fleet road fuel economy,* gasoline and diesel powered vehicle registrations, and urban and rural VMT.

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* The fuel economies listed for LDT1 and LDT2 represent the average of LDT1 and LDT2.

Draft MOBILE3 Fuel Consumption Model
FEB 13, 1985

1983

Fleet Fuel Consumption
(x10**9 Gallons/Year, x10**6 Barrels/Day)

	Diesel		Leaded Gasoline			Unleaded Gasoline			Total Gasoline			Grand Total	
	Gallons	BBL/Day	Pre-Control	Control	Total	Pre-Control	Control	Total	Gallons	BBL/Day	% Unleaded	Gallons	BBL/Day
LDV	0.905	0.059	16.499	2.228	18.727	1.894	38.746	40.640	59.367	3.873	68.46	60.272	3.932
LDT1	0.271	0.018	4.258	1.491	5.749	0.419	8.761	9.179	14.929	0.974	61.49	15.200	0.991
LDT2	0.172	0.011	4.157	0.542	4.699	0.854	3.722	4.576	9.275	0.605	49.33	9.447	0.616
Classes 2B-5	0.174	0.011	3.683	0.0	3.683	0.0	0.0	0.0	3.683	0.240	0.0	3.857	0.252
Class 6	0.512	0.033	2.262	0.0	2.262	0.0	0.0	0.0	2.262	0.148	0.0	2.774	0.181
Classes 7-8A	3.316	0.216	0.952	0.0	0.952	0.0	0.0	0.0	0.952	0.062	0.0	4.268	0.278
Class 8B	13.356	0.871	0.053	0.0	0.053	0.0	0.0	0.0	0.053	0.003	0.0	13.409	0.875
School Buses	0.013	0.001	0.389	0.0	0.389	0.0	0.0	0.0	0.389	0.025	0.0	0.401	0.026
Public Buses	0.730	0.048	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.730	0.048
Off-Highway	NA	NA	2.509	0.0	2.509	0.743	0.0	0.743	3.252	0.212	22.85	3.252	0.212
Total LDT	0.443	0.029	8.415	2.033	10.448	1.273	12.482	13.755	24.203	1.579	56.83	24.646	1.608
Total LDV+LDT	1.348	0.088	24.914	4.262	29.176	3.167	51.228	54.395	83.571	5.451	65.09	84.918	5.539
Total HDV	18.100	1.181	7.340	0.0	7.340	0.0	0.0	0.0	7.340	0.479	0.0	25.439	1.659
Total Highway	19.447	1.269	32.253	4.262	36.515	3.167	51.228	54.395	90.910	5.930	59.83	110.358	7.199
Grand Total	19.447	1.269	34.762	4.262	39.024	3.910	51.228	55.138	94.162	6.142	58.56	113.610	7.411

1983

Vehicle Registrations - Vehicle Miles Traveled
(x10**6 Vehicles) (x10**9 Miles/Year)

	New Vehicles		Fleet												
							VMT								
	Road MPG		Road	Registrations			Urban			Rural			Total		
	Gas	Diesel	MPG	Gas	Diesel	Total	Gas	Diesel	Total	Gas	Diesel	Total	Gas	Diesel	Total
LDV	22.13	26.77	17.12	106.890	2.071	108.961	602.13	13.86	615.99	406.46	9.36	415.82	1008.59	23.22	1031.80
LDT1	17.47	23.06	13.82	18.640	0.387	19.027	104.81	3.14	107.95	99.10	2.97	102.07	203.91	6.11	210.02
LDT2	17.47	23.06	13.87	11.268	0.234	11.502	65.33	1.99	67.33	61.78	1.88	63.66	127.11	3.87	130.98
Classes 2B-5	10.73	13.75	9.51	3.316	0.137	3.453	23.75	1.37	25.12	10.77	0.80	11.57	34.53	2.17	36.70
Class 6	5.84	8.82	6.27	1.065	0.274	1.339	8.75	1.97	10.72	4.20	2.47	6.67	12.95	4.44	17.39
Classes 7-8A	5.14	6.27	5.90	0.382	0.661	1.043	3.15	7.45	10.60	1.60	12.96	14.56	4.75	20.41	25.16
Class 8B	0.0	5.38	5.07	0.043	1.162	1.205	0.13	11.93	12.06	0.10	55.83	55.93	0.23	67.76	67.99
School Buses	7.73	10.75	7.82	0.438	0.020	0.458	1.23	0.06	1.29	1.77	0.08	1.85	3.00	0.13	3.14
Public Buses	NA	5.01	5.01	0.0	0.116	0.116	0.0	2.38	2.38	0.0	1.28	1.28	0.0	3.66	3.66
Off-Highway	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total LDT			13.84	29.909	0.620	30.529	170.14	5.13	175.28	160.87	4.85	165.73	331.02	9.99	341.01
Total LDV+LDT			16.17	136.799	2.691	139.490	772.27	18.99	791.26	567.33	14.21	581.54	1339.61	33.20	1372.81
Total HDV			6.05	5.245	2.369	7.614	37.01	25.15	62.16	18.44	73.43	91.87	55.45	98.58	154.03
Grand Total			13.84	142.044	5.060	147.104	809.28	44.14	853.42	585.78	87.64	673.41	1395.06	131.78	1526.83

V. Validation

Comparing the M3FC outputs to historical data for the nine year period 1975-1983 shows that predicted gasoline consumption is accurate to within an average of three percent. [Figure 6] The proportion of gasoline that was unleaded is predicted accurately to within an average of four percent. In both cases the comparison is made with the statistics published in the Petroleum Supply Monthly.[6] [Figure 7]

Figure 6

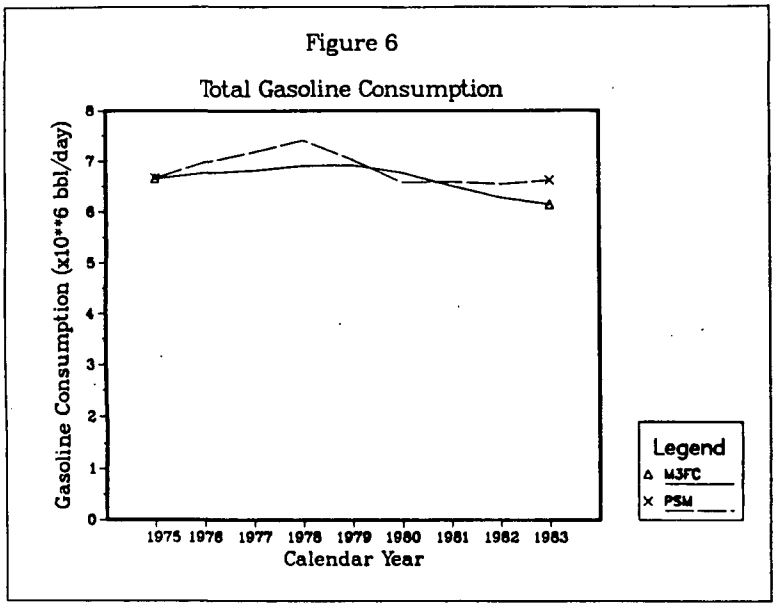
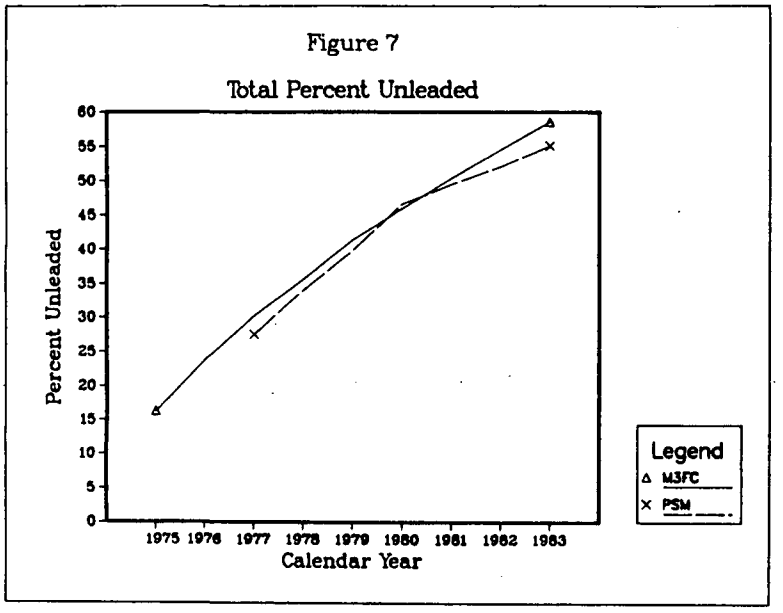
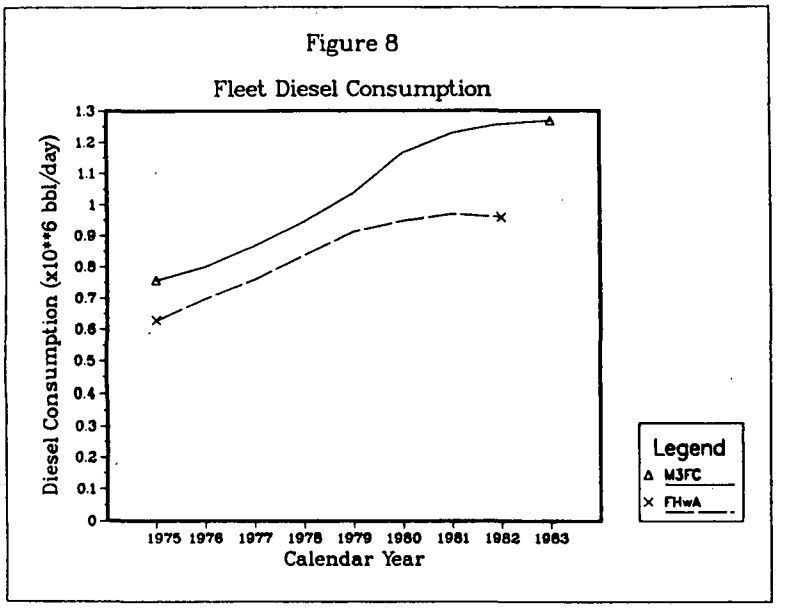


Figure 7



Federal Highway Administration statistics are used as the basis of comparisons for highway diesel fuel consumption. During the 1975-1983 period M3FC diesel fuel estimates were accurate to an average of 20 percent.[21] [Figure 8]



The differences between the model predictions and published reports could be explained by inaccuracies in the underlying registration, VMT, and/or MPG estimates. They could also be explained by changes in driving behavior of the American public. For example, the changing real cost of owning and operating a car as well as the general level of economic activity influence the short-term demand for fuel. While including these economic circumstances is outside of the model's scope, consider that the unemployment rate fell from 8.5 percent in 1975 to 6.1 percent in 1978, then rose again to 9.6 percent in 1982. This trend mirrors the total gasoline consumption trend shown above.

VI. Comparisons

To further evaluate M3FC, we compared the model results with those from three other models. Both Energy and Environmental Analysis, Inc. (EEA), in their Tenth Quarterly Report and in their Eleventh Periodical Report, and Data Resources, Inc. (DRI), in their Trendlong report, provide estimates of fleet gasoline consumption.

All four models predict that gasoline consumption will decline throughout the 1980s. [Figure 9] The decline predicted by the M3FC model is somewhat steeper than that predicted by either the DRI model[4] or the Eleventh Periodical Report.[22] The DRI model also predicts declining gasoline use through the year 2000. However, EEA's Tenth Quarterly Report model predicts that gasoline consumption will mirror that predicted by M3FC.

Both M3FC and EEA's two models predict that the percent of gasoline consumed by highway motor vehicles that is unleaded will increase from approximately 50 percent in 1980 to 87 percent in the year 2000.[22] [Figure 10] All three models also expect diesel fuel consumption to increase at about the same rate, although the M3FC model predicts that somewhat more diesel fuel will be consumed in the year 2000 than does the EEA model.[Figure 11] This is due largely to the greater number of diesels predicted by the M3FC model.

Several factors explain the differences in gasoline consumption. Figure 12 shows the effect of applying each of these model changes. Two of the most important deal with the assumptions about average annual VMT per vehicle and the diesel penetration rate of new vehicles.

The M3FC model assumes that the average number of miles accumulated by each vehicle of any given age is constant within a vehicle class. It makes no difference whether one is predicting fuel consumption for 1985 or 1995. On the other hand, EEA, in their Eleventh Periodical Report, assumes that annual miles traveled per car will increase at 0.75 percent per year through the year 2000. EEA also assumes that annual light duty truck miles traveled will increase by 0.5 percent while medium heavy trucks will increase by 3.0 percent per year. EEA expects annual heavy heavy truck VMT to remain constant or, decline slightly (0.4 percent).[22] Eliminating all of the above growth in annual VMT per vehicle reduces EEA's projected fleet gasoline consumption estimate for the year 2000 by 0.509 million barrels per day to 5.411 million barrels per day.

Figure 9

Fleet Gasoline Consumption

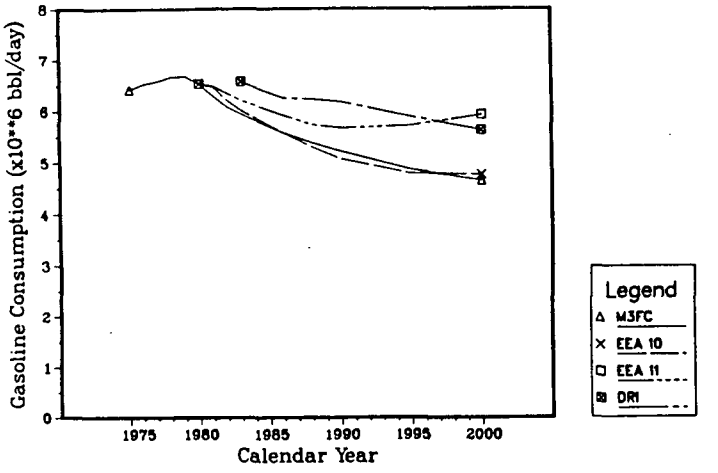


Figure 10

Fleet Percent Unleaded

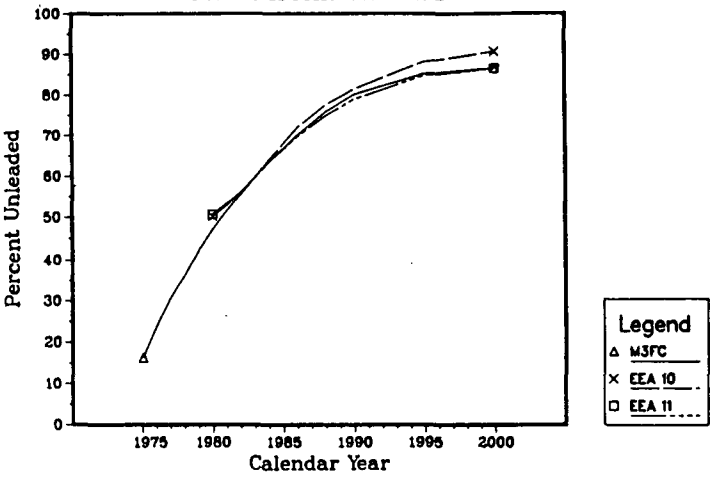
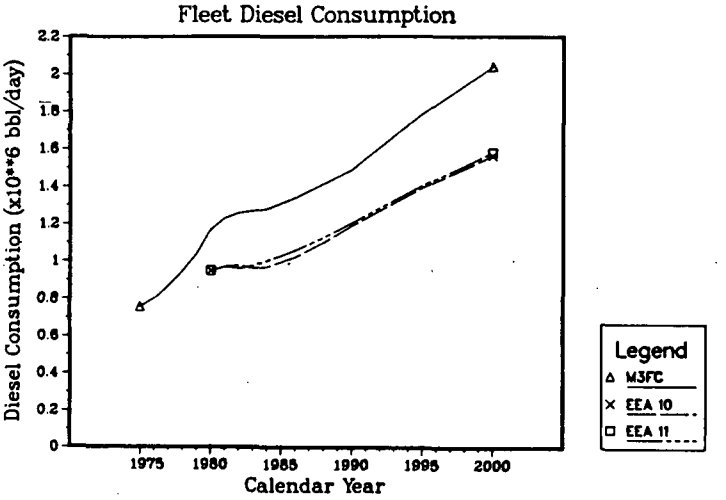


Figure 11

Fleet Diesel Consumption



The second area of significant difference between the two models concerns the diesel penetration rate of new vehicles.

EEA assumes that sales of new domestic diesel passenger cars will stabilize at 1.5 percent of the passenger car fleet in 1995. It also expects that 1995 sales of imported diesel passenger cars will reach 4.0 percent, domestic light truck diesel sales will reach 3.5 percent, and import light truck diesel sales will reach 12.0 percent of the total light truck market.[22]

On the other hand, M3FC assumes that in 1995 an average of 11.5 percent of the passenger cars and 33.9 percent of the light trucks will be diesels.[1] Naturally, if diesels comprise a smaller portion of the fleet, total gasoline consumption will increase.

Two scenarios were devised to measure the model's reaction to the assumed diesel penetration rate. The first scenario kept both passenger car and light duty truck diesel penetration rates at 1983 levels of 1.9 and 7.7 percent, respectively.[10] In this scenario gasoline consumption increases by 0.471 million barrels per day in the year 2000.

The second scenario allowed diesel passenger cars to gain up to 5.0 percent and light trucks to gain up to 15.0 percent of the market. The effect of this is to increase gasoline consumption by 0.308 million barrels per day in the year 2000.

A third factor that will affect the amount of highway gasoline consumed is the proportion of the fleet that consists of light trucks. Since the fuel economy of light trucks is substantially less than that of passenger cars, if more individuals replace their passenger cars with light trucks (pickups, vans, etc.), fleet fuel consumption will increase.

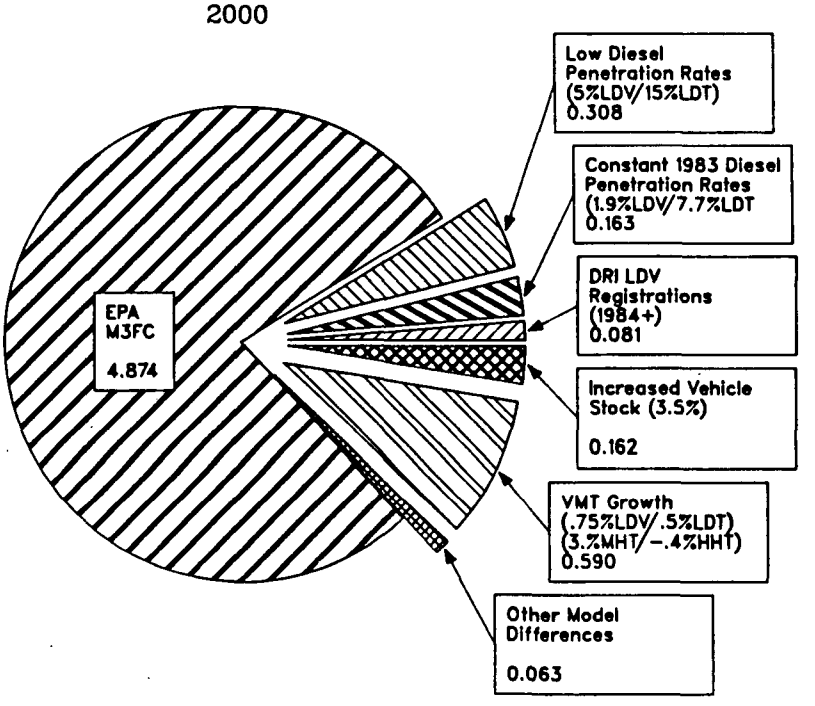
To test the reaction of the model to this third factor, the DRI passenger car projections for year 2000[4] were substituted for the model's original projections. The difference between the two was then added to the light truck stock. This increased highway gasoline consumption by 0.081 million barrels per day in the year 2000.

While these factors account for the major differences between M3FC and EEA's Eleventh Quarterly Report, only M3FC is fundamentally consistent with the MOBILE3 emission factors model. That model, in turn has been extensively reviewed by industry as well as state and local

governments. We believe, therefore, that M3FC estimates have a greater chance of accurately predicting future fuel consumption.

Figure 12

Model Differences
(million barrels of gasoline per day)



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[1] U.S. Environmental Protection Agency, Office of Mobile Sources, User's Guide to MOBILE3, EPA 460/3-84-002, June, 1984.

[2] Energy and Environmental Analysis, Inc., The Motor Fuel Consumption Model, Eleventh Periodical Report, prepared for the U.S. Environmental Protection Agency, November, 1984.

[3] U.S. Environmental Protection Agency, Office of Policy Analysis, Costs and Benefits of Reducing Lead in Gasoline, EPA-230-03-84-005, May 1984.

[4] Data Resources, Inc.

[5] U.S. Environmental Protection Agency, Office of Air Quality, Planning and Standards, User's Manual for Modified Rollback/EKMA Strategy Assessment Model, EPA-450/4-81-025, July, 1981.

[6] U.S. Department of Energy, Energy Information Administration, Petroleum Supply Monthly, DOE/EIA-0109 (84/06), June, 1984.

[7] U.S. Department of Transportation, Federal Highway Administration, Highway Statistics, 1981, Table MF-2.

[8] R.L. Polk and Company, Detroit, MI.

[9] U.S. Environmental Protection Agency, Office of Mobile Sources, "Fuel Consumption Model Inputs", Note from Karl Hellman to Ralph Stahman, October 17, 1984.

[10] U.S. Environmental Protection Agency, Office of Mobile Sources, personal communication from Amy Brochu, December, 1984.

[11] U.S. Department of Transportation, Federal Highway Administration, Highway Statistics, 1967 - 1982, Table VM-1.

[12] U.S. Department of Energy, Oak Ridge National Laboratory, Transportation Energy Data Book: Edition 7, ORNL-6050, June, 1984.

[13] Energy and Environmental Analysis, Inc., The Highway Fuel Consumption Model, Tenth Quarterly Report, prepared for the U.S. Department of Energy, November, 1983.

[14] U.S. Department of Commerce, Bureau of the Census, Truck Inventory and Use Survey, 1977.

[15] Motor Vehicle Manufacturers Association of the United States, Inc., MVMA Motor Vehicle Facts & Figures, 1984.

[16] U.S. Environmental Protection Agency, Office of Mobile Sources, Fleet Characterization Data Used in MOBILE3, August, 1984, EPA-AA-TEB-EF-84-6.

[17] U.S. Environmental Protection Agency, Office of Mobile Sources, personal communication from Amy Brochu, November 20, 1984 and December and November 23, 1984.

[18] U.S. Environmental Protection Agency, Office of Mobile Sources, Fuel Economies of Heavy Duty Vehicles, July, 1984.

[19] U.S. Department of Energy, Patterns of Vehicle Misfueling in 1981 and 1982: Where, When, What Vehicles and How Often?, October, 1984.

[20] U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards and Office of Mobile Sources, Supplementary Guidelines for Lead Implementation Plans, Updated Projections for Motor Vehicle Lead Emissions, EPA-450/2-83-002, March 1983.

[21] U.S. Department of Transportation, Federal Highway Administration, Highway Statistics, 1975-1982, Table MF-2.

[22] Energy and Environmental Analysis, Inc., The Motor Fuel Consumption Model, Eleventh Periodical Report, prepared for the U.S. Environmental Protection Agency, November, 1984.

Appendix A

Model Input

Figures

Figure A-1

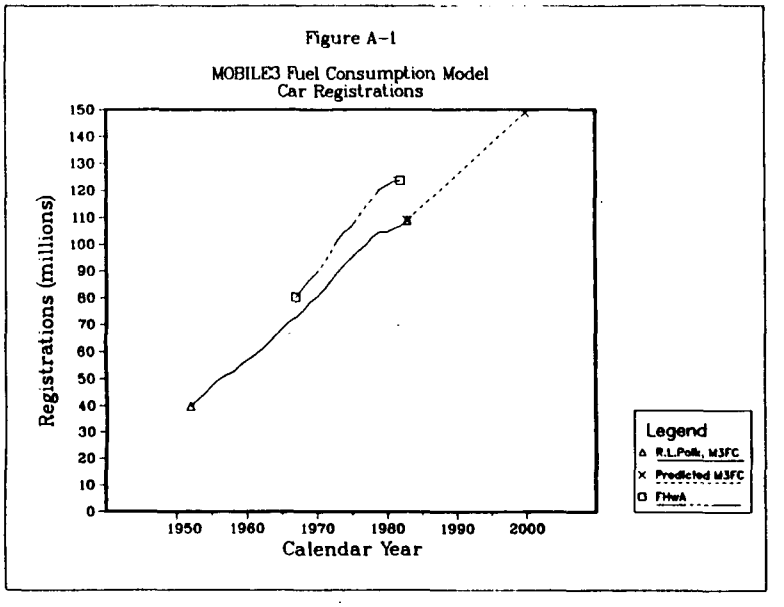


Figure A-2

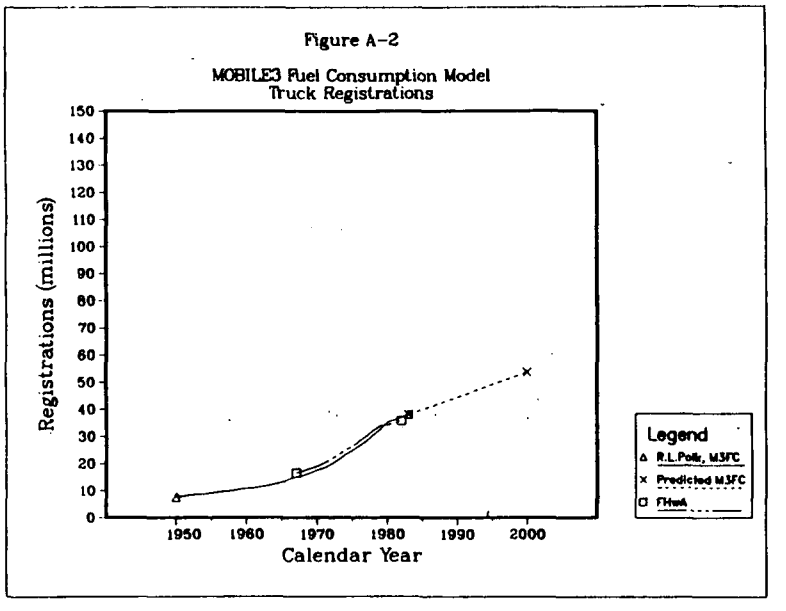


Figure A-3

MOBILE3 Fuel Consumption Model
LDV Registration Distributions

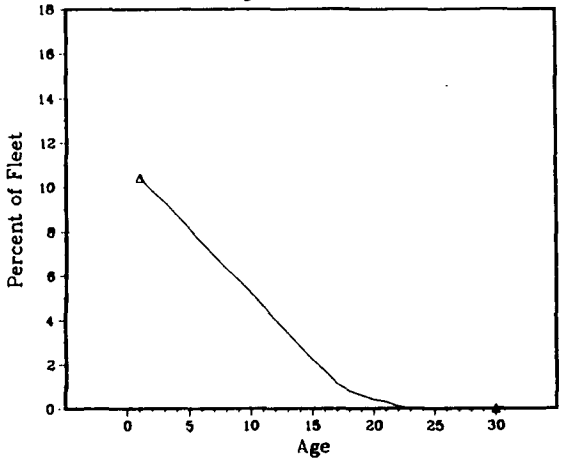


Figure A-4

MOBILE3 Fuel Consumption Model
LDT-Class 3 Registration Distributions

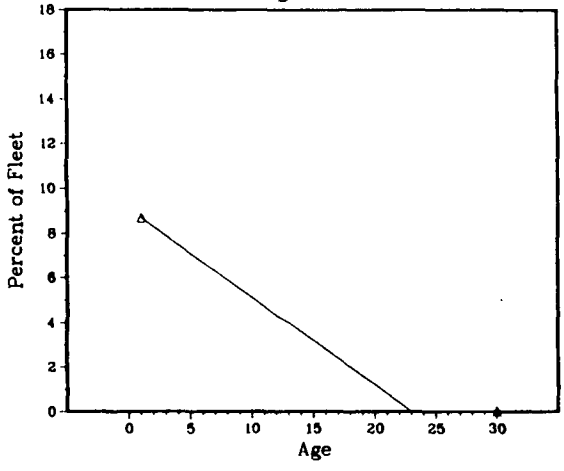


Figure A-5

MOBILE3 Fuel Consumption Model
Classes 4-6 Registration Distributions

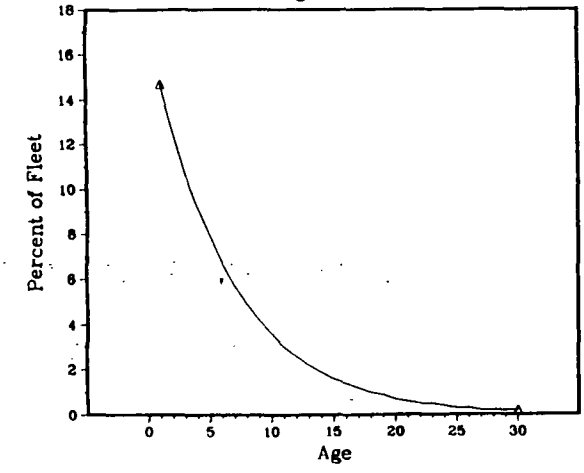


Figure A-6

MOBILE3 Fuel Consumption Model
Classes 7-8B Registration Distributions

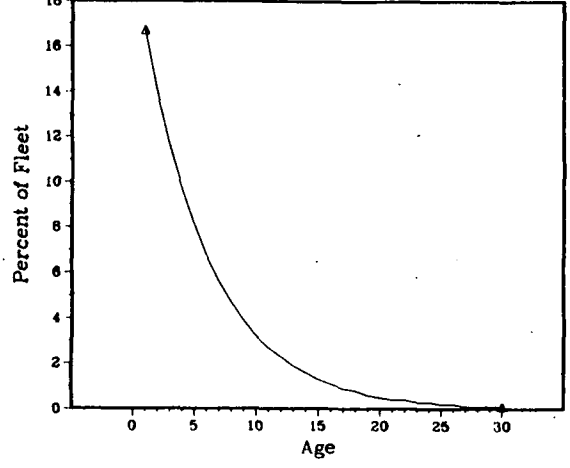
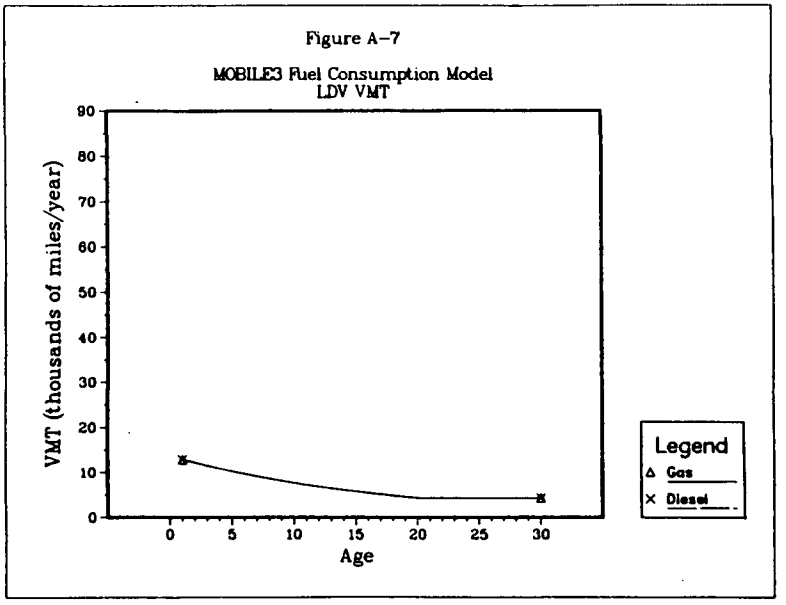


Figure A-7



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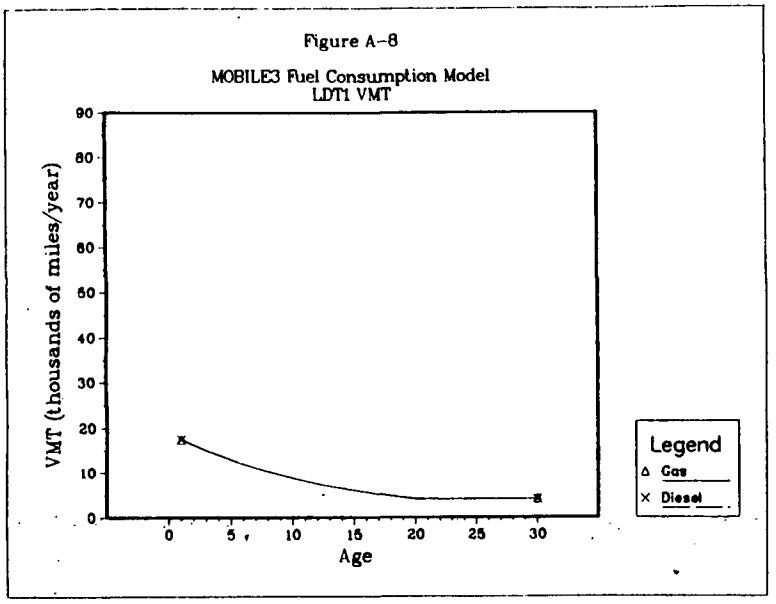

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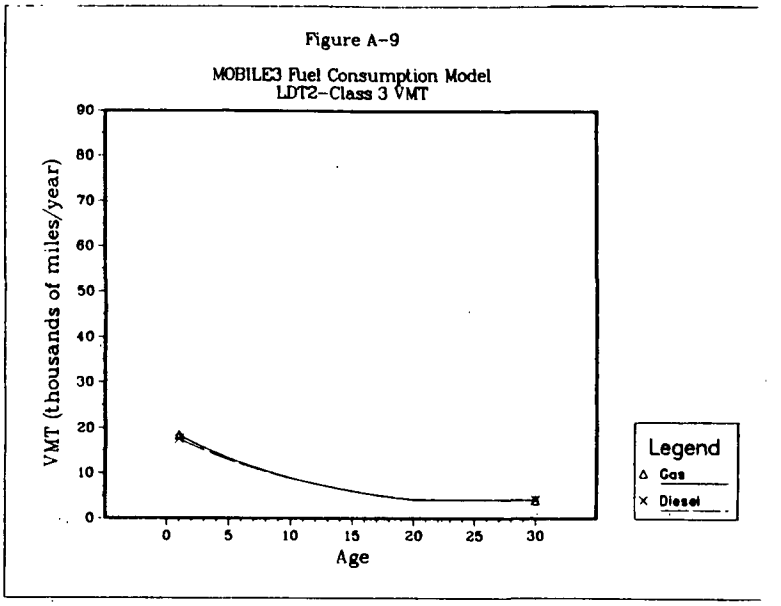

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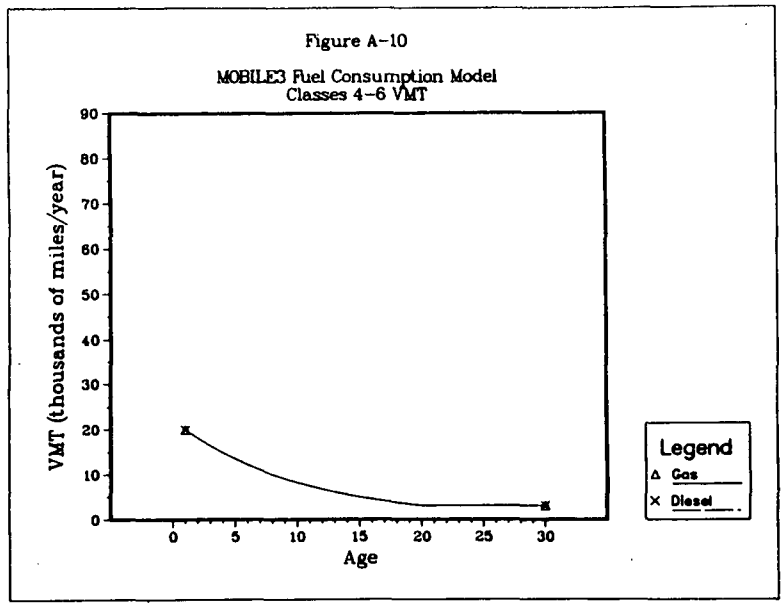

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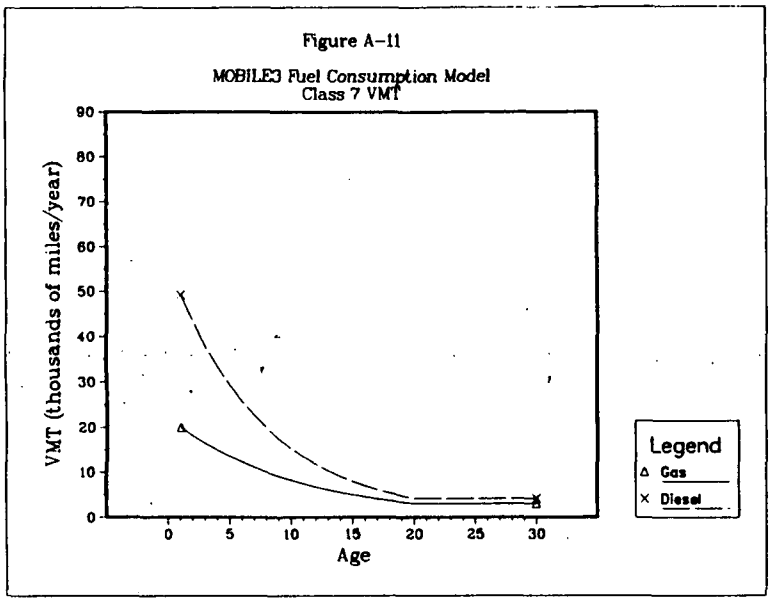

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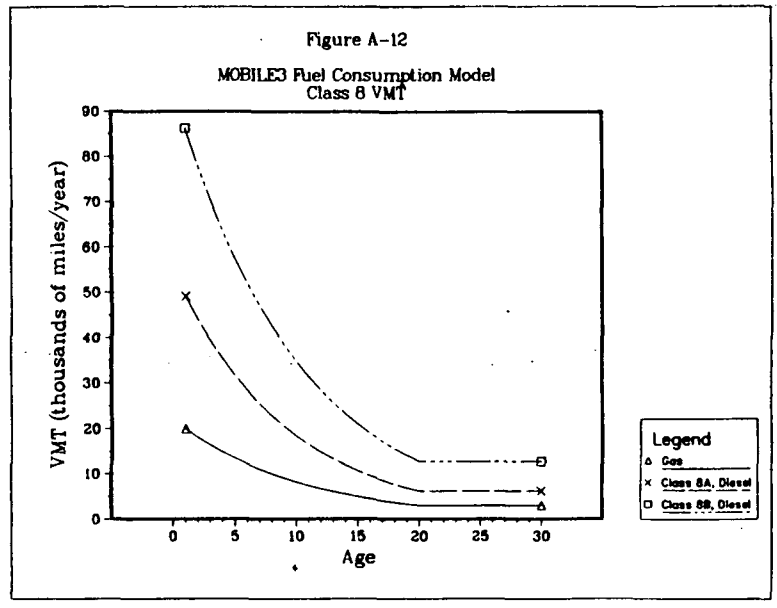

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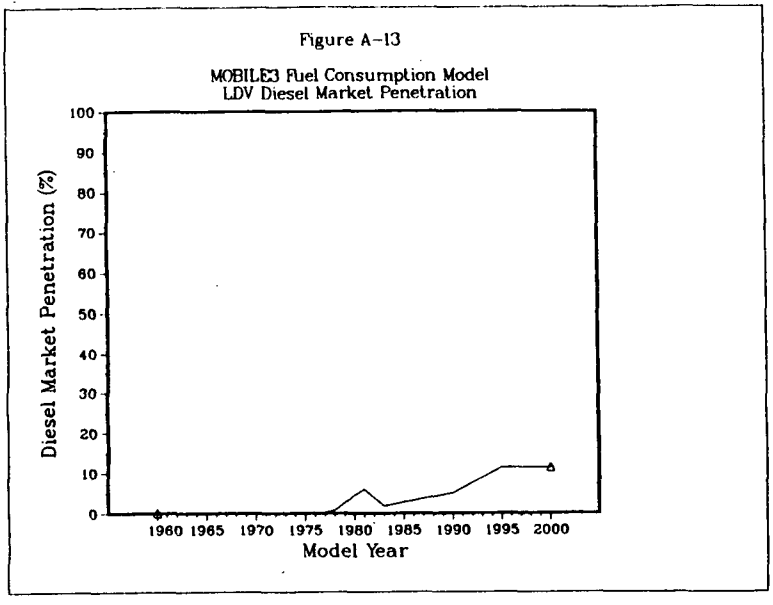

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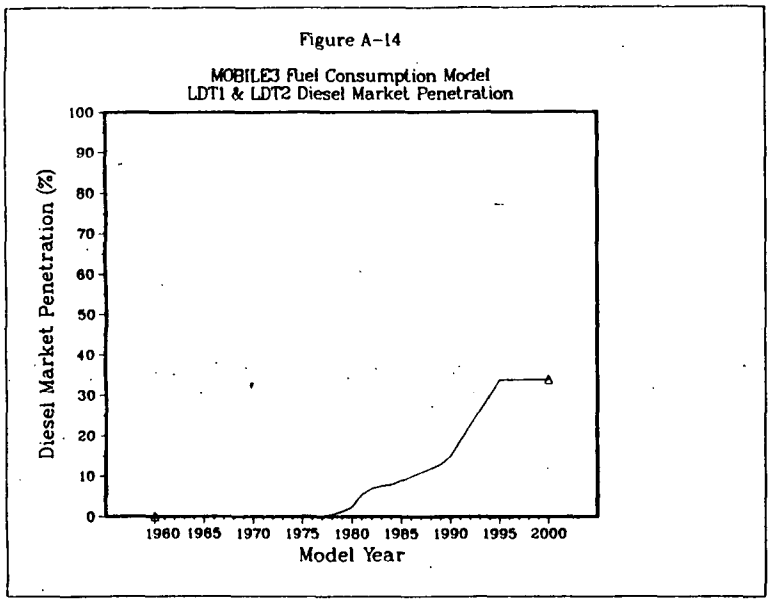

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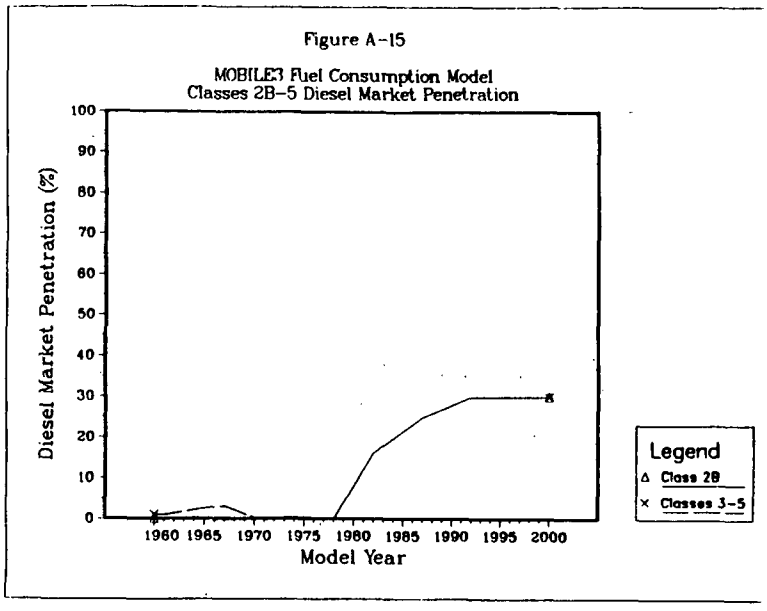


Figure A-16

MOBILE3 Fuel Consumption Model
Class 6 Diesel Market Penetration

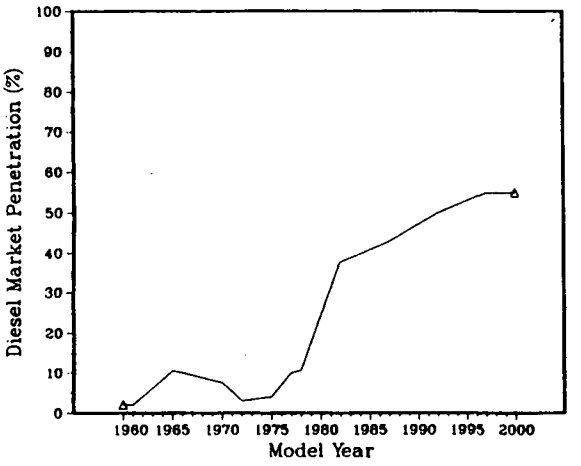


Figure A-17

MOBILE3 Fuel Consumption Model
Class 7 Diesel Market Penetration

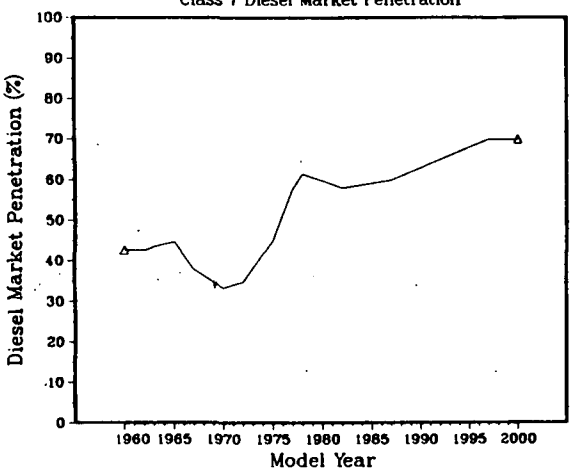


Figure A-18

MOBILE3 Fuel Consumption Model
Class 8 Diesel Market Penetration

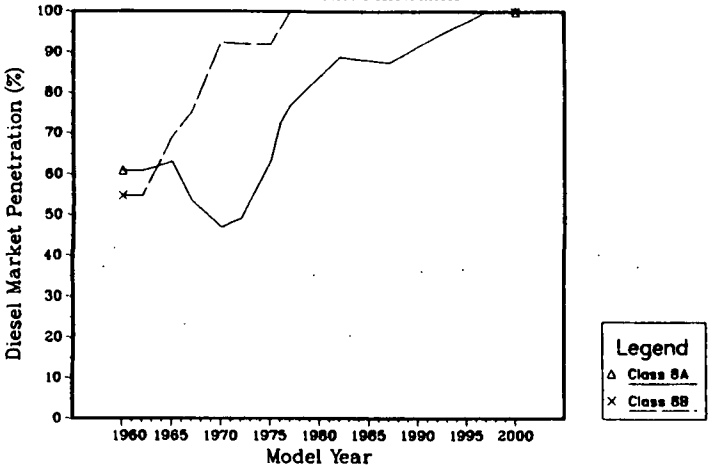


Figure A-19

MOBILE3 Fuel Consumption Model
LDV Road MPG

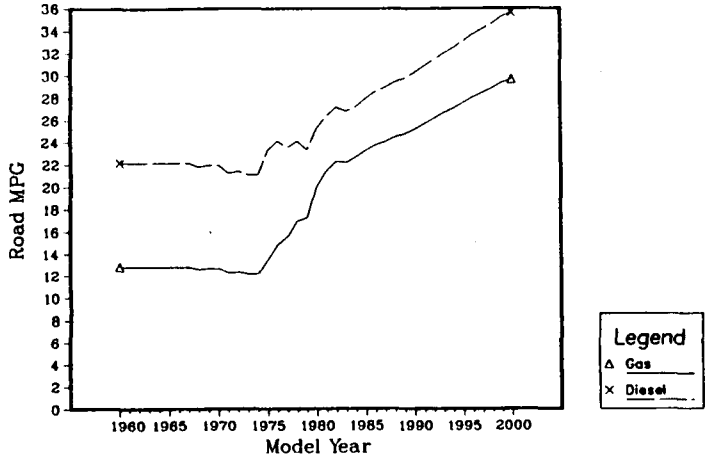


Figure A-20

MOBILE3 Fuel Consumption Model
LDT Road MPG

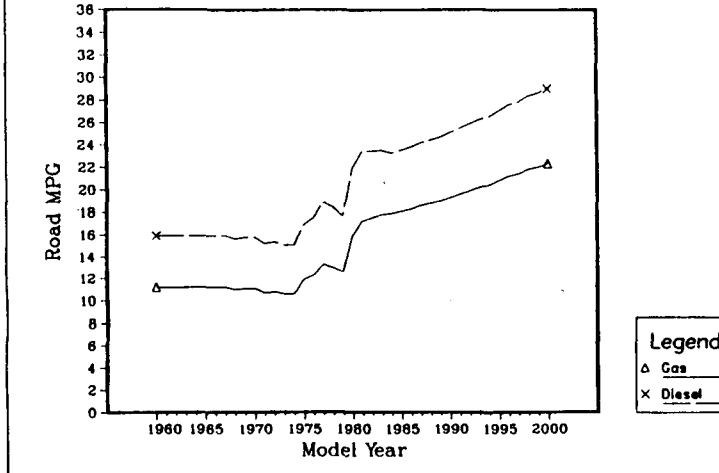


Figure A-21

MOBILE3 Fuel Consumption Model
Class 2B Road MPG

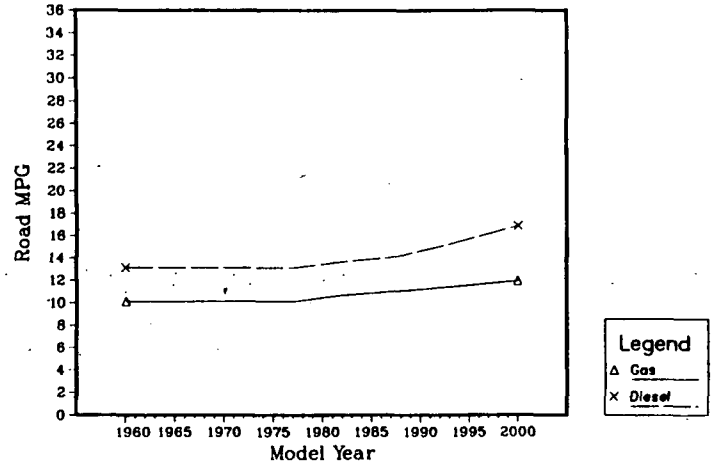
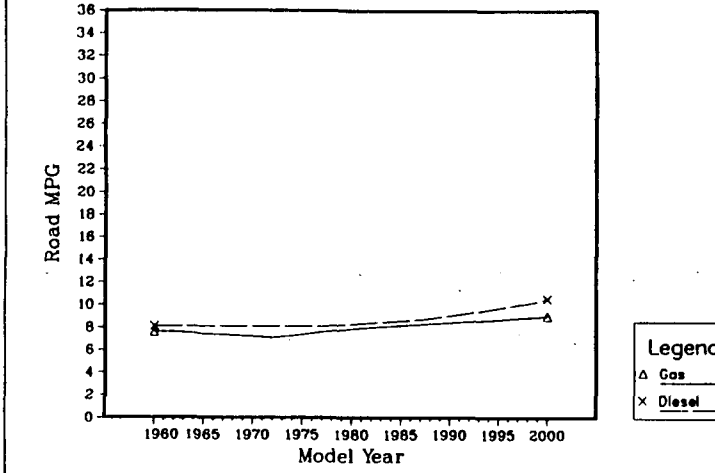


Figure A-22

MOBILE3 Fuel Consumption Model
Classes 3-5 Road MPG



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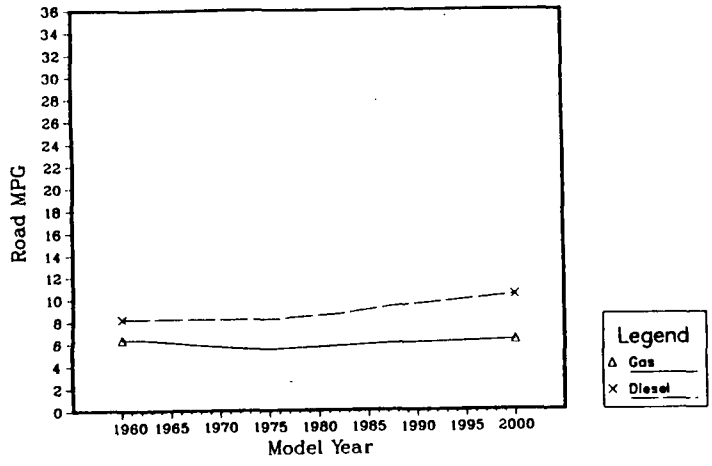

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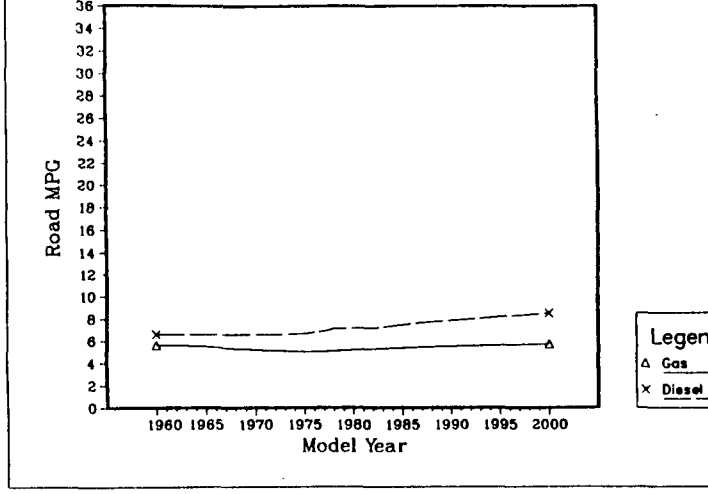

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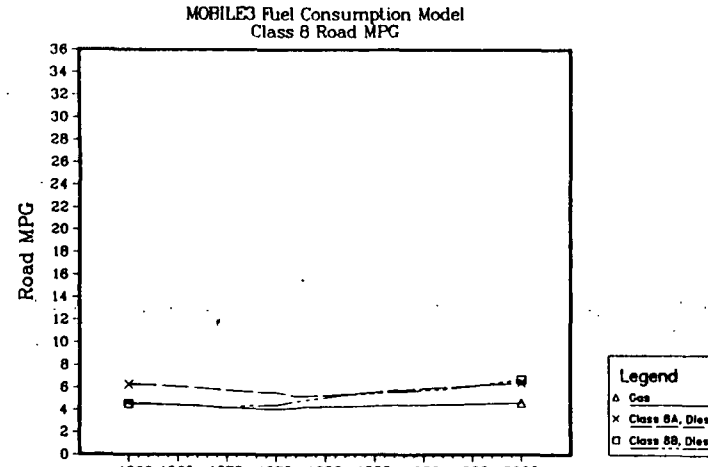

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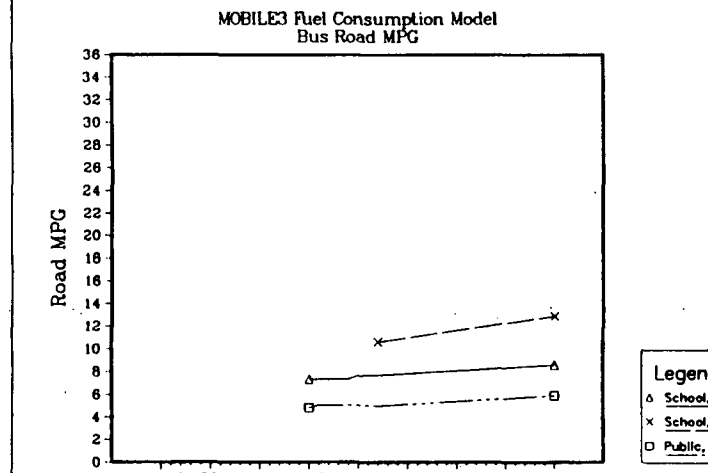

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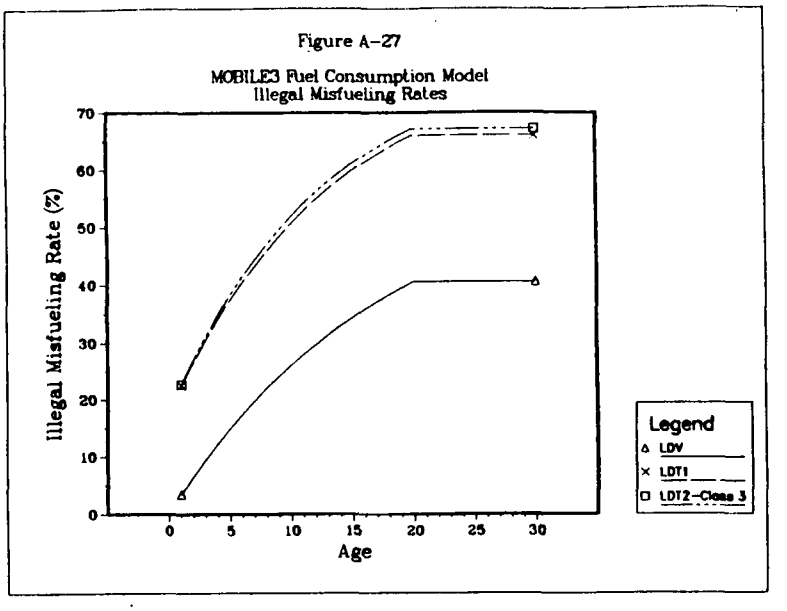

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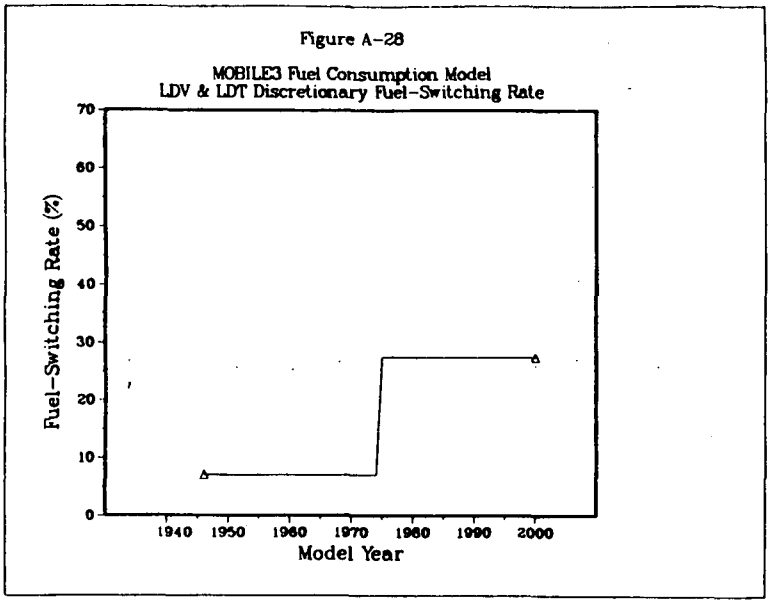


Figure A-29

MOBILE3 Fuel Consumption Model
LDV & LDT Urban VMT Fractions

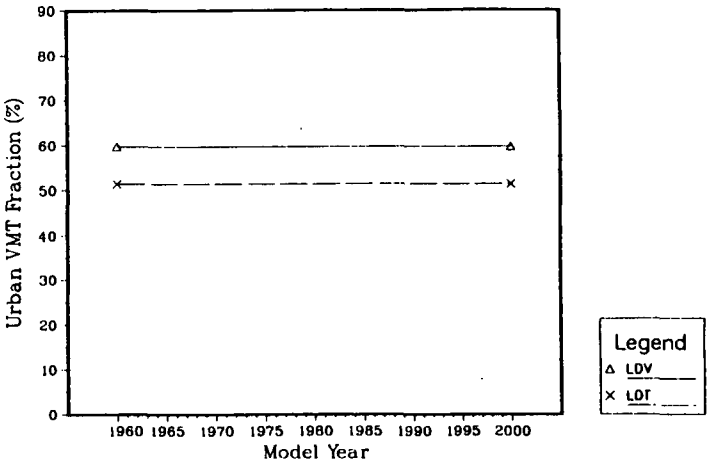


Figure A-30

MOBILE3 Fuel Consumption Model
Classes 2B-5 Urban VMT Fractions

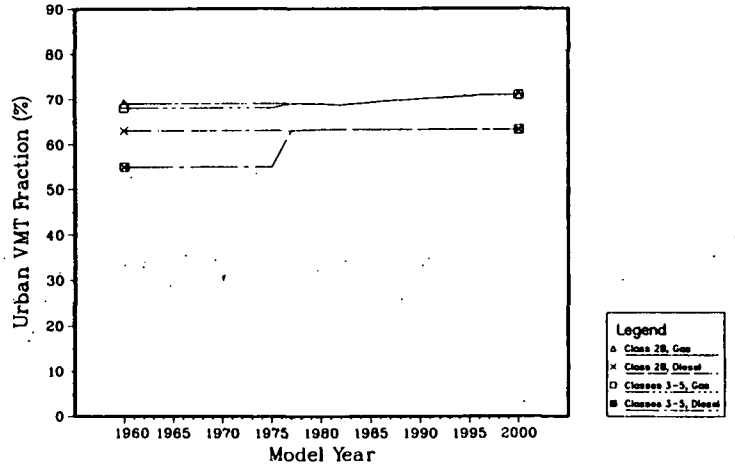


Figure A-31

MOBILE3 Fuel Consumption Model
Class 6 Urban VMT Fractions

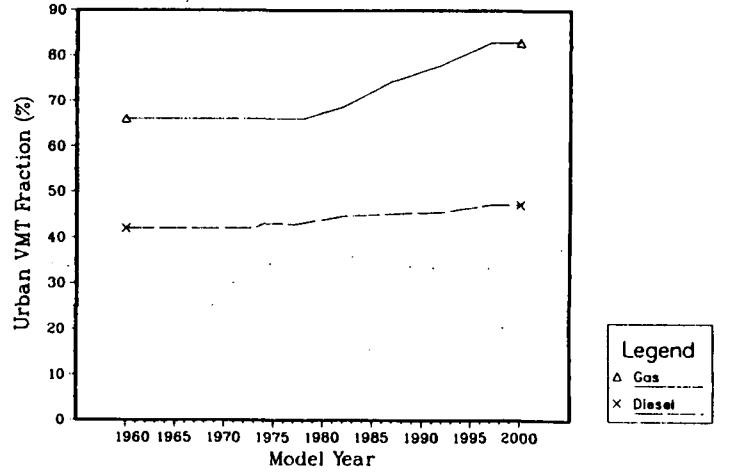


Figure A-32

MOBILE3 Fuel Consumption Model
Class 7 Urban VMT Fractions

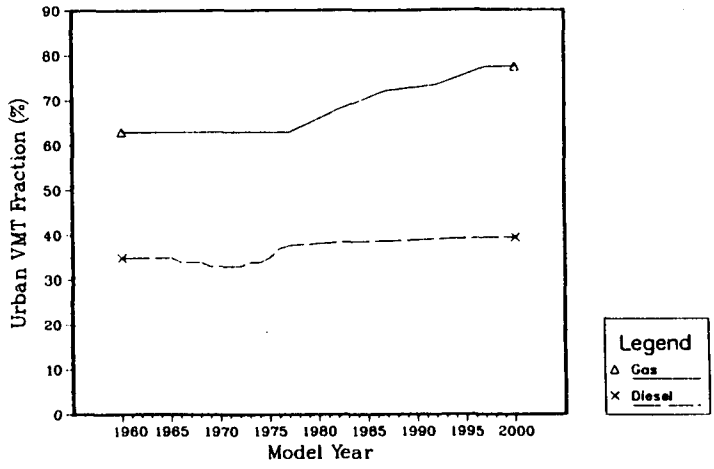


Figure A-33

MOBILE3 Fuel Consumption Model
Class 8 Urban VMT Fractions

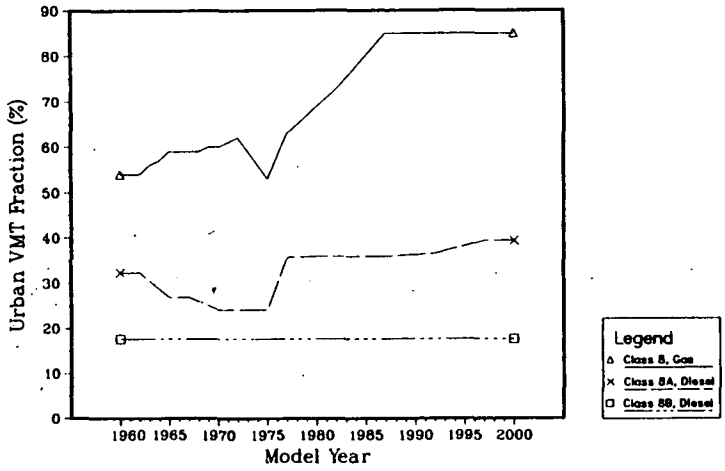
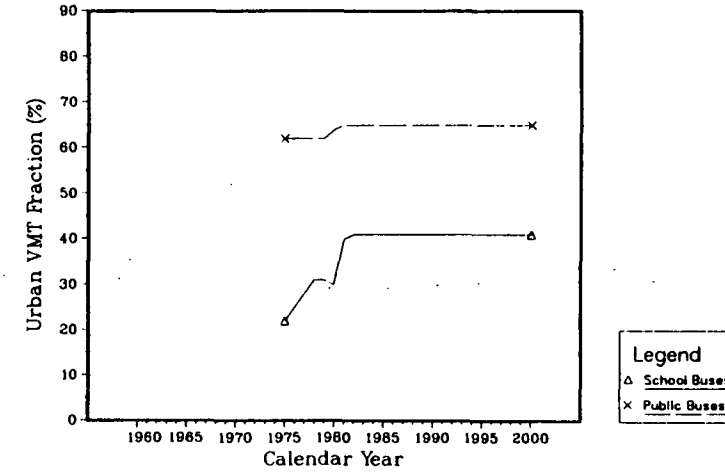


Figure A-34

MOBILE3 Fuel Consumption Model
Bus Urban VMT Fractions



Appendix B

Model Input

Tables

Table B-1

Historical and Predicted Vehicle Stock
(millions of vehicles)

Year	Polk Cars	FHwA Cars	M3-FC Cars	Polk Trucks	FHwA Trucks	M3-FC Trucks
1950				7.567		7.567
1951				8.065		8.065
1952	39.772		39.772	8.420		8.420
1953	42.203		42.203	8.693		8.693
1954	44.384		44.384	8.800		8.800
1955	47.380		47.380	9.162		9.162
1956	49.802		49.802	9.544		9.544
1957	51.434		51.434	9.776		9.776
1958	52.495		52.495	10.056		10.056
1959	55.085		55.085	10.532		10.532
1960	57.103		57.103	10.803		10.803
1961	58.854		58.854	11.043		11.043
1962	60.920		60.920	11.464		11.464
1963	63.384		63.384	11.899		11.899
1964	66.051		66.051	12.445		12.445
1965	68.940		68.940	13.127		13.127
1966	71.264		71.264	14.357		14.357
1967	72.968	80.414000	72.968	14.988	16.530900	14.988
1968	75.358	83.693000	75.358	15.685	17.346800	15.685
1969	78.495	86.861000	78.495	16.586	18.235300	16.586
1970	80.449	89.280000	80.449	17.686	19.127000	17.686
1971	83.138	92.799000	83.138	18.465	20.199600	18.465
1972	86.439	96.860000	86.439	19.773	21.646000	19.773
1973	89.805	101.762000	89.805	21.412	23.233000	21.412
1974	92.608	104.856300	92.608	23.312	25.077200	23.312
1975	95.241	106.712600	95.241	24.813	26.237800	24.813
1976	97.818	110.188640	97.818	26.560	28.257220	26.560
1977	99.904	113.696111	99.904	28.222	30.054159	28.222
1978	102.957	116.574999	102.957	30.565	32.202966	30.565
1979	104.677	120.247990	104.677	32.583	33.870109	32.583
1980	104.564	121.723650	104.564	35.268	34.166042	35.268
1981	105.839	123.291411	105.839	36.069	34.995004	36.069
1982	106.867	123.697863	106.867	36.987	35.811962	36.987
1983	108.961		108.961	38.143		38.143
1984			111.310			39.065
1985			113.660			39.986
1986			116.009			40.908
1987			118.358			41.829
1988			120.708			42.751
1989			123.057			43.673
1990			125.406			44.594
1991			127.755			45.516
1992			130.105			46.437
1993			132.454			47.359
1994			134.803			48.281
1995			137.153			49.202
1996			139.502			50.124
1997			141.851			51.046
1998			144.201			51.967
1999			146.550			52.889
2000			148.899			53.810

Table B-2

Vehicle Stock
(millions of vehicles)

Year	LDV	LDT1	LDT2	Class 2B	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8A	Class 8B	School Buses	Public Buses
1975	95.241	14.631	5.120	0.574	0.437	0.331	0.594	1.058	0.426	0.465	0.715	0.368	0.094
1976	97.818	15.216	6.155	0.651	0.435	0.310	0.562	1.126	0.425	0.447	0.755	0.381	0.097
1977	99.904	15.378	7.338	0.887	0.427	0.291	0.527	1.196	0.426	0.433	0.827	0.394	0.098
1978	102.957	15.617	9.016	1.123	0.477	0.281	0.496	1.272	0.444	0.425	0.913	0.399	0.102
1979	104.677	16.145	10.105	1.349	0.474	0.271	0.473	1.340	0.478	0.422	1.006	0.415	0.105
1980	104.564	17.392	10.967	1.663	0.486	0.272	0.475	1.408	0.544	0.438	1.134	0.382	0.107
1981	105.839	17.766	11.111	1.866	0.479	0.259	0.453	1.394	0.585	0.429	1.183	0.437	0.107
1982	106.867	18.287	11.288	2.099	0.479	0.247	0.432	1.367	0.615	0.416	1.198	0.446	0.113
1983	108.961	19.027	11.502	2.343	0.459	0.237	0.414	1.339	0.639	0.404	1.205	0.458	0.116
1984	111.309	19.750	11.524	2.605	0.427	0.220	0.385	1.285	0.680	0.384	1.214	0.471	0.119
1985	113.656	20.578	11.429	2.846	0.395	0.204	0.356	1.232	0.737	0.366	1.235	0.484	0.123
1986	116.008	21.497	11.237	3.065	0.366	0.189	0.330	1.181	0.803	0.350	1.265	0.498	0.126
1987	118.355	22.525	10.947	3.264	0.339	0.175	0.306	1.126	0.875	0.335	1.297	0.512	0.129
1988	120.707	23.530	10.681	3.462	0.314	0.162	0.283	1.074	0.939	0.321	1.327	0.526	0.132
1989	123.055	24.502	10.453	3.651	0.291	0.150	0.262	1.026	0.996	0.309	1.356	0.541	0.136
1990	125.406	25.444	10.258	3.834	0.270	0.139	0.243	0.983	1.046	0.298	1.384	0.556	0.139
1991	127.754	26.361	10.092	4.010	0.251	0.129	0.226	0.942	1.091	0.289	1.411	0.571	0.143
1992	130.101	27.250	9.950	4.178	0.234	0.120	0.211	0.906	1.134	0.281	1.440	0.587	0.147
1993	132.453	28.114	9.830	4.344	0.218	0.112	0.196	0.873	1.175	0.274	1.469	0.604	0.150
1994	134.801	28.958	9.730	4.501	0.203	0.105	0.183	0.845	1.215	0.267	1.499	0.621	0.154
1995	137.152	29.782	9.647	4.654	0.189	0.098	0.171	0.819	1.253	0.262	1.531	0.638	0.158
1996	139.500	30.584	9.585	4.802	0.177	0.091	0.160	0.796	1.290	0.257	1.562	0.656	0.163
1997	141.851	31.368	9.541	4.945	0.166	0.086	0.150	0.777	1.325	0.253	1.593	0.674	0.167
1998	144.199	32.135	9.513	5.084	0.156	0.081	0.141	0.761	1.359	0.249	1.624	0.693	0.171
1999	146.546	32.888	9.497	5.219	0.147	0.076	0.133	0.746	1.392	0.246	1.655	0.713	0.176
2000	148.898	33.628	9.493	5.352	0.139	0.072	0.125	0.733	1.425	0.244	1.686	0.733	0.180
2001	151.246	34.359	9.499	5.482	0.131	0.068	0.118	0.722	1.457	0.242	1.716	0.753	0.185
2002	153.598	35.079	9.514	5.609	0.124	0.064	0.112	0.712	1.489	0.240	1.747	0.774	0.190
2003	155.946	35.789	9.537	5.734	0.117	0.061	0.106	0.703	1.520	0.239	1.777	0.796	0.195
2004	158.293	36.493	9.567	5.858	0.111	0.057	0.100	0.696	1.551	0.238	1.807	0.818	0.200
2005	160.645	37.190	9.604	5.980	0.105	0.054	0.095	0.689	1.581	0.237	1.837	0.841	0.205
2006	162.992	37.879	9.646	6.100	0.100	0.052	0.090	0.683	1.612	0.236	1.867	0.865	0.210
2007	165.344	38.561	9.693	6.219	0.095	0.049	0.086	0.679	1.641	0.236	1.897	0.889	0.216
2008	167.691	39.239	9.745	6.336	0.090	0.047	0.082	0.674	1.671	0.236	1.927	0.914	0.221
2009	170.043	39.914	9.801	6.453	0.086	0.044	0.078	0.671	1.700	0.235	1.956	0.939	0.227
2010	172.390	40.581	9.861	6.568	0.082	0.042	0.074	0.668	1.730	0.236	1.986	0.966	0.233
2011	174.738	41.245	9.925	6.682	0.078	0.040	0.070	0.666	1.758	0.236	2.015	0.993	0.239
2012	177.090	41.906	9.992	6.795	0.074	0.038	0.067	0.664	1.787	0.236	2.045	1.021	0.245
2013	179.437	42.561	10.062	6.907	0.071	0.037	0.064	0.662	1.816	0.237	2.074	1.049	0.251
2014	181.790	43.213	10.134	7.019	0.068	0.035	0.061	0.661	1.844	0.237	2.103	1.079	0.258
2015	184.137	43.862	10.210	7.129	0.064	0.033	0.058	0.661	1.872	0.238	2.133	1.109	0.265
2016	186.489	44.507	10.287	7.239	0.062	0.032	0.055	0.661	1.900	0.239	2.162	1.140	0.272
2017	188.836	45.149	10.367	7.348	0.059	0.030	0.053	0.661	1.928	0.240	2.191	1.172	0.279
2018	191.184	45.788	10.449	7.457	0.056	0.029	0.051	0.661	1.956	0.241	2.220	1.205	0.286
2019	193.536	46.426	10.533	7.565	0.054	0.028	0.048	0.662	1.983	0.242	2.249	1.238	0.293
2020	195.883	47.061	10.618	7.672	0.051	0.026	0.046	0.663	2.011	0.243	2.278	1.273	0.301

Table B-3

Registration Distributions

Age	LDV	LDT	Classes 2B-3		Classes 4-6		Classes 7-8B	
			Gas	Diesel	Gas	Diesel	Gas	Diesel
1	0.104	0.087	0.087	0.087	0.147	0.147	0.167	0.167
2	0.098	0.083	0.083	0.083	0.126	0.126	0.139	0.139
3	0.093	0.079	0.079	0.079	0.107	0.107	0.116	0.116
4	0.087	0.075	0.075	0.075	0.092	0.092	0.097	0.097
5	0.081	0.071	0.071	0.071	0.078	0.078	0.081	0.081
6	0.075	0.067	0.067	0.067	0.067	0.067	0.067	0.067
7	0.069	0.063	0.063	0.063	0.057	0.057	0.056	0.056
8	0.063	0.059	0.059	0.059	0.049	0.049	0.047	0.047
9	0.058	0.055	0.055	0.055	0.042	0.042	0.039	0.039
10	0.052	0.051	0.051	0.051	0.036	0.036	0.032	0.032
11	0.046	0.047	0.047	0.047	0.030	0.030	0.027	0.027
12	0.040	0.043	0.043	0.043	0.026	0.026	0.023	0.023
13	0.034	0.040	0.040	0.040	0.022	0.022	0.019	0.019
14	0.028	0.036	0.036	0.036	0.019	0.019	0.016	0.016
15	0.022	0.032	0.032	0.032	0.016	0.016	0.013	0.013
16	0.017	0.028	0.028	0.028	0.014	0.014	0.011	0.011
17	0.011	0.024	0.024	0.024	0.012	0.012	0.009	0.009
18	0.008	0.020	0.020	0.020	0.010	0.010	0.008	0.008
19	0.006	0.016	0.016	0.016	0.009	0.009	0.006	0.006
20	0.004	0.012	0.012	0.012	0.007	0.007	0.005	0.005
21	0.003	0.008	0.008	0.008	0.006	0.006	0.004	0.004
22	0.001	0.004	0.004	0.004	0.005	0.005	0.004	0.004
23	0.0	0.0	0.0	0.0	0.005	0.005	0.003	0.003
24	0.0	0.0	0.0	0.0	0.004	0.004	0.003	0.003
25	0.0	0.0	0.0	0.0	0.003	0.003	0.002	0.002
26	0.0	0.0	0.0	0.0	0.003	0.003	0.002	0.002
27	0.0	0.0	0.0	0.0	0.002	0.002	0.001	0.001
28	0.0	0.0	0.0	0.0	0.002	0.002	0.001	0.001
29	0.0	0.0	0.0	0.0	0.002	0.002	0.001	0.001
30	0.0	0.0	0.0	0.0	0.002	0.002	0.001	0.001

Table B-4

VMT Distributions
(thousands of miles/year)

	LDV		LDT1		LDT2-Class 3		Classes 4-6		Class 7		Class 8A		Class 8B	
Age	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel
1	12.818	12.818	17.394	17.552	18.352	17.552	19.967	19.967	19.967	49.249	19.967	49.112	19.967	86.259
2	12.102	12.102	16.132	16.262	16.946	16.262	18.077	18.077	18.077	43.238	18.077	44.022	18.077	78.005
3	11.427	11.427	14.961	15.068	15.648	15.068	16.365	16.365	16.365	37.953	16.365	39.470	16.365	70.519
4	10.789	10.789	13.876	13.961	14.449	13.961	14.815	14.815	14.815	33.315	14.815	35.388	14.815	63.751
5	10.187	10.187	12.869	12.936	13.342	12.936	13.413	13.413	13.413	29.243	13.413	31.729	13.413	57.633
6	9.619	9.619	11.935	11.986	12.320	11.986	12.143	12.143	12.143	25.669	12.143	28.448	12.143	52.102
7	9.082	9.082	11.069	11.105	11.376	11.105	10.993	10.993	10.993	22.532	10.993	25.507	10.993	47.101
8	8.575	8.575	10.266	10.290	10.504	10.290	9.952	9.952	9.952	19.778	9.952	22.869	9.952	42.581
9	8.096	8.096	9.521	9.534	9.700	9.534	9.010	9.010	9.010	17.361	9.010	20.505	9.010	38.494
10	7.645	7.645	8.830	8.833	8.956	8.833	8.156	8.156	8.156	15.239	8.156	18.384	8.156	34.800
11	7.218	7.218	8.189	8.185	8.270	8.185	7.384	7.384	7.384	13.376	7.384	16.483	7.384	31.460
12	6.815	6.815	7.595	7.583	7.637	7.583	6.685	6.685	6.685	11.741	6.685	14.779	6.685	28.441
13	6.435	6.435	7.044	7.026	7.052	7.026	6.052	6.052	6.052	10.306	6.052	13.251	6.052	25.711
14	6.076	6.076	6.533	6.510	6.511	6.510	5.479	5.479	5.479	9.047	5.479	11.881	5.479	23.244
15	5.737	5.737	6.059	6.032	6.012	6.032	4.960	4.960	4.960	7.941	4.960	10.652	4.960	21.013
16	5.416	5.416	5.619	5.589	5.552	5.589	4.490	4.490	4.490	6.969	4.490	9.551	4.490	18.996
17	5.114	5.114	5.211	5.179	5.126	5.179	4.065	4.065	4.065	6.117	4.065	8.565	4.065	17.173
18	4.829	4.829	4.833	4.798	4.734	4.798	3.680	3.680	3.680	5.370	3.680	7.679	3.680	15.525
19	4.559	4.559	4.483	4.446	4.371	4.446	3.332	3.332	3.332	4.713	3.332	6.885	3.332	14.032
20	4.305	4.305	4.157	4.119	4.036	4.119	3.016	3.016	3.016	4.137	3.016	6.173	3.016	12.685
21	4.305	4.305	4.157	4.119	4.036	4.119	3.016	3.016	3.016	4.137	3.016	6.173	3.016	12.685
22	4.305	4.305	4.157	4.119	4.036	4.119	3.016	3.016	3.016	4.137	3.016	6.173	3.016	12.685
23	4.305	4.305	4.157	4.119	4.036	4.119	3.016	3.016	3.016	4.137	3.016	6.173	3.016	12.685
24	4.305	4.305	4.157	4.119	4.036	4.119	3.016	3.016	3.016	4.137	3.016	6.173	3.016	12.685
25	4.305	4.305	4.157	4.119	4.036	4.119	3.016	3.016	3.016	4.137	3.016	6.173	3.016	12.685
26	4.305	4.305	4.157	4.119	4.036	4.119	3.016	3.016	3.016	4.137	3.016	6.173	3.016	12.685
27	4.305	4.305	4.157	4.119	4.036	4.119	3.016	3.016	3.016	4.137	3.016	6.173	3.016	12.685
28	4.305	4.305	4.157	4.119	4.036	4.119	3.016	3.016	3.016	4.137	3.016	6.173	3.016	12.685
29	4.305	4.305	4.157	4.119	4.036	4.119	3.016	3.016	3.016	4.137	3.016	6.173	3.016	12.685
30	4.305	4.305	4.157	4.119	4.036	4.119	3.016	3.016	3.016	4.137	3.016	6.173	3.016	12.685

Table B-5

Diesel Penetration Rates

Year	LDV	LDT	Class 2B	Classes 3-5	Class 6	Class 7	Class 8A	Class 8B	School Buses	Public Buses
1960-	0.000	0.000	0.000	0.010	0.021	0.426	0.609	0.547	-----	-----
1961	0.000	0.000	0.000	0.010	0.021	0.426	0.609	0.547	-----	-----
1962	0.000	0.000	0.000	0.014	0.042	0.426	0.609	0.547	-----	-----
1963	0.000	0.000	0.001	0.018	0.063	0.436	0.616	0.595	-----	-----
1964	0.000	0.000	0.001	0.022	0.084	0.442	0.624	0.642	-----	-----
1965	0.000	0.000	0.002	0.026	0.105	0.447	0.632	0.690	-----	-----
1966	0.000	0.000	0.003	0.029	0.100	0.413	0.583	0.721	-----	-----
1967	0.000	0.000	0.003	0.031	0.094	0.379	0.535	0.751	-----	-----
1968	0.000	0.000	0.002	0.022	0.088	0.364	0.514	0.809	-----	-----
1969	0.000	0.000	0.002	0.012	0.082	0.348	0.492	0.867	-----	-----
1970	0.000	0.000	0.001	0.003	0.076	0.333	0.470	0.925	-----	-----
1971	0.001	0.000	0.000	0.003	0.054	0.341	0.482	0.923	-----	-----
1972	0.002	0.000	0.000	0.003	0.031	0.348	0.492	0.921	-----	-----
1973	0.002	0.000	0.000	0.004	0.034	0.382	0.540	0.921	-----	-----
1974	0.003	0.000	0.000	0.004	0.038	0.415	0.586	0.920	-----	-----
1975	0.003	0.001	0.000	0.005	0.041	0.449	0.634	0.920	0.000	1.000
1976	0.003	0.001	0.000	0.003	0.071	0.514	0.726	0.960	0.000	1.000
1977	0.003	0.001	0.000	0.000	0.100	0.578	0.770	1.000	0.000	1.000
1978	0.009	0.006	0.000	0.000	0.106	0.615	0.794	1.000	0.000	1.000
1979	0.026	0.013	0.041	0.041	0.174	0.606	0.818	1.000	0.000	1.000
1980	0.045	0.024	0.081	0.081	0.242	0.598	0.841	1.000	0.000	1.000
1981	0.060	0.056	0.122	0.122	0.309	0.589	0.865	1.000	0.000	1.000
1982	0.039	0.071	0.162	0.162	0.377	0.580	0.889	1.000	0.023	1.000
1983	0.019	0.077	0.180	0.180	0.388	0.584	0.886	1.000	0.043	1.000
1984	0.023	0.080	0.197	0.197	0.398	0.588	0.883	1.000	0.067	1.000
1985	0.028	0.090	0.215	0.215	0.409	0.592	0.881	1.000	0.089	1.000
1986	0.032	0.100	0.232	0.232	0.419	0.596	0.878	1.000	0.108	1.000
1987	0.037	0.110	0.250	0.250	0.430	0.600	0.875	1.000	0.127	1.000
1988	0.041	0.120	0.260	0.260	0.444	0.610	0.888	1.000	0.144	1.000
1989	0.046	0.130	0.270	0.270	0.458	0.620	0.901	1.000	0.160	1.000
1990	0.050	0.150	0.280	0.280	0.472	0.630	0.915	1.000	0.175	1.000
1991	0.063	0.188	0.290	0.290	0.486	0.640	0.928	1.000	0.189	1.000
1992	0.076	0.226	0.300	0.300	0.500	0.650	0.941	1.000	0.203	1.000
1993	0.089	0.263	0.300	0.300	0.510	0.660	0.953	1.000	0.215	1.000
1994	0.102	0.300	0.300	0.300	0.520	0.670	0.965	1.000	0.226	1.000
1995	0.115	0.339	0.300	0.300	0.530	0.680	0.976	1.000	0.236	1.000
1996	0.115	0.339	0.300	0.300	0.540	0.690	0.988	1.000	0.244	1.000
1997	0.115	0.339	0.300	0.300	0.550	0.700	1.000	1.000	0.252	1.000
1998	0.115	0.339	0.300	0.300	0.550	0.700	1.000	1.000	0.259	1.000
1999	0.115	0.339	0.300	0.300	0.550	0.700	1.000	1.000	0.265	1.000
2000+	0.115	0.339	0.300	0.300	0.550	0.700	1.000	1.000	0.270	1.000

Table B-6

Leaded Fuel Penetration Rates

Year	LDV	LDT1	LDT2	Classes 2B-3	Classes 4-8B	School Buses	Public Buses
1960-	1.000	1.000	1.000	1.000	1.000	-----	-----
1961	1.000	1.000	1.000	1.000	1.000	-----	-----
1962	1.000	1.000	1.000	1.000	1.000	-----	-----
1963	1.000	1.000	1.000	1.000	1.000	-----	-----
1964	1.000	1.000	1.000	1.000	1.000	-----	-----
1965	1.000	1.000	1.000	1.000	1.000	-----	-----
1966	1.000	1.000	1.000	1.000	1.000	-----	-----
1967	1.000	1.000	1.000	1.000	1.000	-----	-----
1968	1.000	1.000	1.000	1.000	1.000	-----	-----
1969	1.000	1.000	1.000	1.000	1.000	-----	-----
1970	1.000	1.000	1.000	1.000	1.000	-----	-----
1971	1.000	1.000	1.000	1.000	1.000	-----	-----
1972	1.000	1.000	1.000	1.000	1.000	-----	-----
1973	1.000	1.000	1.000	1.000	1.000	-----	-----
1974	1.000	1.000	1.000	1.000	1.000	-----	-----
1975	0.097	0.076	1.000	1.000	1.000	1.000	1.000
1976	0.119	0.063	1.000	1.000	1.000	1.000	1.000
1977	0.119	0.014	1.000	1.000	1.000	1.000	1.000
1978	0.100	0.010	1.000	1.000	1.000	1.000	1.000
1979	0.069	0.011	0.000	1.000	1.000	1.000	1.000
1980	0.000	0.007	0.000	1.000	1.000	1.000	1.000
1981	0.000	0.011	0.000	1.000	1.000	1.000	1.000
1982	0.000	0.014	0.000	1.000	1.000	1.000	1.000
1983	0.000	0.017	0.000	1.000	1.000	1.000	1.000
1984	0.000	0.000	0.000	1.000	1.000	1.000	1.000
1985	0.000	0.000	0.000	1.000	1.000	1.000	1.000
1986	0.000	0.000	0.000	1.000	1.000	1.000	1.000
1987	0.000	0.000	0.000	0.000	1.000	1.000	1.000
1988	0.000	0.000	0.000	0.000	1.000	1.000	1.000
1989	0.000	0.000	0.000	0.000	1.000	1.000	1.000
1990	0.000	0.000	0.000	0.000	1.000	1.000	1.000
1991	0.000	0.000	0.000	0.000	1.000	1.000	1.000
1992	0.000	0.000	0.000	0.000	1.000	1.000	1.000
1993	0.000	0.000	0.000	0.000	1.000	1.000	1.000
1994	0.000	0.000	0.000	0.000	1.000	1.000	1.000
1995	0.000	0.000	0.000	0.000	1.000	1.000	1.000
1996	0.000	0.000	0.000	0.000	1.000	1.000	1.000
1997	0.000	0.000	0.000	0.000	1.000	1.000	1.000
1998	0.000	0.000	0.000	0.000	1.000	1.000	1.000
1999	0.000	0.000	0.000	0.000	1.000	1.000	1.000
2000+	0.000	0.000	0.000	0.000	1.000	1.000	1.000

Table B-7

Road MPG and Diesel Advantage Factors

Year	LDV Fleet	Diesel Factor	LDT Fleet	Diesel Factor	Class 2B		Classes 3-5		Class 6		Class 7		Class 8A		Class 8B		School Buses		Public Buses	
					Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel
1960-	12.80	1.73	11.20	1.42	10.12	13.12	7.60	8.11	6.37	8.25	5.62	6.60	4.57	6.26	4.57	4.51	----	----	----	----
1961	12.80	1.73	11.20	1.42	10.12	13.12	7.60	8.11	6.37	8.25	5.62	6.60	4.57	6.26	4.57	4.51	----	----	----	----
1962	12.80	1.73	11.20	1.42	10.12	13.12	7.60	8.11	6.37	8.25	5.62	6.60	4.57	6.26	4.57	4.51	----	----	----	----
1963	12.80	1.73	11.20	1.42	10.12	13.12	7.54	8.11	6.29	8.25	5.58	6.60	4.52	6.20	4.52	4.49	----	----	----	----
1964	12.80	1.73	11.20	1.42	10.12	13.12	7.48	8.11	6.21	8.25	5.54	6.60	4.48	6.13	4.48	4.46	----	----	----	----
1965	12.80	1.73	11.20	1.42	10.12	13.12	7.42	8.11	6.13	8.25	5.50	6.60	4.43	6.07	4.43	4.44	----	----	----	----
1966	12.80	1.73	11.20	1.42	10.12	13.12	7.39	8.11	6.04	8.25	5.44	6.60	4.39	6.02	4.39	4.41	----	----	----	----
1967	12.80	1.73	11.20	1.42	10.12	13.12	7.36	8.11	5.95	8.25	5.37	6.60	4.35	5.96	4.35	4.38	----	----	----	----
1968	12.60	1.73	11.00	1.42	10.12	13.12	7.31	8.11	5.88	8.25	5.32	6.60	4.30	5.89	4.30	4.30	----	----	----	----
1969	12.70	1.73	11.10	1.42	10.12	13.12	7.27	8.11	5.82	8.25	5.28	6.60	4.25	5.82	4.25	4.22	----	----	----	----
1970	12.70	1.73	11.10	1.42	10.12	13.12	7.22	8.11	5.75	8.25	5.23	6.60	4.20	5.75	4.20	4.14	----	----	----	----
1971	12.30	1.73	10.70	1.42	10.12	13.12	7.16	8.11	5.68	8.25	5.19	6.60	4.15	5.68	4.15	4.25	----	----	----	----
1972	12.40	1.73	10.80	1.42	10.12	13.12	7.11	8.11	5.60	8.25	5.15	6.60	4.10	5.61	4.10	4.36	----	----	----	----
1973	12.20	1.73	10.60	1.42	10.12	13.12	7.21	8.11	5.57	8.25	5.12	6.63	4.09	5.59	4.09	4.37	----	----	----	----
1974	12.20	1.73	10.60	1.42	10.12	13.12	7.30	8.11	5.53	8.25	5.08	6.67	4.07	5.56	4.07	4.39	----	----	----	----
1975	13.50	1.73	11.90	1.42	10.12	13.12	7.40	8.11	5.50	8.25	5.05	6.70	4.05	5.54	4.05	4.40	7.31	----	----	4.79
1976	14.90	1.62	12.30	1.42	10.12	13.12	7.52	8.11	5.58	8.25	5.08	6.82	4.10	5.37	4.10	4.57	7.34	----	----	5.05
1977	15.60	1.51	13.30	1.42	10.12	13.12	7.63	8.11	5.60	8.40	5.10	6.93	4.15	5.20	4.15	4.74	7.35	----	----	5.04
1978	17.00	1.42	13.00	1.42	10.23	13.23	7.71	8.18	5.64	8.46	5.15	7.15	4.25	5.24	4.25	4.86	7.35	----	----	5.02
1979	17.30	1.35	12.60	1.40	10.34	13.34	7.79	8.24	5.68	8.52	5.18	7.15	4.26	5.27	4.26	4.98	7.36	----	----	5.06
1980	20.10	1.26	15.90	1.38	10.45	13.44	7.88	8.31	5.72	8.58	5.22	7.16	4.27	5.31	4.27	5.09	7.64	----	----	5.03
1981	21.50	1.23	17.20	1.36	10.55	13.55	7.96	8.38	5.75	8.64	5.25	7.17	4.28	5.34	4.28	5.21	7.65	----	----	4.98
1982	22.30	1.22	17.50	1.34	10.66	13.66	8.04	8.44	5.79	8.70	5.28	7.17	4.28	5.38	4.28	5.33	7.68	10.62	----	4.96
1983	22.20	1.21	17.80	1.32	10.73	13.75	8.09	8.50	5.84	8.82	5.32	7.27	4.31	5.45	4.31	5.38	7.73	10.75	----	5.01
1984	22.70	1.20	17.90	1.30	10.80	13.84	8.14	8.55	5.89	8.95	5.36	7.38	4.33	5.53	4.33	5.44	7.78	10.87	----	5.06
1985	23.30	1.20	18.10	1.30	10.87	13.93	8.20	8.61	5.94	9.07	5.39	7.48	4.36	5.60	4.36	5.49	7.83	11.00	----	5.12
1986	23.80	1.20	18.30	1.30	10.94	14.01	8.25	8.66	5.98	9.20	5.43	7.59	4.38	5.68	4.38	5.55	7.88	11.13	----	5.17
1987	24.10	1.20	18.60	1.30	11.02	14.10	8.30	8.72	6.03	9.32	5.47	7.69	4.41	5.75	4.41	5.60	7.94	11.25	----	5.22
1988	24.50	1.20	18.80	1.30	11.09	14.29	8.36	8.84	6.05	9.40	5.49	7.76	4.43	5.80	4.43	5.65	7.99	11.38	----	5.27
1989	24.80	1.20	19.00	1.30	11.16	14.49	8.41	8.95	6.07	9.48	5.51	7.82	4.45	5.86	4.45	5.70	8.04	11.51	----	5.33
1990	25.20	1.20	19.30	1.30	11.23	14.68	8.47	9.07	6.09	9.56	5.53	7.89	4.46	5.91	4.46	5.76	8.09	11.63	----	5.38
1991	25.70	1.20	19.60	1.30	11.30	14.87	8.52	9.19	6.11	9.64	5.55	7.95	4.48	5.97	4.48	5.81	8.14	11.76	----	5.43
1992	26.20	1.20	19.90	1.30	11.38	15.06	8.58	9.31	6.13	9.72	5.57	8.02	4.50	6.02	4.50	5.86	8.19	11.89	----	5.48
1993	26.70	1.20	20.20	1.30	11.45	15.29	8.63	9.45	6.15	9.80	5.59	8.09	4.52	6.07	4.52	5.96	8.24	12.01	----	5.53
1994	27.10	1.20	20.40	1.30	11.53	15.52	8.69	9.60	6.17	9.88	5.61	8.15	4.53	6.12	4.53	6.07	8.29	12.14	----	5.59
1995	27.60	1.20	20.80	1.30	11.60	15.76	8.74	9.74	6.20	9.96	5.63	8.22	4.55	6.17	4.55	6.17	8.34	12.27	----	5.64
1996	28.10	1.20	21.20	1.30	11.68	15.99	8.80	9.88	6.22	10.04	5.65	8.28	4.56	6.22	4.56	6.28	8.40	12.39	----	5.69
1997	28.50	1.20	21.40	1.30	11.75	16.22	8.86	10.03	6.24	10.11	5.68	8.35	4.58	6.27	4.58	6.38	8.45	12.52	----	5.74
1998	28.90	1.20	21.80	1.30	11.83	16.45	8.92	10.17	6.26	10.19	5.70	8.42	4.60	6.32	4.60	6.48	8.50	12.65	----	5.80
1999	29.40	1.20	22.00	1.30	11.90	16.68	8.97	10.31	6.29	10.27	5.72	8.48	4.61	6.37	4.61	6.59	8.55	12.77	----	5.85
2000+	29.70	1.20	22.30	1.30	11.98	16.92	9.03	10.56	6.31	10.35	5.74	8.55	4.63	6.42	4.63	6.69	8.60	12.90	----	5.90

Table B-8

Urban VMT Fractions

			Class 2B		Classes 3-5		Class 6		Class 7		Class 8A		Class 8B		School Buses		Public Buses	
Year	LDV	LDT	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel
1975-	0.597	0.514	0.690	0.630	0.680	0.550	0.660	0.430	0.630	0.350	0.530	0.241	0.530	0.176	0.220	0.220	-----	0.620
1976	0.597	0.514	0.690	0.630	0.685	0.590	0.660	0.430	0.630	0.370	0.580	0.300	0.580	0.176	0.250	0.250	-----	0.620
1977	0.597	0.514	0.690	0.630	0.690	0.630	0.660	0.428	0.630	0.377	0.630	0.358	0.630	0.176	0.280	0.280	-----	0.620
1978	0.597	0.514	0.690	0.631	0.690	0.631	0.660	0.432	0.640	0.379	0.650	0.358	0.650	0.176	0.310	0.310	-----	0.620
1979	0.597	0.514	0.689	0.631	0.689	0.631	0.667	0.436	0.650	0.380	0.669	0.358	0.669	0.176	0.310	0.310	-----	0.620
1980	0.597	0.514	0.689	0.632	0.689	0.632	0.674	0.439	0.660	0.382	0.689	0.359	0.689	0.176	0.300	0.300	-----	0.640
1981	0.597	0.514	0.688	0.632	0.688	0.632	0.680	0.443	0.670	0.383	0.708	0.359	0.708	0.176	0.400	0.400	-----	0.650
1982	0.597	0.514	0.687	0.633	0.687	0.633	0.687	0.447	0.681	0.385	0.728	0.359	0.728	0.176	0.410	0.410	-----	0.650
1983	0.597	0.514	0.689	0.633	0.689	0.633	0.698	0.448	0.689	0.385	0.752	0.359	0.752	0.176	0.410	0.410	-----	0.650
1984	0.597	0.514	0.691	0.633	0.691	0.633	0.709	0.449	0.698	0.386	0.777	0.359	0.777	0.176	0.410	0.410	-----	0.650
1985	0.597	0.514	0.693	0.633	0.693	0.633	0.721	0.450	0.706	0.386	0.801	0.359	0.801	0.176	0.410	0.410	-----	0.650
1986	0.597	0.514	0.695	0.633	0.695	0.633	0.732	0.451	0.715	0.387	0.826	0.359	0.826	0.176	0.410	0.410	-----	0.650
1987	0.597	0.514	0.697	0.633	0.697	0.633	0.743	0.452	0.723	0.387	0.850	0.359	0.850	0.176	0.410	0.410	-----	0.650
1988	0.597	0.514	0.698	0.633	0.698	0.633	0.750	0.453	0.725	0.388	0.850	0.360	0.850	0.176	0.410	0.410	-----	0.650
1989	0.597	0.514	0.699	0.633	0.699	0.633	0.757	0.454	0.728	0.389	0.850	0.362	0.850	0.176	0.410	0.410	-----	0.650
1990	0.597	0.514	0.701	0.633	0.701	0.633	0.765	0.454	0.730	0.390	0.850	0.363	0.850	0.176	0.410	0.410	-----	0.650
1991	0.597	0.514	0.702	0.633	0.702	0.633	0.772	0.455	0.733	0.391	0.850	0.365	0.850	0.176	0.410	0.410	-----	0.650
1992	0.597	0.514	0.703	0.633	0.703	0.633	0.779	0.456	0.735	0.392	0.850	0.366	0.850	0.176	0.410	0.410	-----	0.650
1993	0.597	0.514	0.704	0.633	0.704	0.633	0.789	0.459	0.743	0.393	0.850	0.372	0.850	0.176	0.410	0.410	-----	0.650
1994	0.597	0.514	0.706	0.633	0.706	0.633	0.799	0.463	0.751	0.394	0.850	0.377	0.850	0.176	0.410	0.410	-----	0.650
1995	0.597	0.514	0.707	0.633	0.707	0.633	0.809	0.466	0.759	0.394	0.850	0.382	0.850	0.176	0.410	0.410	-----	0.650
1996	0.597	0.514	0.709	0.633	0.709	0.633	0.819	0.470	0.767	0.395	0.850	0.388	0.850	0.176	0.410	0.410	-----	0.650
1997	0.597	0.514	0.710	0.633	0.710	0.633	0.829	0.473	0.775	0.396	0.850	0.394	0.850	0.176	0.410	0.410	-----	0.650
1998	0.597	0.514	0.710	0.633	0.710	0.633	0.829	0.473	0.775	0.396	0.850	0.394	0.850	0.176	0.410	0.410	-----	0.650
1999	0.597	0.514	0.710	0.633	0.710	0.633	0.829	0.473	0.775	0.396	0.850	0.394	0.850	0.176	0.410	0.410	-----	0.650
2000+	0.597	0.514	0.710	0.633	0.710	0.633	0.829	0.473	0.775	0.396	0.850	0.394	0.850	0.176	0.410	0.410	-----	0.650