MASTER

LIGHT DUTY VEHICLE
FUEL CONSUMPTION MODEL
1975-1986

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Prepared By:
Energy and Environmental Analysis, Inc.
1111 North 19th Street
Arlington, Virginia 22209

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TABLE OF CONTENTS

	<u>Page</u>
SECTION I INTRODUCTION	1
SECTION II MODEL STRUCTURE	3
SECTION III METHODOLOGY	5
SECTION IV DATA SOURCES	8
A. Introduction	8
B. Historical Data	8
C. Future Data Assumptions	8
D. Fuel Type Methodology	11
E. Fuel Economy Adjustment Factor	11
SECTION V MODEL OPERATION	18
A. Accessing and Running the Program	18
B. Interactive Input	18
APPENDIX A	21
APPENDIX B	24

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SECTION I

INTRODUCTION

The This report summarizes the Light Duty Vehicle Fuel Consumption Model developed for the Office of Conservation and Advanced Energy Systems Policy in the Department of Energy. The purpose of the model is to estimate annual passenger auto (PA) and non-passenger auto (NPA)* fuel consumption through 1986. The model is intended to: 1) provide information on future estimated petroleum demand for the majority of the U.S. transportation sector, and 2) generate a better understanding of the trends in fuel consumption in light of fuel economy standards issued by the Department of Transportation (DOT) under the Energy Policy and Conservation Act of 1975 (EPCA). The model also is designed to provide disaggregated data for PA's and NPA's in order to analyze their relative importance in estimating total fuel consumption and to calculate the proportion of diesel, leaded, and unleaded fuels in total fleet consumption.

The Light Duty Vehicle Fuel Consumption Model is an accounting model which uses data for past and projected characteristics of the PA and NPA vehicle fleet to derive fuel consumption through a series of mathematical computations. The logic of the model does not rely on behavioral equations which would use econometrically derived parameters to determine future fuel consumption. The model is deterministic in that output changes can be accounted for directly by assumptions made for past or future data.

The following sections of this report provide a brief discussion of the model logic, documentation of data sources, and an example of the model's output. Section II reviews the basic

* NPA's are trucks and vans.

model structure. Section III explains the methodology and computer algorithm. The data sources are described in Section IV. Section V shows the interactive commands controlled by the user, and examples of the model output and its format are presented in Appendices A and B.

SECTION II

MODEL STRUCTURE

The light Duty Vehicle Model estimates annual fuel consumption for 1975 through 1986 by calculating two major parameters: annual vehicle miles of travel (VMT) and average on-road fleet fuel economy. The model inputs historical data and future estimates for the following variables to compute VMT and fleet mpg:

- The annual new vehicle registrations;
- The scrappage rate of new vehicles, which reflects their retirement over time;
- The annual VMT per vintage car year, which captures the effect of decreasing VMT per vehicle with age;
- The new vehicle average fuel economies as determined through the EPA test procedure; and
- An on-road mpg discount factor, which accounts for in-use driving conditions and reduces actual fuel economy below the EPA test value.

The model is designed so that data inputs can vary by vehicle categories. These categories are:

- Domestic passenger autos;
- Import passenger autos;
- Domestic nonpassenger autos, 0-6000 lb. GVW;
- Non-captive import nonpassenger autos, 0-6000 lb GVW; and
- Nonpassenger autos, 6-8500 lb GVW.

Since some vehicles operate for up to 25 years (as determined by the scrappage rate), data from 1953 to the present are required to project the size and composition of the vehicle fleet and compute the annual VMT, fleet fuel economy, and resulting level of fuel consumption for each year.

The model also computes the proportions of diesel fuel, leaded gasoline, and unleaded gasoline within total annual fuel consumption. This disaggregation assumes a new vehicle diesel penetration rate which varies by vehicle category and year. The leaded/unleaded breakout is obtained from data on the past and future ratio of gasoline engines using leaded fuel to total new gasoline engine registrations.

The model's output includes for each year and vehicle class:

- Average on-road new vehicle fuel economy;
- New vehicle registrations with:
 - Spark ignition engines, and
 - Diesel engines;
- Average on-road fleet fuel economy;
- Fleet vehicle registrations with:
 - Spark ignition engines, and
 - Diesel engines;
- Total VMT; and
- Fuel consumption disaggregated by:
 - Diesel fuel,
 - Leaded gasoline, and
 - Unleaded gasoline.

SECTION III

METHODOLOGY

This section briefly describes the sequence of calculations used to derive annual fleet fuel consumption estimates. These estimates are derived through mathematical computations involving:

- The age distribution of the vehicle fleet in a given year;
- The fuel economy characteristics of that fleet; and
- The travel characteristics of the in-use fleet, which vary by the age of the vehicles in the fleet.

The model's calculations of the total stock of vehicles must account for each year's new purchases in addition to resultant fleet turnover. The procedure used to derive the age distribution of the vehicle fleet:

- Takes new registrations for the 25 years preceding the year of the analysis; and
- Applies a scrappage rate which reflects past retirement patterns of new vehicles.

The scrappage rate is based on vehicle age data for a single historical period and does not take into account slight changes in fleet composition which may occur over time. Separate scrappage rates are utilized for passenger and nonpassenger autos.

The mpg performance of the stock is directly related to the fuel economy and age distribution of the vehicles in use. The

model uses fuel economy information for each vintage year to determine the average mpg for the individual categories in the fleet.

Travel characteristics of the fleet are directly related to the age distribution of vehicles and the VMT associated with the age of the vehicle. Travel characteristics are derived by:

- Taking annual VMT per vehicle which varies by age; and
- Applying it to the stock of in-use vehicles to produce total VMT for the fleet distributed age.

The data on decreasing VMT per vehicle with age differ for passenger autos and nonpassenger autos. These schedules are held constant through time.

The actual calculation procedure used to determine fleet VMT, mpg, and fuel consumption in any given year is described below:

$$TVMT_j = \sum_i \sum_k RG_{ij} \times SP_{kj} \times VMT_{kj} ,$$

where: $TVMT_j$ = total VMT per vehicle type j (one of the five categories of light duty vehicles);

RG_{ij} = registrations of vehicles in year i and vehicle type j;

SP_{kj} = scrappage (percent of new vehicle registrations left on the road) of age k and vehicle type j;

VMT_{kj} = vehicle miles traveled of age k and vehicle type j.

$$TFC_t = \sum_i \sum_k \sum_j RG_{ij} \times VMT_{kj} \times PCT_{ijt} / MPG_{ij} \times ADJ ,$$

where: TFC_t = total fuel consumed of type t (leaded, unleaded, diesel);

PCT_{ijt} = percentage of registrations of vehicles in year i and vehicle type j and fuel type t (leaded, unleaded, diesel);

MPG_{ij} = MPG of registrations of vehicles in year i and vehicle type j;

ADJ = an optional discount factor which adjusts the EPA MPG to an on-road MPG.

$$AMPG_j = TVMT_j / \sum_i \sum_k (RG_{ij} * VMT_{kj} / MPG_{ij})$$

where: $AMPG_j$ = average fleet MPG for vehicle type j.

The average fleet fuel economy is determined harmonically in order to calculate fuel consumption. The calculation is weighted by both the age distribution of vehicles on the road and their relative VMT. This weighting takes into account the fact that there are relatively fewer older vehicles on the road and that these older vehicles are driven relatively less than later model year vehicles.

SECTION IV

DATA SOURCES

A. Introduction

This section discusses the sources used to assemble the data inputs. In some cases historical data on light duty vehicles were incomplete. In these instances, certain assumptions were made to produce all necessary inputs. When possible, sources utilized were DOT support documents. The input data are shown in Tables IV-1 through IV-5 and are discussed below.

B. Historical Data

1. Registrations and Fuel Economy

Data for 1953 through 1975 were obtained from the Technology Assessment Division of DOT's National Highway Traffic and Safety Administration (NHTSA). These data represent preliminary results of NHTSA's analysis of historical registrations and fuel economy and may be revised.

2. VMT and Scrappage Rates

Passenger auto scrappage rates were derived from DOT's Transportation System Center analysis using its Highway Fuel Consumption Computer Model.^{1/} Nonpassenger auto scrappage rates and all VMT (e.g., age) data were obtained from NHTSA's Technology Assessment Division.

C. Future Data Assumptions

1. New Vehicle Registrations

a. Passenger Autos

New passenger car registrations were based on DOT data from the Wharton Auto Model. Total new car registrations were divided into domestic and imports using the Motor Vehicle Manufacturers Association's (MVMA) 1977 figure of 20 percent import sales. This percentage of imports then was phased down to 18 percent in 1978, 17 percent in 1979, and 16 percent thereafter. This constant percentage represents a conservative estimate which assumes domestic cars eventually will become more competitive with foreign models.

b. Nonpassenger Autos

Domestic (0-6000 lb.) new truck registrations for 1977-78 were projected by straight-line calculations between actual 1976 registrations from MVMA and 1981 registration estimates by NHTSA. This calculation assumes that 40 percent of new NPA's in 1981 will be in the 0-6000 lb. weight category. The 40 percent figure is based on the ratio of Class I registrations to total NPA registrations which existed in 1977. Import truck (0-6000 lb.) registrations were straight-lined from 1976 imports to 1981 imports as projected by NHTSA.^{2/} Registrations for 6-8500 lb. NPA's were estimated using the same method as used for 0-6000 lb. domestic NPA's. For 1982 through 1986, all categories of NPA new registrations increased three percent annually. This percentage is slightly less than one-half of the 7.2 percent NPA growth rate implicit in 1977-81 registration figures.

2. Fuel Economies

a. Passenger Autos

Domestic and import fuel economy figures for 1975 through 1978 were taken from an EPA paper on light duty fuel economy

trends.^{3/} Fuel economy projections for 1979 and 1980 were determined by straight-line projections between 1978 EPA test values and 1981 mpg estimates from DOT based on auto manufacturers' projections.^{4/} For 1982 through 1984, DOT fuel economy estimates also were used for domestic and imported PA's. A two percent annual growth rate was applied to the 1984 fuel economy estimate in order to produce 1985 and 1986 values.

b. Nonpassenger Autos

NPA fuel economy estimates for 0-6000 lb. GVW vehicles for 1976-78 were based on actual EPA fuel economy test ratings. For 1980 and 1981, DOT fuel economy standards promulgated under EPCA served as the basis for mpg estimates for the 0-6000 and 6-8500 lb. GVW categories.

Two steps were required to compute the NPA fuel economy estimates:

- The two and four wheel drive fuel economy standards were aggregated, using NHTSA^{5/} projection that four wheel drive vehicles represent 28 percent of NPA sales in 1980 and 1981.
- The 0-6000 lb. and 6-8500 lb. categories for domestic NPA's were computed with the assumptions that: 1) 60 percent of their registrations, based on 1977 data, are in the 0-6000 lb. category, and 2) the 1977 ratio between 0-6000 and 6-8500 lb. GVW fuel economies, as calculated by NHTSA, is 0.82.

Fuel economy estimates for both categories from 1982 through 1986 are assumed to increase four percent annually.

NPA import fuel economy data for 1976 through 1978 were obtained from EPA's report on light duty vehicle fuel economy

trends.^{6/} A two percent annual growth rate for 1979 through 1986 is used to reflect an expected slower rate of increase in fuel economy for imports than for domestic PA's.

D. Fuel Type Methodology

1. Unleaded Fuel Estimates

The annual penetration rate of new registrations in each vehicle category with spark ignition engines which consume unleaded fuel was computed from sales data for individual models. If the model was equipped with a catalytic converter, it was assumed that all new vehicle registrations for that model used unleaded fuel. The registration information on new vehicles for 1975 through 1979 was taken from Wards Automotive Yearbook. Unleaded fuel was not required in any vehicles before the 1975 model year. The annual unleaded penetration rate for 1980-86 was assumed to be equal to the 1979 penetration rate. This assumption takes into account the fact that many foreign technologies do not require unleaded fuel (e.g., CVCC), and their percentage share of the market will remain constant.

2. Diesel Fuel Estimates

Diesel fuel consumption figures were computed, assuming a 25 percent increase in fuel economy in diesel over the spark ignition engine. Penetration rates for diesel registrations were taken from articles in Automotive News Magazine and were approved for use in the model by DOE.

E. Fuel Economy Adjustment Factor

The fuel economy values used by DOT in the development of the fuel economy standards represent estimates of performance on the EPA certification test procedure. Performance

on the EPA test procedures, however, may not reflect actual performance under on-road conditions with production vehicles. A recent study^{7/} has quantified the difference between EPA and on-road fuel economy for automobiles for model years 1974 through 1977. The equations used to quantify this relationship are shown below for model years 1974 and 1976.

- 1974 on-road = $.65 \times \text{EPA mpg} + 4.38 \text{ mpg}$
- 1976 on-road = $.74 \times \text{EPA mpg} + 2.32 \text{ mpg}$

Appendix A is an example of a base case run using these discount factors. For reference, the fuel economies and fuel consumption for undiscounted values are shown in Appendix B.

TABLE IV-1

NEW VEHICLE REGISTRATIONS x 10⁶

<u>Year</u>	<u>Domestic Passenger Auto</u>	<u>Imported Passenger Auto</u>	<u>Domestic 0-6000 lb NPA</u>	<u>Imported 0-6000 lb NPA</u>	<u>Domestic 6-8500 lb NPA</u>
1953	5.71	.03	.44	--	.12
1954	5.50	.03	.41	--	.12
1955	7.11	.06	.50	--	.12
1956	5.86	.10	.49	--	.12
1957	5.78	.21	.45	--	.13
1958	4.28	.38	.38	--	.10
1959	5.42	.61	.50	.01	.13
1960	6.08	.50	.52	.01	.14
1961	5.48	.38	.54	--	.13
1962	6.60	.34	.62	--	.16
1963	7.17	.39	.74	--	.19
1964	7.59	.48	.84	.01	.21
1965	8.74	.57	.93	.01	.25
1966	8.35	.66	.95	.02	.27
1967	7.58	.78	.90	.02	.27
1968	8.42	1.00	1.05	.02	.37
1969	8.46	1.07	1.09	.03	.40
1970	7.22	1.24	.98	.07	.40
1971	8.46	1.50	1.13	.09	.44
1972	9.06	1.55	1.32	.15	.53
1973	9.74	1.74	1.60	.25	.71
1974	7.41	1.38	1.43	.19	.63
1975	6.70	1.50	.97	.24	.88
1976	8.40	1.45	1.30	.17	1.43
1977	9.00	2.25	1.32	.18	1.88
1978	9.50	2.09	1.43	.19	1.97
1979	9.53	1.95	1.54	.20	2.06
1980	9.79	1.86	1.65	.21	2.16
1981	10.69	2.04	1.78	.22	2.34
1982	10.47	1.99	1.83	.23	2.41
1983	10.23	1.96	1.89	.23	2.48
1984	10.36	1.97	1.94	.24	2.56
1985	10.38	1.98	2.00	.25	2.63
1986	10.24	1.95	2.06	.26	2.71

TABLE IV-2

FUEL ECONOMIES

<u>Year</u>	<u>Domestic Passenger Auto</u>	<u>Imported Passenger Auto</u>	<u>Domestic 0-6000 lb NPA</u>	<u>Imported 0-6000 lb NPA</u>	<u>Domestic 6-8500 lb NPA</u>
1953	16.0	37.0	14.7	18.0	11.3
1954	16.0	37.0	14.7	18.0	11.3
1955	16.0	37.0	14.7	18.0	11.3
1956	15.9	35.6	14.7	18.0	11.3
1957	15.8	34.3	14.7	18.0	11.3
1958	15.7	33.0	14.7	18.0	11.3
1959	15.6	31.7	14.7	18.0	11.3
1960	15.5	30.4	14.0	18.0	10.8
1961	15.4	30.7	14.0	18.0	10.8
1962	15.4	30.9	14.0	18.0	10.8
1963	15.4	31.3	14.0	18.0	10.8
1964	15.4	31.7	14.0	18.0	10.8
1965	15.4	32.1	14.0	18.0	10.8
1966	15.0	30.8	14.0	18.0	10.8
1967	14.6	29.6	13.3	18.0	10.2
1968	14.2	28.4	12.9	18.0	9.9
1969	14.1	27.9	12.9	18.0	9.9
1970	14.1	27.2	12.7	18.0	9.8
1971	13.7	24.0	12.4	18.0	9.5
1972	13.6	22.5	11.9	18.0	9.2
1973	13.3	22.6	11.2	18.0	8.6
1974	12.8	21.5	11.0	18.0	8.5
1975	14.9	24.5	13.1	21.0	10.8
1976	16.8	24.9	16.6	22.2	13.6
1977	17.7	27.3	18.2	24.2	14.9
1978	18.7	26.8	18.0	24.0	14.8
1979	20.2	28.8	18.4	24.5	15.1
1980	21.8	30.8	18.8	25.0	15.4
1981	23.3	32.9	19.7	25.5	16.1
1982	24.3	34.0	20.5	26.0	16.8
1983	26.3	35.1	21.3	26.5	17.5
1984	28.1	36.5	22.2	27.0	18.2
1985	28.6	37.0	23.0	27.5	18.9
1986	29.2	37.7	24.0	28.0	19.7

TABLE IV-3

VEHICLE MILES TRAVELED/AUTO $\times 10^3$

<u>Age in Years</u>	<u>Passenger Autos</u>	<u>Nonpassenger Autos</u>
1	16.2	14.2
2	13.5	14.8
3	12.2	13.9
4	12.0	12.2
5	11.3	11.1
6	10.5	9.9
7	12.4	9.3
8	9.9	8.8
9	10.0	8.0
10	7.0	7.6
11	7.0	7.3
12	6.0	6.9
13	6.7	6.0
14	6.7	6.0
15	5.9	5.3
16	5.9	5.0
17	5.9	5.7
18	3.3	5.1
19	3.3	4.6
20	3.3	4.2
21	--	4.0
22	--	3.7
23	--	3.2
24	--	2.5
25	--	2.0

TABLE IV-4

SCRAPPAGE RATE (% in Use)

<u>Age in Years</u>	<u>Passenger Autos</u>	<u>Nonpassenger Autos</u>
1	100.0	100.0
2	99.5	99.9
3	99.0	98.8
4	98.5	96.6
5	97.7	94.6
6	94.8	92.5
7	88.9	89.7
8	79.7	86.2
9	67.2	82.5
10	52.9	77.1
11	39.5	71.0
12	28.5	64.5
13	20.2	57.3
14	13.7	50.2
15	8.5	44.1
16	5.0	38.0
17	4.9	32.0
18	3.0	26.0
19	2.0	20.0
20	1.0	14.0
21	--	8.0
22	--	5.0
23	--	3.0
24	--	2.0
25	--	1.0

TABLE IV-5

PERCENT LEADED

<u>Year</u>	<u>Domestic Passenger Auto</u>	<u>Imported Passenger Auto</u>	<u>Domestic 0-6000 lb NPA</u>	<u>Imported 0-6000 lb NPA</u>	<u>Domestic 6-8500 lb NPA</u>
1953	100	100	100	100	100
1954	100	100	100	100	100
1955	100	100	100	100	100
1956	100	100	100	100	100
1957	100	100	100	100	100
1958	100	100	100	100	100
1959	100	100	100	100	100
1960	100	100	100	100	100
1961	100	100	100	100	100
1962	100	100	100	100	100
1963	100	100	100	100	100
1964	100	100	100	100	100
1965	100	100	100	100	100
1966	100	100	100	100	100
1967	100	100	100	100	100
1968	100	100	100	100	100
1969	100	100	100	100	100
1970	100	100	100	100	100
1971	100	100	100	100	100
1972	100	100	100	100	100
1973	100	100	100	100	100
1974	100	100	100	100	100
1975	0.3	73	0	95	100
1976	1.2	83	0	76	100
1977	0	58	0	58	100
1978	0	58	0	22	100
1979	0	27	0	20	0
1980	0	27	0	20	0
1981	0	27	0	20	0
1982	0	27	0	20	0
1983	0	27	0	20	0
1984	0	27	0	20	0
1985	0	27	0	20	0
1986	0	27	0	20	0

SECTION V

MODEL OPERATION

A. Accessing and Running the Program

To run the "Light Duty Vehicle Fuel Consumption Model," type EXEC TRUCK and LOAD TRUCK.OBJ FORTLIB. The first command executes a CLIST program that is designed to allocate the data files necessary to run the model. The second command loads and runs a compiled version of the program on the TSO operating system. The second command also specifies the line size (i.e., the maximum number of characters) required for the program output.

B. Interactive Input

When a model run is initiated from a time-sharing computer terminal, the user must answer a series of questions which specify the parameters of the model. This section presents each question to be answered by the user, the alternative entries which can be made, and the effect of each variable on the model run. Questions posed on the terminal (program response) are underlined. User responses are given in quotation marks. All entries must be followed by a carriage return.

ENTER SCENARIO(1-2) 1 to 2

Response: "1" All documented projections of sales and fuel economy are used.

"2" All projections of fuel economy are held to 1976 levels.

ENTER SLOPE, INTERCEPT FOR 1953-74

and ENTER SLOPE, INTERCEPT FOR 1975-86

Response: ".65,4.38" Enter discount factors for appropriate
and ".74,2.32" years.

WANT TO STRAIGHTLINE DIESEL PENETRATIONS to 1986(1=Yes)?

Response: "1" Diesel penetration fractions are straightlined
from 1980 to 1986.

"0" Diesel penetration fractions will be held con-
stant from a given year input in the next question.

If straightlining is to occur:

ENTER DIESEL PENETRATIONS FOR 1986

Response: ".2,.15,.15,0.,.15" A fraction for each of 5 categories
is entered.

Otherwise:

HOLD WHICH YEAR CONSTANT TO 1986?

Response: "1976" Holds 1976 diesel penetration fractions to
1986.

ANOTHER RUN (1=Yes)?

Response: "1" = Yes
"0" = No

FOOTNOTES

1. H.H. Gould and A.C. Mallrarias, Transportation Systems Center, Highway Fuel Consumption Computer Model (Version I), April, 1974.
2. U.S. Department of Transportation, National Highway Traffic Safety Administration, Preliminary Impact Assessment of the Nonpassenger Automobile Fuel Economy Standard for Model Years 1980 and 1981, November 29, 1977, p. II-18.
3. U.S. Environmental Protection Agency, Light Duty Fuel Economy Trends through 1978, March 3, 1978.
4. U.S. Department of Transportation, National Highway Traffic Safety Administration, Final Impact Assessment of the Automotive Fuel Economy Standards for Model Year 1981 through 1984 Passenger Cars, June 30, 1977.
5. U.S. DOT, NHTSA, Preliminary Impact Assessment
6. U.S. EPA, Light Duty Fuel Economy Trends
7. U.S. Department of Energy and Energy and Environmental Analysis, Inc., A Comparison of Fuel Economy Results from EPA Tests and Actual In-Use Experience, 1974-1977 Model Year Cars, February, 1978.

APPENDIX A

An example of this model's base case run is presented for 1978-1980 and 1985. The base case uses all documented projections of sales and fuel economy. In addition, the current market penetration of diesel engines is straightlined to the following assumed penetrations in 1986.

Domestic PA's	20%
Imported PA's	15%
Domestic NPA's (0-6000 lbs)	15%
Imported NPA's (0-6000 lbs)	0%
Domestic NPA's (6-8500 lbs)	15%

These projections are based on currently announced manufacturer plans.

In order to more closely approximate in-use fuel economy experience a 1974 discount factor was applied to pre-1975 models and a 1976 discount factor was applied to 1975 and later model year vehicles.

BASE CASE OUTPUT^{1/}

* 1978 *

	NEW			FLEET						
	MPG	REGISTRATIONS		MPG	REGISTRATIONS		VMT	FUEL CONSUMPTION		
		GAS	DSL		GAS	DSL		DSL	LEAD	UNLI
PA DOM	16.16	9.44	0.06	14.07	83.94	0.06	945.19	0.04	37.08	30.02
PA IMP	22.15	2.04	0.05	20.78	14.98	0.16	179.16	0.07	6.97	1.55
TOTAL PA	16.99	11.47	0.12	14.80	98.93	0.22	1124.35	0.11	44.05	31.57
NPA DOM 0-6	15.64	1.42	0.01	13.27	15.19	0.01	153.00	0.00	6.82	4.70
NPA IMP 0-6	20.08	0.19	0.0	17.78	1.53	0.0	17.71	0.0	0.80	0.20
NPA 6-8.5	13.27	1.96	0.01	11.95	9.86	0.01	117.92	0.01	9.86	0.0
TOTAL NPA	14.40	3.58	0.01	12.93	26.58	0.01	288.63	0.01	17.48	4.90
TOTAL	16.29	15.05	0.13	14.36	125.50	0.24	1412.97	0.12	61.53	36.47

* 1979 *

	NEW			FLEET						
	MPG	REGISTRATIONS		MPG	REGISTRATIONS		VMT	FUEL CONSUMPTION		
		GAS	DSL		GAS	DSL		DSL	LEAD	UNLI
PA DOM	17.27	9.35	0.18	14.49	85.14	0.24	965.78	0.15	30.56	35.84
PA IMP	23.63	1.83	0.12	21.15	15.70	0.28	187.30	0.11	6.40	2.29
TOTAL PA	18.10	11.18	0.30	15.25	100.84	0.52	1153.08	0.27	36.96	38.13
NPA DOM 0-6	15.94	1.52	0.02	13.63	15.84	0.03	159.63	0.02	5.94	5.74
NPA IMP 0-6	20.45	0.20	0.0	18.19	1.68	0.0	19.04	0.0	0.74	0.30
NPA 6-8.5	13.49	2.04	0.02	12.29	11.57	0.03	138.44	0.02	9.09	2.14
TOTAL NPA	14.67	3.75	0.05	13.25	29.09	0.06	317.11	0.04	15.77	8.19
TOTAL	17.10	14.93	0.35	14.75	129.93	0.58	1470.19	0.31	52.73	46.32

^{1/} Registrations are expressed in millions of vehicles. VMT is expressed in billions of miles. Fuel consumption figures are expressed in billions of gallons.

BASE CASE OUTPUT (cont.)

* 1980 *

	NEW			FLEET						
	MPG	REGISTRATIONS		MPG	REGISTRATIONS		VMT	FUEL CONSUMPTION		
		GAS	DSL		GAS	DSL		DSL	LEAD	UNLI
PA DOM	18.45	9.43	0.36	15.05	86.33	0.61	980.98	0.34	23.99	40.70
PA IMP	25.11	1.74	0.12	21.68	16.21	0.39	192.05	0.15	5.78	2.86
TOTAL PA	19.27	11.17	0.48	15.82	102.55	1.00	1173.03	0.50	29.76	43.55
NPA DOM 0-6	16.23	1.60	0.05	13.99	16.53	0.08	167.29	0.05	5.17	6.72
NPA IMP 0-6	20.82	0.21	0.0	18.58	1.84	0.0	20.37	0.0	0.69	0.40
NPA 6-8.5	13.72	2.11	0.05	12.58	13.30	0.08	158.05	0.06	8.06	4.42
TOTAL NPA	14.93	3.92	0.10	13.55	31.67	0.16	345.71	0.11	13.92	11.54
TOTAL	17.93	15.09	0.58	15.22	134.21	1.16	1518.74	0.60	43.69	55.09

* 1985 *

	NEW			FLEET						
	MPG	REGISTRATIONS		MPG	REGISTRATIONS		VMT	FUEL CONSUMPTION		
		GAS	DSL		GAS	DSL		DSL	LEAD	UNLI
PA DOM	23.48	8.32	2.06	19.11	89.89	7.45	1104.82	3.02	3.44	49.82
PA IMP	29.70	1.64	0.34	25.71	17.55	1.57	217.13	0.47	3.04	4.67
TOTAL PA	24.30	9.97	2.39	19.95	107.43	9.02	1321.95	3.49	6.48	54.49
NPA DOM 0-6	19.34	1.70	0.30	16.31	19.62	1.02	209.13	0.51	2.12	9.94
NPA IMP 0-6	22.67	0.25	0.0	20.52	2.56	0.0	26.36	0.0	0.49	0.79
NPA 6-8.5	16.31	2.25	0.38	14.30	21.52	1.26	249.88	0.77	4.18	12.19
TOTAL NPA	17.70	4.20	0.68	15.42	43.70	2.29	485.37	1.28	6.80	22.93
TOTAL	21.98	14.17	3.07	18.42	151.13	11.31	1807.31	4.77	13.28	77.42

APPENDIX B

AN UNDISCOUNTED BASE CASE^{1/}

* 1978 *

	NEW			FLEET						
	MPG	REGISTRATIONS		MPG	REGISTRATIONS		VMT	FUEL CONSUMPTION		
		GAS	DSL		GAS	DSL		DSL	LEAD	UNL
PA DOM	13.70	9.44	0.06	15.16	83.94	0.06	945.19	0.04	36.03	26.2
PA IMP	26.80	2.04	0.05	24.96	14.98	0.16	179.16	0.07	5.81	15.2
TOTAL PA	19.78	11.47	0.12	16.13	98.93	0.22	1124.35	0.11	41.84	27.5
NPA DOM 0-6	18.00	1.42	0.01	13.85	15.19	0.01	153.00	0.00	6.90	4.1
NPA IMP 0-6	24.00	0.19	0.0	20.56	1.53	0.0	17.71	0.0	0.70	0.1
NPA 6-8.5	14.80	1.96	0.01	12.24	9.86	0.01	117.92	0.01	9.63	0.0
TOTAL NPA	16.28	3.58	0.01	12.45	26.58	0.01	288.63	0.01	17.22	4.3
TOTAL	18.82	15.05	0.13	15.47	125.50	0.24	1412.97	0.12	59.06	31.8

* 1979 *

	NEW			FLEET						
	MPG	REGISTRATIONS		MPG	REGISTRATIONS		VMT	FUEL CONSUMPTION		
		GAS	DSL		GAS	DSL		DSL	LEAD	UNL
PA DOM	20.20	9.35	0.18	15.79	85.14	0.24	965.78	0.15	29.75	31.21
PA IMP	28.80	1.83	0.12	25.43	15.70	0.28	187.30	0.11	5.34	1.89
TOTAL PA	21.28	11.18	0.30	16.80	100.84	0.52	1153.08	0.27	35.09	33.09
NPA DOM 0-6	18.40	1.52	0.02	14.41	15.84	0.03	159.63	0.02	6.02	5.04
NPA IMP 0-6	24.50	0.20	0.0	21.14	1.68	0.0	19.04	0.0	0.65	0.25
NPA 6-8.5	15.10	2.04	0.02	12.84	11.57	0.03	138.44	0.02	8.84	1.91
TOTAL NPA	16.65	3.75	0.06	13.99	29.09	0.06	317.11	0.04	15.50	7.21
TOTAL	19.90	14.93	0.35	16.03	129.93	0.58	1470.19	0.31	50.59	40.30

^{1/} Registrations are expressed in millions of vehicles. VMT is expressed in billions of miles. Fuel consumption figures are expressed in billions of gallons.

APPENDIX B (cont'd)

* 1980 *

	NEW			FLEET						
	MPG	REGISTRATIONS		MPG	REGISTRATIONS		VMT	FUEL CONSUMPTION		
		GAS	DSL		GAS	DSL		DSL	LEAD	UNL
PA DOM	21.80	9.43	0.36	16.61	86.33	0.61	280.98	0.34	23.40	35.2
PA IMP	30.80	1.74	0.12	26.12	16.21	0.39	192.05	0.15	4.81	2.7
TOTAL PA	22.87	11.17	0.48	17.64	102.55	1.00	1172.02	0.50	28.21	37.8
NPA DOM 0-6	18.80	1.60	0.05	14.27	16.53	0.08	167.29	0.05	5.24	5.8
NPA IMP 0-6	25.00	0.21	0.0	21.62	1.84	0.0	20.37	0.0	0.60	0.3
NPA 6-8.5	15.40	2.11	0.05	13.33	13.30	0.08	158.05	0.06	7.34	3.0
TOTAL NPA	17.00	3.92	0.10	14.48	31.67	0.16	345.71	0.11	13.68	10.1
TOTAL	21.01	15.09	0.58	16.78	134.21	1.16	1518.74	0.60	41.90	47.7

* 1985 *

	NEW			FLEET						
	MPG	REGISTRATIONS		MPG	REGISTRATIONS		VMT	FUEL CONSUMPTION		
		GAS	DSL		GAS	DSL		DSL	LEAD	UNL
PA DOM	28.60	8.32	2.06	22.45	89.89	7.45	1104.82	3.02	3.36	42.08
PA IMP	37.00	1.64	0.34	31.54	17.55	1.57	217.12	0.47	2.50	3.80
TOTAL PA	29.68	9.97	2.39	23.56	107.43	9.02	1321.95	3.49	5.86	45.87
NPA DOM 0-6	23.00	1.70	0.30	18.44	19.62	1.02	209.13	0.51	2.17	8.5
NPA IMP 0-6	27.50	0.25	0.0	24.44	2.56	0.0	26.36	0.0	0.42	0.36
NPA 6-8.5	18.00	2.25	0.38	15.05	21.52	1.26	249.88	0.77	4.02	10.60
TOTAL NPA	20.75	4.20	0.68	17.34	43.70	2.29	485.37	1.28	6.61	19.80
TOTAL	26.46	14.17	3.07	21.39	151.13	11.31	1807.31	4.77	12.47	65.70