ENERGY INFORMATION ADMINISTRATION

SUPPLEMENTAL ENERGY-RELATED DATA FOR THE 2001 NATIONAL HOUSEHOLD TRAVEL SURVEY

APPENDIX K.
DOCUMENTATION ON ESTIMATION METHODOLOGIES FOR FUEL ECONOMY AND FUEL COST

JUNE 2003

FOR THE
U.S. DEPARTMENT OF TRANSPORTATION

BY

ENERGY INFORMATION ADMINISTRATION
OFFICE OF ENERGY MARKETS AND END USE
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WASHINGTON, DC 20585

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The 2001 National Household Travel Survey (NHTS) was funded and coordinated by the U.S. Department of Transportation, which included the Federal Highway Administration, Bureau of Transportation Statistics, and the National Highway Traffic Safety Administration. The NHTS is the integration of two national travel surveys: the Federal Highway Administration-sponsored Nationwide Personal Transportation Survey (NPTS) and the Bureau of Transportation Statistics-sponsored American Travel Survey.

Data support was received from the National Highway and Traffic Safety Administration (NHTSA) for special components of this project.

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APPENDIX K. FUEL ECONOMY AND FUEL COST

ESTIMATION METHODOLOGIES

K. INTRODUCTION

Statistics concerning vehicle-miles traveled (VMT), vehicle fuel economy (given in terms of miles per gasoline equivalent gallon (MPG)), vehicle fuel consumption, and vehicle fuel expenditures are presented in this documentation appendix. The methodology used to estimate these statistics relied on data from the U.S. Federal Highway Administration (FHWA) 2001 National Household Travel Survey (NHTS); the U.S. Energy Information Administration (EIA) 1985, 1988, and 1991 Residential Transportation Energy Consumption Survey (RTECS); the U.S. Environmental Protection Agency (EPA) fuel economy test results[1]; and the EIA's retail pump price series[2] for 2001 and 2002.

The estimation of these four statistics (VMT, vehicle fuel economy, vehicle fuel consumption, and vehicle fuel expenditures) occurred in several steps (Figure 1). First, for each NHTS vehicle, the annualized VMT was derived from two actual odometer readings or imputed using modeled data (see 2-B.5. ODOMETER READING and APPENDIX J in the User's Guide). Second, the annual on-road fuel economy, given in terms of MPG, was estimated using the questionnaire responses[3], EPA fuel economy test results, and the fixed 12-month period between May 1, 2001 and April 30, 2002 that the vehicle was in use. The Composite MPG values were adjusted to account for the difference between EPA test values and on-road values. Third, estimated vehicle fuel consumption was derived by dividing the VMT by the estimated MPG. Finally, multiplying the vehicle fuel consumption by the fuel price derived the estimated vehicle fuel expenditures. The NHTS did not collect vehicle fuel prices via fuel purchase diaries. Instead, each NHTS vehicle was assigned a price based on its imputed fuel type. All price information, with the notable exception of fuel tax rates for gasoline that were obtained from FHWA's *Highway Statistic* reports, was obtained from the EIA's fuel price series.

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[1] Test data was received from the U.S. Department of Transportation, National Highway and Traffic Safety Administration for model year's 1978 through 2001. It is unfortunate that 2002 model year data will become available after the Version 3 release of the 2001 NHTS. Shortly following that release, this project will attempt to update the NHTS for 2002 model year vehicles.

[2] Energy Information Administration. Forms EIA-782A, "Refiners'/Gas Plant Operators' Monthly Petroleum Product Sales report," and EIA-782B, "Resellers'/Retailers' Monthly Petroleum Product Sales Report." Form EIA-888, "On-Highway Diesel Fuel Price Survey." Form EIA-895, "Monthly Quantity and Value of Natural Gas Report." Form EIA-826, "Monthly Electric Utility Sales and Revenue Report with State Distributions."

[3] Vehicle Identification Numbers (VIN) were not collected in FHWA's 2001 NHTS. Instead, FHWA collected make (MAKECODE), model (MODLCODE), model year (VEHYEAR), and 8 categories of vehicle type (VEHTYPE), as given in *Section B: Vehicle Data* of the 2001 NHTS questionnaire.

The following sections of this appendix describe the estimation procedures used for calculating a monthly VMT, the MPG, the vehicle fuel consumption, the vehicle fuel prices, and the vehicle fuel expenditures. Also described in this appendix are the sources of data that were used in the estimation procedures.

The following terms are used throughout this appendix:

Term	Definition
EPA Composite MPG	The EPA dynamometer test procedure, performed on pre-production prototype vehicles, yields separate test values for EPA city and highway MPG. These city and highway MPG are often combined to form the "composite" MPG.
On-Road MPG	A Composite MPG that was adjusted to account for the shortfall between the test value and the fuel economy actually obtained on the road. The adjustment did not take into account the driving patterns of individual drivers and seasonal differences.
In-Use MPG	MPG that were adjusted for seasonal differences and annual miles driven. Vehicles that are driven relatively few miles during the year are assumed to be driven mostly on short trips that involve frequent stops. Vehicles that are driven relatively many miles are assumed to be driven mostly on long trips where few stops are needed.
MPG Shortfall	A measure of the difference between actual on-road MPG and the EPA laboratory test MPG, expressed as the ratio of test MPG to on-road MPG.

The use of EPA test value data from NHTSA is restricted to vehicles that are used to derive Corporate Average Fuel Economy under Title V of the Motor Vehicle Information and Cost Savings Act (15 U.S.C. 1901, et seq.) with subsequent amendments and Subtitle VI (49 U.S.C. 329). Corporate Average Fuel Economy (CAFE) is the sales-weighted average fuel economy, expressed in miles per gallon, of a manufacturer's fleet of passenger cars or light trucks with a gross vehicle weight rating (GVWR) of 8,500 lbs. or less, manufactured for sale in the United States, for any given model year.[4] Fuel economy is defined as the average mileage traveled by a vehicle per gallon of gasoline (or equivalent amount of other fuel) consumed as measured in accordance with the testing and evaluation protocol set forth by Environmental Protection Agency (EPA).

Manufacturers also perform their own fuel economy tests of new vehicle models and submit the results to EPA. EPA is responsible for conducting its own tests or verifying the manufacturers' dynamometer tests. EPA also is responsible for compiling the production data from manufacturers' reports and furnishing CAFE results to NHTSA.

[4] These vehicles are consistent with 2001 NHTS sample vehicles having a vehicle type of 01 (Automobile), 02 (Van), 03 (Sport Utility Vehicle), or 04 (Pickup Truck). EPA does not provide test data for vehicles such as the Ford Excursion, Hummer H1 and Hummer H2 because they have a GVWR greater than 8,500 lbs.

Fuel economy test data from the manufacturers and EPA serves as the starting point for both CAFE values and real-world fuel economy projections. For CAFE, the test data are adjusted upward to account for any credits for dual-fuel alternative fuel vehicles (AFV) and dedicated AFV, and for passenger cars only, is also adjusted upward for credits available to manufacturers to account for test procedure changes since the CAFE program was established. For NHTS, such credits and their associated upward adjustments were removed.

Table 1. Distribution of All NHTS Sample Vehicles by Vehicle Type and Model Year, 2001

Vehicle Type	Code	Model Year Range				Total
		Pre-1978	1978 - 2001	2002	Missing	
Automobile	01	988	26,829	443	800	29,060
Van	02	51	4,633	81	147	4,912
Sport Utility Vehicle	03	90	5,998	255	166	6,509
Pickup Truck	04	603	9,250	160	356	10,369
Other Truck	05	85	162	2	15	264
Recreation Vehicle	06	56	368	3	21	448
Motorcycle	07	136	1,126	32	130	1,424
Other	91	25	172	3	34	234
Missing	-1,-7, or-8	2	12	1	43	58
Total		2,036	48,550	980	1,712	53,278

Source: U.S. Department of Transportation, Federal Highway Administration, *2001 National Household Travel Survey*, Version 1 release. (Washington, DC).

Since the NHTS is a national survey, it collected data from a nationally representative sample of households to derive statistically reliable travel estimates at the national and division levels. Sample data in the NHTS are not adequate to provide statewide, or smaller area-specific estimates. However, the 2001 NHTS sample included several jurisdictions where additional sample household were purchased and interviewed. The jurisdictions that purchased these additional samples are referred to as the "add-on" areas. There are nine add-on areas:

1) Baltimore Metropolitan Planning Organization (MPO), Maryland

2) Des Moines MPO, Iowa

3) Edmonson, Carter, Pulaski, and Scott Counties, Kentucky

4) Lancaster MPO, Pennsylvania

5) Oahu MPO, Hawaii

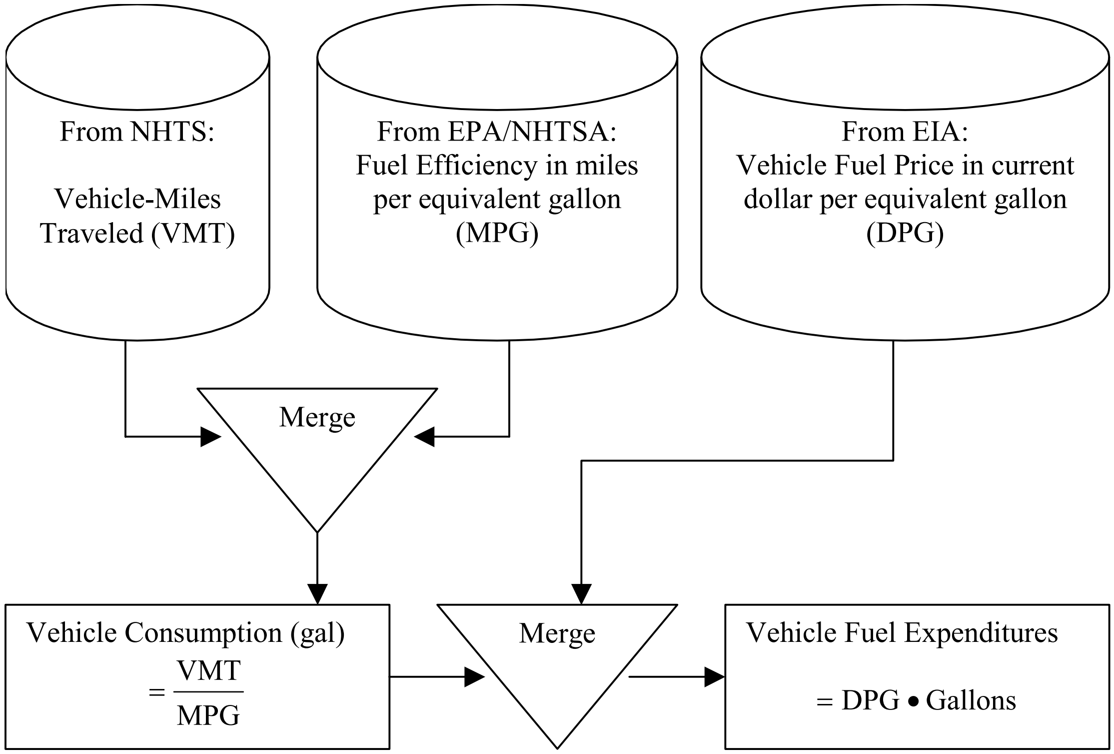
6) State of Hawaii, except Oahu

7) State of New York

8) State of Texas

9) State of Wisconsin

Figure 1. Estimation Schematic



Note: NHTS – National Household Travel Survey, EPA – Environmental Protection Agency, EIA – Energy Information Administration, and NHTSA – National Highway Transportation Safety Administration.

K-1. VEHICLE MILES TRAVELED

When possible, VMT were determined for a sample vehicle by taking the difference between two odometer readings, which spanned a period of time, expanding them to cover the year. These methods are discussed in Appendix J in the User's Guide, as written by the Oak Ridge National Laboratory, Engineering Science Technology Division, Center for Transportation Analysis.

K-2. VEHICLE FUEL ECONOMY

Fuel economy (MPG) must be estimated for each NHTS sample vehicle in order to estimate each vehicle's fuel consumption for the survey year. Then, fuel consumption is estimated by dividing the VMT for time of possession (a fixed 12-month period starting on May 1, 2001 and ending April 30, 2002[5]) by the MPG. The NHTS neither obtained actual fuel consumption data nor on-road MPG from fuel purchase diaries maintained by the respondents. Because NHTS did not require these data or diaries, MPG values were estimated using EPA laboratory test MPG that

[5] The 2001 NHTS was conducted over the 14-month period from March 2001 to May 2002. Unfortunately, that timing turned out to be problematic due to the September 11, 2001 terrorist attacks on the World Trade Center in New York and the Pentagon in Washington, DC. These attacks disrupted transport services for months, especially curtailing long-distance travel. It is not certain what impacts the attacks had on urban travel, but it seems likely that both the amount of travel and modal choice were affected. That may have distorted the survey results to some unknown extent. Information courtesy of John Pucher and John L. Renne, *Transportation Quarterly*, Vol. 57, No. 3, 2003.

were adjusted to account for differences between actual on-road MPG and the EPA test MPG. This difference is known as MPG "shortfall." Lax, 1987[6]; Mintz, 1993[7]; and Reichert, 2000[8], investigated the feasibility of using shortfall-adjusted MPG in a household survey. The Lax study verified that the method yielded unbiased MPG, when using a database from a 1984 fuel purchase diary study performed by NPD Research, Inc. The adequacy of current shortfall adjustment methods is sufficient for late 1980 through early 1993's motor vehicle model years also (RTECS Technical Note 5).[9] For the 2001 NHTS, the adequacy of shortfall adjustments has been extended for 1994 through 2002's motor vehicle model years.

The NHTS sample vehicles were assigned EPA test MPG from the NHTSA Corporate Average Fuel Economy files. Each record of the NHTSA files contained an EPA Composite MPG (i.e., an unadjusted 45 percent highway and 55 percent city weighted estimate) for each unique combination of vehicle attributes within a given manufacture, model/carline, type and model year. These attributes included (1) number of cylinders, (2) cubic inches of engine displacement (CID), (3) type of transmission (manual or automatic), and (4) fuel metering (gasoline, diesel, electric, natural gas, duel-, or flexible-fuel vehicle). However, NHTSA file records did not include whether the vehicle's emissions control package met Federal or California standards. Each record of the NHTSA files also contained the number of vehicles sold, in thousands of vehicles, for each unique combination of attributes. The vehicle attributes needed to assign a Composite MPG for sample vehicles were obtained from vehicle attributes collected for each NHTS vehicle. Specifically, NHTS queried respondents on their vehicle’s make, model, vehicle type, and model year attributes. Hence, merging (or statistical linking) to NHTSA Corporate Average Fuel Economy files were restricted to those four attributes. If, in the future, NHTS collects Vehicle Identification Numbers (VIN), then statistical linking may be performed on a more robust set of vehicle attributes.[10]

NHTSA files serve multiple purposes. In addition to assigning a Composite MPG, the NHTSA files were used to impute “missing” vehicle attributes: fuel metering and engine type for purposes of assigning an appropriate fuel price. Based on the nonmissing vehicle attributes obtained from the NHTS questionnaire, several records from the NHTSA files were usually found to be potential “matches” to a given sample vehicle. A matching record was chosen from among the several applicable ones, with probability proportional to sales, using the sales figures on the NHTSA files. Once chosen, a record provided (1) EPA Composite MPG, (2) fuel metering, and (3) engine type. Although more attributes were available for selection, EIA limited its matched

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[6] Lax, D. 1987. “Feasibility of Estimating In-Use Vehicle Fuel Efficiency from Household Survey Data.” Research performed under contract for ORNL/DOE/EIA. Energy and Environmental Analysis Inc., Arlington, VA.

[7] Mintz, M., A. Vyas, and L. Conley, 1993. “Differences Between EPA-Test and In-Use Fuel Economy: Are the Correction Factors Correct?” Transportation Research Record 1416, pp. 124-130, Transportation Research Board, National Research Council, Washington, DC.

[8] Reichert, J. 2000. “Change in Method for Estimating Fuel Economy for the Residential Transportation Energy Consumption Survey,” Energy Information Administration on www.eia.doe.gov/emeu/rtecs/contents.html.

[9] Harrison, I.M. “VMT 1991 Patterns,” Residential Transportation Energy Consumption Survey Technical Note 5, unpublished document. (Washington, DC).

[10] VINs may be decoded to yield the vehicle attributes, by use of the Highway Loss Data Institute's "Vindicator" software.

attributes to those required to assign an appropriate fuel price to a sample vehicle. This matching routine commonly results in a 1-to-many record linkage (see Figure 5 for more details).

The 2001 NHTS employs a sequential adjustment procedure where the EPA Composite MPG was adjusted first to an on-road MPG, and then to an in-use MPG.

K-2.1 THE EPA COMPOSITE MPG

Beginning in the early 1970's, EPA measured fuel economy from tests that were conducted on a dynamometer to simulate actual driving conditions. By 1975, EPA had incorporated separate “city” and “highway” driving cycles into the test. The city and highway MPG were combined to form a “composite” MPG that was then weighted according to sales of the production vehicles in order to assess compliance with Corporate Average Fuel Economy (CAFE) standards. The EPA Composite MPG is based on the assumption of a "typical" vehicle-use pattern of 55 percent city driving and 45 percent highway driving, and has become a convenient single fuel economy measure for analytical and regulatory purposes.

The EPA Composite MPG[11] is defined as:

$$\mathrm{MPG}_{(\mathrm{EPA}\ 55/45)} = \frac{1}{0.55 \bullet \dfrac{1}{\mathrm{MPG}_{(\mathrm{EPA\ city})}} + 0.45 \bullet \dfrac{1}{\mathrm{MPG}_{(\mathrm{EPA\ hwy})}}} \tag{1}$$

where:

$\mathrm{MPG}_{(\mathrm{EPA}\ 55/45)}$ denotes the composite MPG; $\mathrm{MPG}_{(\mathrm{EPA\ city})}$ denotes the fuel economy when vehicle use pattern is city driving only; and, $\mathrm{MPG}_{(\mathrm{EPA\ hwy})}$ denotes the fuel economy when vehicle use pattern is highway driving only.

Because separate city and highway fuel economy estimates were not available on the NHTSA files, a single “shortfall” adjustment factor was derived, approximating the adjustments given in the following sections.

K-2.2 FUEL ECONOMY SHORTFALL

Fuel economy shortfall occurs when the fuel economy that is actually obtained while using the vehicle is lower than the EPA test results. Reasons for this shortfall are (1) a result of the differences between EPA test vehicles and the vehicles actually in use and (2) the differences between EPA procedures for simulated driving conditions and actual driving conditions. For example, EPA test vehicles are prototypes that do not contain the wide variety of power-consuming accessories often found on vehicles sold to consumers. The test procedures also do not simulate the actual driving conditions that affect fuel economy such as speed and acceleration of individual drivers, road conditions, weather, and traffic. In the 2001 NHTS, adjustments for this

[11] Specifically, the following formulas, as stated in Part 600, Subpart F, §600.207-86, §600.208-77, §600.209-85, §600.510-86 of the 7-1-1994 edition of the 40 CFR, are identified for these calculations.

fuel economy shortfall were made to the composite MPG ($MPG_{(EPA\ 55/45)}$) that were assigned to the sample vehicles.

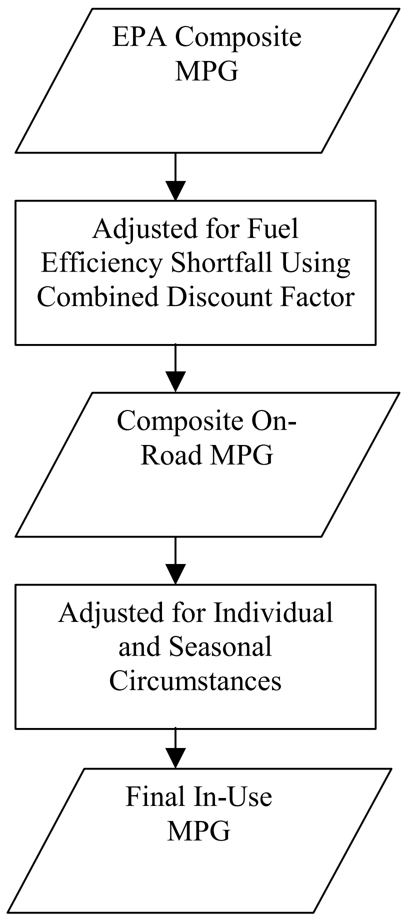
Fuel economy shortfall was expressed in terms of the "Gallons per Mile Ratio" or GPMR:

$$GPMR_i = \frac{MPG_{i\,(EPA55/45)}}{MPG_i} \qquad (2)$$

where:

$GPMR_i$ denotes Gallons per Mile Ratio for the i^th^ vehicle; MPG_i denotes the on-road MPG or in-use MPG for the i^{th} vehicle, depending on the analysis; and, $MPG_{i\,(EPA\ 55/45)}$ denotes the EPA Composite MPG applicable to the i^{th} vehicle.

Figure 2. Miles per Gasoline Equivalent Gallon Adjustment Procedures



If $GPMR_i = 1$ then there is no perceived shortfall. If $GPMR_i > 1$ then there is a shortfall for vehicle i. That is, the on-road or in-use fuel economy is less than the fuel economy indicated by the EPA Composite MPG. Note that $GPMR_i$ can represent shortfall with respect to either the on-road or in-use MPG_i, depending on the analysis being performed. $GPMR_i$ is commonly chosen as a measure of shortfall as opposed to MPG_i for the following reasons:

- A shortfall adjustment is most often thought of as a correction factor, or multiplicative constant, rather than as an additive correction. $GPMR_i$ satisfies this convention.

- Shortfall is usually dependent on a vehicle's fuel economy level. That is, shortfall is usually higher at high levels of $MPG_{(EPA\ 55/45)}$ than at low levels of $MPG_{(EPA\ 55/45)}$. Therefore, it is more informative to express the amount of shortfall relative to $MPG_{(EPA\ 55/45)}$ rather than as an absolute quantity.

- $GPMR_i$ is a linear function of $MPG_{(EPA\ 55/45)}$ and can be modeled using ordinary least squares linear regression.

- $GPMR_i$ is a transformation that stabilizes error variances for the purposes of least squares linear regression.

K-2.3 THE ON-ROAD MPG

On-road MPG is a composite MPG that was adjusted to account for the shortfall between the EPA fuel economy and the actual fuel economy obtained on the road.

The EPA developed two general procedures for adjusting $MPG_{(EPA\ 55/45)}$ to an on-road value. One procedure bases the size of the adjustment on specific technology features of the vehicle. The other procedure uses just two MPG discount factors, one to adjust the EPA highway estimate, the other to adjust the city estimate. These two factors are used for all vehicles, regardless of technology class. For our purposes, we approximated the earlier procedure with a single adjustment factor.

Either of these procedures could have been approximated to adjust $MPG_{(EPA\ 55/45)}$ to an on-road MPG value for use in the 2001 NHTS. Since both procedures were unbiased for trucks, the choice as to which to employ in the 2001 NHTS should be based on their performance with cars. According to the 1994 RTECS, the adjustment based on discount factors seemed to be less biased than the Technology-Specific Adjustment. Further, the discount factors are also less expensive since they do not require collection or imputation of information on fuel delivery system and drive-train. Because of these reasons the Discount Factors Adjustment Method was selected for approximation.

K-2.4 SHORTFALL ADJUSTMENT BASED ON DISCOUNT FACTORS

EPA's discount factors have widespread appeal because of their simplicity (Hellman and Murrell, 1985[12]; Hellman and Murrell, 1984[13]). The factors are 10 percent for city MPG and 22 percent for highway MPG. That is, for any vehicle i,

[12] Hellman, K.H., and Murrell, J.D. 1985. "On the Stability of the EPA MPG Adjustment Factors." Society of Automotive Engineers Technical Paper Series, SAE Paper No. 851216, Warrendale, PA.

[13] Hellman, K.H., and Murrell, J.D. 1984. "Development of Adjustment Factors for the EPA City and Highway MPG Values." Society of Automotive Engineers Technical Paper Series, SAE Paper No. 840496, Warrendale, PA.

$$MPG_{i(on\text{ - }road,\ EPA\ city)} = 0.90 \bullet MPG_{i(epa\ city)}$$
$$MPG_{i(on\text{ - }road,\ EPA\ hwy)} = 0.78 \bullet MPG_{i(EPA\ hwy)} \tag{3}$$

These discount factors are the ones used to produce the "sticker" MPG figures seen on vehicles on dealer lots, and are used to produce the DOE/EPA Gas Mileage Guide. The analysis behind the development of these factors was performed on a conglomerate database with data from Ford Motor Company, General Motors, Chrysler Corporation, DOE, and EPA. The database contained approximately 38,000 vehicle records with model years from 1979 through 1981 with some 1982 models included. The database contained predominately American-made vehicles, but also included foreign vehicles as well. The technology mix was dominated by rear-wheel drive and carbureted vehicles, but contained some vehicles with front-wheel drive or fuel injection. Vehicle records contained make, model, year, vehicle characteristics, the MPG as measured on the road, $MPG_{(EPA\ city)}$, and $MPG_{(EPA\ highway)}$. The database also included the driver's perceptions of the proportion of their travel that was mostly urban (so called “city fraction”), and their average miles driven per day (AMPD).

Fuel economy shortfall is affected by the vehicle use pattern: frequent starts and short trip lengths characterize city-driving pattern, while highway-driving pattern is characterized by infrequent starts and long trips. AMPD is a good surrogate variable for representing these different driving patterns.

The city-driving pattern was characterized by AMPD from 5 to 22 miles per day, while the highway-driving pattern was characterized by AMPD's from 15 to 105 miles per day (Hellman and Murrell, 1984). City fraction and AMPD were used to split the data into two sets, one for development of the city discount factor, the other for development of the highway factor. The “city” and “highway” data sets were each stratified by vehicle technology classes. Linear regression was performed within each stratum. GPMR was regressed on city fraction, AMPD, $MPG_{(EPA\ 55/45)}$, odometer reading, and average temperature. The fitted models were then weighted and combined across vehicle technology strata, to produce a single "city" shortfall model and a single "highway" shortfall model. The weights were used to increase the influence of those models that represented technology mixes expected to become more prominent in the future (e.g., front-wheel drive and fuel-injected vehicles). The discount factors were derived from the two weighted models set at average or typical values of the independent variables.

For each NHTS vehicle, if and only if separate city and highway MPG were available, discounted city and highway on-road MPG may be computed and then combined to form an on-road 55/45 composite as follows:

$$MPG_{(on\text{ - }road,\ 55/45)} = \frac{1}{0.55 \bullet \dfrac{1}{MPG_{(on\text{ - }road,\ EPA\ city)}} + 0.45 \bullet \dfrac{1}{MPG_{(on\text{ - }road,\ EPA\ hwy)}}} \tag{4}$$

Then, a shortfall ratio based on EPA discount factors would be computed for each NHTS vehicle as follows:

$$GPMR_{i(on\text{ - }road)} = \frac{MPG_{i(EPA\ 55/45)}}{MPG_{i(on\text{ - }road,55/45)}} \tag{5}$$

Unfortunately, separate on-road city and highway test MPG were not available from the NHTSA Corporate Average Fuel Economy files. Although a literature review reveals that shortfalls vary for particular vehicles or groups of vehicles, we have used a combined shortfall estimate of 15 percent, equating to a $GMPR_{i(on\text{-}road)}$ of 1/0.85, which may also be written to reveal that $MPG_{i(on\text{-}road,\ 55/45)} = 0.85 \bullet MPG_{i(EPA55/45)}$.[14] Such an approximation is empirically shown in Table 12, where the arithmetic average of the inverse of GMPR is presented by manufacture, vehicle class, and model years 1998-2001. These data were downloaded from the EPA and DOE www.fueleconomy.gov website.

K-2.5 THE IN-USE MPG

In-use MPG are MPG that are adjusted for individual driving circumstances. The on-road adjustments to $MPG_{(EPA\ 55/45)}$ discussed in the previous sections were "general" in that they did not take into account any effects on fuel economy that are due to the driver's individual circumstances. They, instead, utilized general attributes such as the technology features of the vehicle and average driving conditions. Fuel economy shortfall estimates can be refined for an individual vehicle by taking into account the following "in-use" effects.

- Urban versus rural driving pattern. That is, frequent starts and short trips as opposed to infrequent starts and longer trips. As mentioned in the previous section, a useful single variable for representing this effect is AMPD. High AMPD's usually represent mileage accumulated on the highway.
- Traffic congestion, which increases with population density.
- Seasonal temperature variations, especially for gasoline-carbureted vehicles.
- Humidity, which together with temperature affects air-conditioner use.
- Differences among geographic areas of the country.
- Altitude.
- Wind.
- Road gradient and road surface conditions.

Additionally, the seasonal change in gasoline composition and the mechanical condition of the sample vehicles affect on-road fuel economy. Both of these effects are unknown. More importantly, EIA has made no attempt to account for these unknown effects.

However, this appendix does address some of the individual vehicle influences. In general, the first four items are considered the most significant in-use influences (Crawford, 1983).[15] In

[14] Hellman, K.H. and Murrell J.D., June 1982. "Why Vehicles Don't Achieve EPA MPG On the Road and How That Shortfall Can Be Accounted For," SAE Paper 820791.

[15] Crawford, R. 1983. "Seasonal and Regional MPG as Influenced by Environmental Conditions and Travel Patterns." Research performed under contract for DOE. Energy and Environmental Analysis, Inc., Arlington, VA.

the cited study, shortfall variations as high as 25 percent or more occurred over the range of typical AMPD. Shortfall was 16 percent higher in urban areas than in completely uncongested areas, and was 12 percent higher in suburban areas. Shortfall varied seasonally (i.e., monthly) by 7 percent in the South and by 13 percent in the North.

Regression models were developed (Crawford, 1983) for use in adjusting $GPMR_{i(on\text{-}road)}$ to an in-use shortfall employing measurements of several in-use effects as the independent variables.

The regressions yielded a shortfall adjustment that was an additive one, which may be written as follows:

$$GPMR_{ij(in\text{ - }use)} = GPMR_{i(on\text{ - }road)} + \delta_{ij} \tag{6}$$

where GPMRij(in-use) denotes the in-use shortfall ratio estimate for the i^{th} vehicle during the j^{th} month (j = 1, 2, … 12); GPMRi(on-road) denotes the combined shortfall ratio fixed for the i^{th} vehicle; and, δ_{ij} denotes the adjustment calculated for the i^{th} vehicle during month j, from the a regression model.

One regression model from the Crawford reference that is appropriate for use in NHTS is as follows:

$$\begin{aligned}
\delta_{ij} &= 3.296 \bullet \left[\left(\frac{1}{AMPD_{ij}}\right) - \left(\frac{1}{35.6}\right)\right] + \\
&NORTH \bullet \left[0.050 \bullet \sin\left(\frac{j\pi}{6}\right) + 0.075 \bullet \cos\left(\frac{j\pi}{6}\right)\right] + \\
&SOUTH \bullet \left[0.030 \bullet \sin\left(\frac{j\pi}{6}\right) + 0.031 \bullet \cos\left(\frac{j\pi}{6}\right)\right]
\end{aligned} \tag{7}$$

where $AMPD_{ij}$ = Average Miles per Day for vehicle i and month j, typically 35.6 (i.e., 13,000 miles per year); NORTH = 1 if the household is in the North, otherwise NORTH = 0 if the household is not in the North; and, SOUTH = 1 if the household is in the South, otherwise SOUTH = 0 if the household is not in the South.

This regression model was chosen because the independent variables that are important in explaining shortfall were readily available from the 2001 NHTS data, using BESTMILE and the distribution of average monthly vehicle miles travel fractions found in Table 2. The model had two components. One component involved $AMPD_{ij}$ and represented the influence of individual driving patterns for a given vehicle and month. The other component represented the change in shortfall that occurred throughout the seasons, due to the annual temperature cycle. The original regression equation also contained a minor term that accounted for the influence of air-conditioner use during hot, humid weather. This term was dropped in the estimations because it involved the rather complex computation of "Discomfort Index" from NOAA weather records, and the slight additional precision was judged insufficient to warrant the additional processing expense. Additional terms representing geographic regional effects, and the natural logarithm of population density (people per square mile, to represent the influence of traffic congestion) were not considered because of the computational cost.

Once a $GPMR_{ij(in\text{-}use)}$ was estimated it was used to estimate the final in-use fuel economy for vehicle i and month j as follows:

$$MPG_{ij(in\text{ - }use)} = \frac{MPG_{i(EPA\ 55/45)}}{GPMR_{ij(in\text{ - }use)}} \qquad (8)$$

The regression equation had separate seasonal components for the "North" and "South" because the difference between the winter shortfall and the summer shortfall was greater in the North than in the South. This difference can be seen in the model parameters. To define the North and South geographic areas the continental United States were divided into 97 two-digit ZIP Code regions. These regions were grouped to form two aggregate regions ("North" and "South") according to average winter and summer temperatures, and seasonal shortfall trends.

K-3. ANNUAL VEHICLE FUEL CONSUMPTION

In the 2001 NHTS, annual consumption was calculated by dividing the annual VMT by the annual MPG. The derivation of the "annualized" VMT is given in Appendix J.

The $MPG_{ij(in\text{-}use)}$ shown in the above section about fuel economy estimation procedures were final estimates of monthly in-use fuel economies for vehicle i, and could have been used for estimating monthly fuel consumptions and expenditures, if monthly VMT were known. Unfortunately, NHTS only collected data to annualize VMT. Nevertheless, the 2001 NHTS still made use of the $MPG_{ij(in\text{-}use)}$ by disaggregating the annual VMT of sample vehicles into monthly VMT, using monthly VMT driving fractions from the standard distribution in Table 2.

Table 2. Distribution of Average Monthly Vehicle-Miles Traveled Fractions

$Month_j$	**Average VMT per Vehicle**	**F_j**
January	688	0.0728
February	697	0.0738
March	771	0.0816
April	783	0.0829
May	832	0.0880
June	847	0.0896
July	868	0.0919
August	872	0.0923
September	800	0.0847
October	802	0.0849
November	756	0.0800
December	734	0.0777
Total	9,450	1.0000

Source: 1984 Petroleum Marketing Index (PMI) Survey, NPD Research Inc. The survey is a demographically and geographically balanced-quota sample of 4,100 households. Respondents maintained fuel purchase diaries for an average of 10 months. As part of the survey, information was collected on the characteristics of trips taken in vehicles during a designated day. Trip lengths were recorded as respondent perception rather than from odometer readings. The distribution of monthly mileage fractions has been obtained from this survey.

The annual consumption for vehicle i can be thought of as the sum of the individual monthly consumptions:

$$C_i = \sum_{j=1}^{12} c_{ij} \tag{9}$$

where C_i denotes annual consumption of vehicle fuel for the ith vehicle, in gasoline equivalent gallons and c_{ij} denotes consumption of vehicle fuel for the i^{th} vehicle during the j^{th} month.

Consumption is calculated over 12 months, based on NHTS assuming 12 month for its annualizing-VMT procedure. That is, according to NHTS, a sample vehicle is assumed to exist for a complete 12-month duration in a sample household. Consumption estimates, with respect to vehicle duration, are dependent upon those annualization assumptions employed in the NHTS.

Consumption for each month may be expressed in terms of monthly VMT and monthly in-use fuel economy:

$$c_{ij} = \frac{m_{ij}}{mpg_{ij}}, \forall\, j = 1, 2, \ldots, 12 \tag{10}$$

where m_{ij} denotes VMT for the i^{th} vehicle during the j^{th} month and mpg_{ij} denotes fuel economy in miles per gasoline equivalent gallon for the i^{th} vehicle during the j^{th} month. Now, Equation can be rewritten as:

$$C_i = \sum_{j=1}^{12} \frac{m_{ij}}{mpg_{ij}} \tag{11}$$

ORNL provided the annualized VMT estimate for NHTS that was used to calculate monthly VMT values. Given that value, a monthly VMT was derived for each annualized vehicle VMT as:

$$m_{ij} = M_i \bullet f_{ij} \tag{12}$$

where M_i denotes for the i^{th} vehicle, calculated using odometer readings and procedures discussed in Appendix J and f_{ij} denotes the average fraction of "annual" VMT that was driven during the j^{th} month, estimate for the i^{th} vehicle. For all sample vehicles, f_{ij} was approximated with the average fractions, F_j, found in Table 2.

Substituting $mpg_{ij} = MPG_{ij(in\text{-}use)}$ and m_{ij} from Equation 12 into Equation 11 yields the following estimate of annual consumption for the i^{th} vehicle:

$$C_i = \sum_{j=1}^{12} \frac{M_i \bullet f_{ij}}{MPG_{ij(in\text{ - }use)}} \tag{13}$$

Since NHTS assumes that each sample vehicle exists in the sample household for an entire year, no alternative estimators for acquired or disposed vehicles were created.

To simply calculations, a single "annualized" fuel economy that is analogous to the "annualized" MPG_i was estimated as:

$$MPG_{i(annualized)} = \frac{MPG_{i(EPA\ 55/45)}}{\sum_{j=1}^{12} f_{ij} \bullet GPMR_{ij(in-use)}} \tag{14}$$

Thus, annual consumption equals:

$$C_i = \frac{M_i}{MPG_{i(annualized)}}. \tag{15}$$

K-4. ANNUAL VEHICLE-FUEL EXPENDITURES AND PRICE

K-4.1 VEHICLE FUEL EXPENDITURES

In the 2001 NHTS, fuel expenditures were calculated by multiplying the vehicle-fuel consumption by the price of the vehicle fuel. The 2001 NHTS did not collect vehicle fuel prices via fuel purchase diaries. Instead, each NHTS sample vehicle was assigned a price based on imputed engine type and fuel metering values obtained from the NHTSA Corporate Average Fuel Economy files for model year's 1978-2001. For pre-1978 model year vehicles, otto engine and gasoline were imputed for engine type and fuel metering, respectively. Fuel prices, by month, were obtained from the following Energy Information Administration survey questionnaires:

- Form EIA-782A[16] "Refiners'/Gas Plant Operators' Monthly Petroleum Product Sales Report."
- Form EIA-782B[17] "Resellers'/Retailers' Monthly Petroleum Product Sales Report."
- Form EIA-888[18] "On-Highway Diesel Fuel Price Survey."
- Form EIA-895[19] "Monthly Quantity and Value of Natural Gas Report."

[16] Price and volume data at a State level for 14 petroleum products for various retail and wholesale marketing categories are reported by the universe of refiners and gas plant operators.

[17] Price and volume data at the State level for gasoline, No. 2 distillate, propane, and residual fuel are reported by a sample of distillate fuel oil resellers and retailers, motor gasoline wholesalers, and residual fuel oil resellers and retailers.

[18] The Form EIA-888 survey collects data on the National and Petroleum Administration for Defense (PAD) District level cash price of self-serve, motor vehicle diesel fuel. The data are used to monitor changes in motor vehicle diesel fuel prices and to report to the Congress and others when requested. Respondents are a scientifically selected sample of companies owning retail outlets which sell motor vehicle diesel fuel.

- Form EIA-826[20] "Monthly Electric Utility Sales and Revenue Report with State Distributions."

It is important to define the transportation fuels included in each of these prices. See the following sections for further details on transportation fuel prices.

It is also important to point out that the NHTS did not collect information on the use of alternate fuels. Because of that omission, it was not possible to properly assign fuel consumption for dual-fuel (or flexible-fuel) vehicles. While these supplemental data do not explicitly account for alternative fuel use, the supplemental NHTS data should allow for a user to freely assign an alternative fuel use fraction. For example, one common assumption is to assign an operating scenario where 50 percent of the time the vehicle runs on alternative fuel (e.g., E85) and 50 percent of the time on conventional fuel (i.e., gasoline). Using the supplemental data and VMT estimate, in conjunction with EIA's fuel economy adjustment methodology, a user may make their own assignment of alternative fuel use. Because allowances have been made for self-estimating alternate fuel use and, more importantly, the NHTS collected no data to verify any method for assigning alternative fuel use, all consumption and expenditures supplemental data are based on a dedicated use of motor gasoline, diesel, natural gas, or electricity. That is, all flexible-fuel vehicles are assumed to operate on 100 percent gasoline. Thus, estimates for flexible-fuel vehicles are accurate to the extent that this assumption is valid.

Unfortunately, respondents were not asked the type of fuel purchased for their transportation demands. Further, respondents were not queried on the grade of their purchased fuels. Thus, fuel type was imputed to a sample vehicle based on its representative "match" with the selected vehicle from the NHTSA files. A matching record was chosen from among the several applicable ones, with probability proportional to sales, using the sales figures on the NHTSA files. Once chosen, a record provided (1) EPA Composite MPG, (2) fuel metering, and (3) engine type. The later two items provided enough information to impute a fuel type to a "matched" sample vehicle.

The EIA price series are published by month, by State, 5 PAD districts (PADD), and by type and grade of fuel. For the 2001 NHTS, annual fuel expenditures, E_i, was estimated by multiplying monthly gasoline prices by monthly consumption to produce monthly expenditures, summing over the monthly expenditures derived annual expenditures.

K-4.2 TYPE OF FUEL USED

Table 3 provides the percentage distribution of RTECS vehicles by fuel type categories. In 1994, the latest year for which RTECS estimates are available, 97.9 percent of the 156.8 million RTECS vehicles used gasoline. The remaining 2.1 percent of vehicles used diesel fuel or other fuel types.

[19] Monthly and annual production data are collected from the appropriate agencies of the natural gas producing States.

[20] Form EIA-826 collects information from regulated and unregulated companies that sell or deliver electric power to end users, including electric utilities, energy service providers, and distribution companies..

Table 3. Distribution of Residential Transportation Energy Consumption Survey Vehicles by Type of Fuel Used, 1994

Type of Vehicle Fuel	Number of Vehicles	Percent of Vehicles
Total	156.8	100.0
Gasoline	153.4	97.9
Leaded	Q	Q
Unleaded	151.5	96.7
Regular	14.2	66.4
Premium	26.7	17.1
Intermediate	20.6	13.2
Diesel	1.8	1.1
Gasohol	1.4	0.9

Notes: Because of rounding, data may not sum to totals. Q = Data withheld either because the Relative Standard Error (RSE) was greater than 50 percent or fewer than 10 households were sampled. Source: Energy Information Administration, Office of Energy Markets and End Use, *1994 Residential Transportation Energy Consumption Survey*.

Comparing the 1994 RTECS and supplemented 2001 NHTS is not viable because of the differences in data collected by the RTECS and the imputed information for the NHTS. Table 4 shows the NHTS distribution obtained from imputed fuel type and fuel metering information.

Table 4. Distribution of National Household Travel Survey Vehicles by Imputed Type of Fuel Used, 2001

Type of Vehicle Fuel	Number of Vehicles	Percent of Vehicles
Total	203.9	100.0
Gasoline	200.0	98.1
Duel-Fuel	1.4	0.7
Diesel	0.7	0.3
Other	(s)	(s)
Not Imputed	3.1	1.5

Notes: Because of rounding, data may not sum to totals. (s) = cell value rounds to zero. Sources: U.S. Department of Transportation, Federal Highway Administration, *2001 National Household Travel Survey*, U.S. Department of Transportation, National Highway and Traffic Safety Administration, Corporate Average Fuel Economy files with vehicle model year's 1978 through 2001 and Energy Information Administration, Office of Energy Markets and End Use, Residential Transportation Energy Consumption Surveys.

K-4.3 GASOLINE PRICES

Prices published by the EIA supplier surveys are pre-tax prices for conventional, oxygenated, and reformulated motor gasoline. Pre-tax prices were supplemented with Federal and State tax rates, by month, to derive retail motor gasoline prices; information on tax rates for gasoline are available from the Federal Highway Administration's web site. These pre-tax prices are published monthly, by State, in EIA's *Petroleum Marketing Monthly*, which includes price (excluding taxes) and volume data at a State level for 14 petroleum products for various retail and wholesale marketing categories are reported by the universe of refiners and gas plant operators.

Because the NHTS did not collect the type or grade of gasoline consumed in each sample vehicle, gasoline price was assigned a monthly fuel price that represents a State's volume-weighted average of gasoline. The below is an excerpt from the glossary of the *Petroleum Marketing Monthly*, as reported by EIA, which identifies the composition of the motor gasoline prices used in this appendix.

> ***Motor Gasoline (Finished)****: A complex mixture of relatively volatile hydrocarbons with or without small quantities of additives, blended to form a fuel suitable for use in spark-ignition engines. Motor gasoline, as defined in ASTM Specification D-4814 or Federal Specification VV-G-1690B, is characterized as having a boiling range of 122 to 158 degrees Fahrenheit at the 10 percent recovery point to 365 to 374 degrees Fahrenheit at the 90 percent recovery point. "Motor Gasoline" includes conventional gasoline; all types of oxygenated gasoline, including gasohol; and reformulated gasoline, but excludes aviation gasoline.*
>
> ***Conventional Gasoline****: Motor gasoline not included in the oxygenated or reformulated gasoline categories. Excludes reformulated gasoline blendstock for oxygenate blending (RBOB).*
>
> ***Oxygenated Gasoline****: Finished motor gasoline, other than reformulated gasoline, having an oxygen content of 2.7 percent or higher by weight and required by the U.S. Environmental Protection Agency (EPA) to be sold in areas designated by EPA as carbon monoxide (CO) nonattainment areas. Note: Oxygenated gasoline excludes oxygenated fuels program reformulated gasoline (OPRG) and reformulated gasoline blendstock for oxygenate blending (RBOB). Data on gasohol that has at least 2.7 percent oxygen, by weight, and is intended for sale inside CO nonattainment areas are included in data on oxygenated gasoline. Other data on gasohol are included in data on conventional gasoline.*
>
> ***Reformulated Gasoline****: Finished motor gasoline formulated for use in motor vehicles, the composition and properties of which meet the requirements of the reformulated gasoline regulations promulgated by the U.S. Environmental Protection Agency under Section 211(k) of the Clean Air Act. Note: This category includes oxygenated fuels program reformulated gasoline (OPRG) but excludes reformulated gasoline blendstock for oxygenate blending (RBOB).*

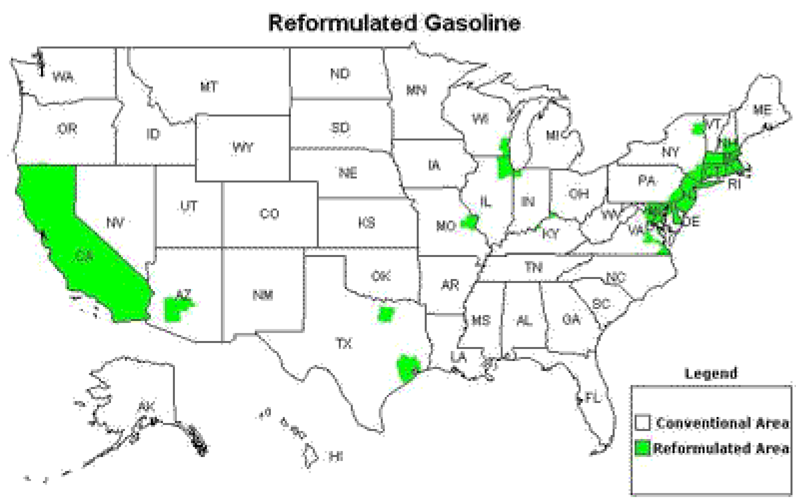
Further, EIA classifies gasoline by octane ratings, where each type of gasoline (conventional, oxygenated, and reformulated) is classified by three grades:

1) Regular Gasoline: Gasoline having an antiknock index (i.e., octane rating) greater than or equal to 85 and less than 88. Note: Octane requirements may vary by altitude.

2) Midgrade Gasoline: Gasoline having an antiknock index (i.e., octane rating) greater than or equal to 88 and less than or equal to 90. Note: Octane requirements may vary by altitude.

3) Premium Gasoline: Gasoline having an antiknock index (i.e., octane rating) greater than 90. Note: Octane requirements may vary by altitude.

Figure 3. Area Map for Reformulated Gasoline



Source: Energy Information Administration, website www.eia.doe.gov/oil_gas/petroleum/data_publications/wrgp/reformulated_map.html.

K-4.4 DIESEL FUEL PRICES

Prices published by the EIA supplier surveys are at the retail level for diesel fuel. The form EIA-888 survey collects data on the National and Petroleum Administration for Defense (PAD) District[21] level cash price of self-serve, motor vehicle diesel fuel. The data are used to monitor changes in motor vehicle diesel fuel prices and to report to the Congress and others when requested. Respondents are a scientifically selected sample of companies owning retail outlets that sell motor vehicle diesel fuel. Prices are published on http://tonto.eia.doe.gov/oog/info/wohdp/diesel.asp by EIA.

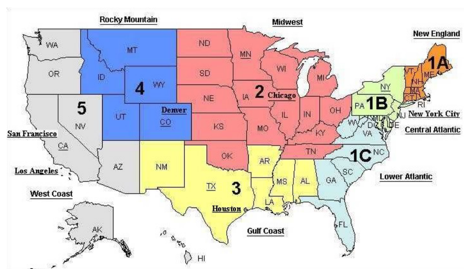
EIA conducts weekly Computer Assisted Telephone Interview surveys that collect prices at the outlet level. The EIA-888 collects prices of diesel fuel from truck stops and service stations

[21] PAD District 1 (East Coast) is composed of the following three subdistricts: Subdistrict 1A (New England): Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont. Subdistrict 1B (Central Atlantic): Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania. Subdistrict 1C (Lower Atlantic): Florida, Georgia, North Carolina, South Carolina, Virginia, West Virginia. PAD District 2 (Midwest): Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Ohio, Oklahoma, Tennessee, Wisconsin. PAD District 3 (Gulf Coast): Alabama, Arkansas, Louisiana, Mississippi, New Mexico, Texas. PAD District 4 (Rocky Mountain): Colorado Idaho, Montana, Utah, Wyoming. PAD District 5 (West Coast): Alaska, Arizona, California, Hawaii, Nevada, Oregon, and Washington.

across the country each Monday morning. Average prices of diesel fuel through outlets at the five Petroleum Administration for Defense District (PADD) levels, regions of the country, sub-PADD levels, and the state of California are released by the end of the day through Listserv, the Web, Fax, and telephone hotline.

Because the NHTS did not collect the type or grade of diesel consumed in each sample vehicle, diesel price was assigned to a diesel-powered vehicle based on a monthly fuel price represented by a PAD that includes the State in which the sample vehicle resides, according to NHTS, with the notable exception of the state of California where assignment was completed within state geographic boundaries.

Figure 4. Map of Petroleum Administration for Defense Districts



K-4.5 OTHER FUEL TYPE PRICES

According to the 1994 RTECS, approximately 1.4 million vehicles were reported using gasohol. Unfortunately, in the 2001 NHTS, there is no comparable statistic because gasohol-consuming vehicles were imputed as dedicated gasoline vehicles. This imputation was needed because NHTS did not collect fuel use information on its survey questionnaire.

While the NHTS cannot delineate gasohol use, this appendix does address dedicated compressed natural gas (CNG) and electric vehicles.[22] For CNG, retail prices were obtained from form EIA-895, "Monthly Quantity and Value of Natural Gas Report". The EIA-895 collects monthly information from the applicable State agencies that collect data concerning natural gas production. Data are published in several of EIA's monthly and annual reports. For electricity, retail prices were obtained from form EIA-826, "Monthly Electric Utility Sales and Revenue Report with State Distributions." Form EIA-826 collects information from regulated and unregulated companies that sell or deliver electric power to end users. While three customer groups were available, residential customers were selected to represent electric prices because

[22] Propane vehicles are not included in the NHTSA files. Thus, no propane-fuel vehicles exist in NHTS supplemental data.

this group most accurately reflected the retail electric price for NHTS households. State and regional summaries of these data are published by EIA and used by public and private analysts. Respondents are a sample of natural gas companies that deliver gas to consumers in the United States.

APPENDIX K. FUEL ECONOMY AND FUEL COST

QUALITY OF THE DATA

K-5. INTRODUCTION

This section discusses several issues relating to the quality of the National Household Travel Survey (NHTS) data and to the interpretation of conclusions based on these data. In particular, the focus of our discussion is on the quality of specific data items, such as the fuel economy and fuel type that were imputed to the NHTS via a cold-decking imputation procedure. This imputation procedure used vehicle-level information from the NHTSA Corporate Average Fuel Economy files for model year's 1978 through 2001.[23] It is nearly impossible to quantify directly the quality of this imputation procedure because NHTS does not collect the necessary fuel economy information for comparison. At best, we have indirect evidence on the quality of our imputations, which is addressed in the following sections. Indeed, such an imputation procedure could be vastly improved with the collection of Vehicle Identification Number (VIN), fuel type and retail fuel price for each sample vehicle. However, those collections may represent an unreasonable burden on NHTS respondents.

The quality of the data collection and the processing of the data affect the accuracy of estimates based on survey data. All the statistics published in this appendix, such as total vehicle-miles traveled (VMT), are estimates of population values. These estimates are based on observations from a randomly chosen subset of the entire population of occupied housing units. Consequently, the estimates always differ from the true population values. Because the NHTS is a sample survey, data from the survey are subject to various sources of nonsampling and sampling error.

Nonsampling error is a measure of variability due to the execution and processing of the survey. These errors can include: population undercoverage during sampling; questionnaire wording and format; response bias and variance; interviewer error; coding and/or keypunching error; and nonresponse bias. Nonsampling errors are treated in several sections of this appendix. The main section pertains to the imputation procedures used for "missing" fuel economy, fuel type, and fuel economy adjustments. In the previous sections, fuel economy adjustments were addressed. So, this section deals mainly with imputing fuel economy or $MPG_{i(EPA\ 55/45)}$ to each appropriate sample vehicle.

K-5.1 NONSAMPLING ERROR

Nonsampling errors are due to the conduct of the survey, and include both random errors and systematic errors or biases. The magnitudes of nonsampling biases cannot be estimated from the

[23] NHTSA files exclude 2002 model year vehicles because data were not available at the time of the Version 3 release of NHTS data. It is anticipated that EIA/FHWA will release a "value-added" addendum for 2002 model year vehicles.

sample data. Thus, avoidance of systematic biases is a primary objective of all stages of survey design. Subsequent to conducting a survey, problems of unit nonresponse and item nonresponse need to be addressed.

In surveys with complex questionnaires and procedures, such as the NHTS, the final dataset reflects fundamental approaches taken in the data collection and editing processes. For the 2001 NHTS, two approaches may have had considerable impact on the resulting data.

The first is the reluctance to impute data. If the respondent did not answer an item, its value was generally not imputed, (i.e., determine what the logical response would be given the response to other items). Carefully performed imputation has its place in many statistical surveys, however Westat and USDOT determined that imputation would be limited in the NHTS data. If data were imputed, an imputation/edit flag was set for the variable to indicate the values that were imputed. The treatment in the NHTS of these types of errors is discussed in 3-D.3. APPROACH TO POST INTERVIEW EDITING of the NHTS User's Guide.

Supplemental data, by definition, are 100 percent imputed. Thus, it is important that EIA thoroughly present the approach used to impute energy-related supplemental NHTS data.

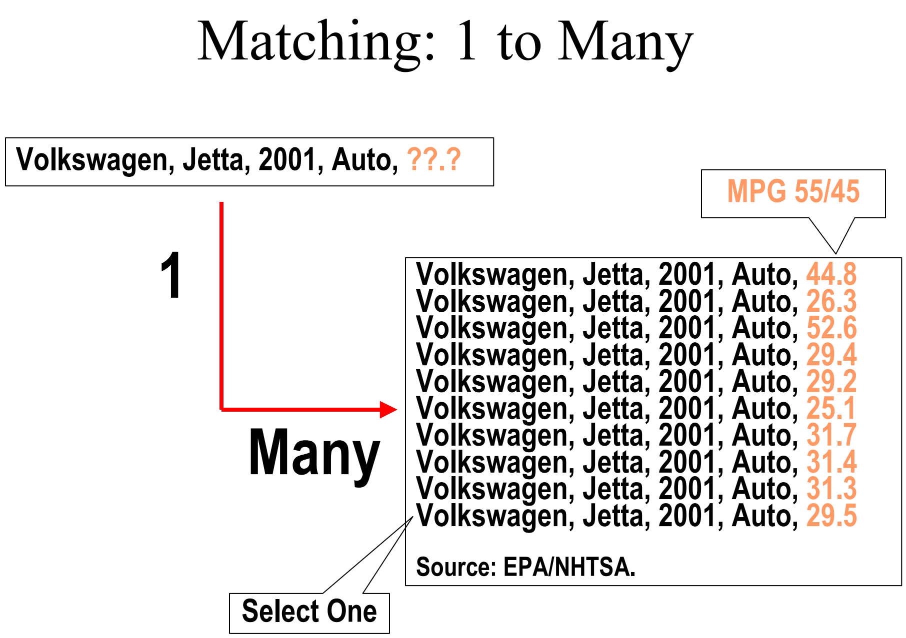
K-5.2 UNIT NONRESPONSE

Unit nonresponse is the type of nonresponse that occurs when no data are available for an entire sampled household. The respondent being unavailable or the respondent's refusal to cooperate causes most unit nonresponse cases. See the NHTS User's Guide, CHAPTER 4. SURVEY RESPONSE RATES, for further details on unit nonresponse.

K-5.3 IMPUTATION PROCEDURES FOR SUPPLEMENTAL DATA

Imputation procedures fill in the gaps of "missing" data. Item nonresponse occurs when the respondents do not know the answer or refuse to answer a question, or when an interviewer does not ask a question or does not record an answer. Or, as in the case of this appendix, item nonresponse occurs when a question was not asked, such that imputation procedures are required to address the need to append supplemental data to a pre-existing file from other external, but related, files. As already mentioned, NHTS took a conservative approach to item nonresponse. For supplemental data, in an effort to facilitate "full-sample" data analyses, imputations were made to provide the most probable responses when responses were "missing." For linking supplemental data, a pseudo cold-decking imputation was employed. Figure 5 depicts the cold-deck approach, using NHTS make, model, model year, and vehicle type information to "match" with eligible donors from the NHTSA CAFE files.

Figure 5. Schematic for Linking or Matching a NHTS Sample Vehicle to Eligible EPA/NHTSA Vehicles



Note: EPA – Environmental Protection Agency, NHTSA – National Highway Transportation Safety Administration.

K-5.4 COLD-DECK PROCEDURE

Because we cannot deduce the fuel economy for a sample vehicle by its collected NHTS data, a cold-deck imputation procedure was employed to “match” a NHTSA file record to a sample vehicle. A matching record was chosen from among the several applicable ones, with probability proportional to sales, using the sales figures on the NHTSA files. Once chosen, a record provided (1) EPA Composite MPG, (2) fuel metering, and (3) engine type. Although more attributes were available for selection, EIA limited its “donated” vehicle attributes to those required to assign an appropriate fuel price to a sample vehicle. This matching routine commonly resulted in a 1-to-many record linkage (see Figure 5 for an example).

Cold-deck procedures make use of a fixed set of values, which covers all of the perspective data items. These values can be constructed with the use of historical data, subject-matter expertise, or a combination of both. Such a procedure is an attempt to create a “perfect'” questionnaire in order to fill in the missing data gaps or, in this case, append supplemental data. If these procedures are completed properly and with limited bias, imputation has the ability to derive a complete and accurate record that (1) contains an audit trail for evaluation purposes; and (2) ensures that the imputed records are internally consistent.

Multiple paths were used to “match” recipient NHTS sample vehicles to eligible donor NHTSA file record vehicles. Because matching used a combination of four common linking variables – vehicle manufacturer, vehicle model, vehicle model year, and vehicle type – several "matching" paths were followed. These paths are denoted (i.e., internally audited) with imputation flags, which may be defined as follows:

- 10# represents a NHTS sample vehicle that had a single model name "matching" to eligible NHTSA file records using four linking variables: vehicle manufacturer, vehicle model, vehicle model year, and vehicle type.

- 20# represents a NHTS sample vehicle that had multiple model names "matching" to eligible NHTSA file records using four linking variables: vehicle manufacturer, vehicle model, vehicle model year, and vehicle type.

- 30# represents a NHTS sample vehicle that had a single model name "matching" to eligible NHTSA file records using three linking variables: vehicle manufacturer, vehicle model, and vehicle model year.

- 40# represents a NHTS sample vehicle that had multiple model names "matching" to eligible NHTSA file records using three linking variables: vehicle manufacturer, vehicle model, and vehicle model year.

- 50# represents a NHTS sample vehicle that had a single model name "matching" to eligible NHTSA file records using three linking variables: vehicle manufacturer, vehicle type, and vehicle model year.

- 60# represents a "match" based on EIA expert analysis using subject matter experience, in conjunction with past RTECS. Additionally, this imputation flag value represents motorcycles (VEHTYPE = 07), where $MPG_{(EPA\ 55/45)}$ has been fixed at 50 mile per gallon of gasoline based on the U.S. Department of Transportation, *National Transportation Statistics 2000*.[24]

- 999 represents an imputation flag where no eligible NHTSA file records were found to "match" a NHTS sample vehicle. It is important to point out that 2002 model year vehicles were not included in the NHTSA files because those data had not been release before the Version 3 release of the NHTS occurred.

In the above listing, # is a number between 0 and 5. This number, #, represents a year increment. Due to the errors in respondents reporting accurate model year or, to a lesser extent, due to deficiencies in the NHTSA files, it was necessary to incrementally increase or decrease (not simultaneously increase and decrease) the model year for "matching" to successively larger range of years. If, for example, an eligible match was not found for a NHTS sample vehicle having the following attributes: Volkswagen, Scirocco, 1990, Automobile. Toggling of model years, by a single year increase followed by a single year decrease of the reported model year, resulted in a match with a Volkswagen, Scirocco, 1988, Automobile. In this example, the Volkswagen, Scirocco, 1990, Automobile, while seemingly a respondent reporting error, would receive an imputation flag of "102" due to the "match" with the NHTSA file record corresponding to a Volkswagen, Scirocco, 1988, Automobile.

[24] Table 4-11. Passenger Car and Motorcycle Fuel Consumption and Travel, *National Transportation Statistics 2000* Bureau of Transportation Statistics, U.S. Department of Transportation. (Washington, DC).

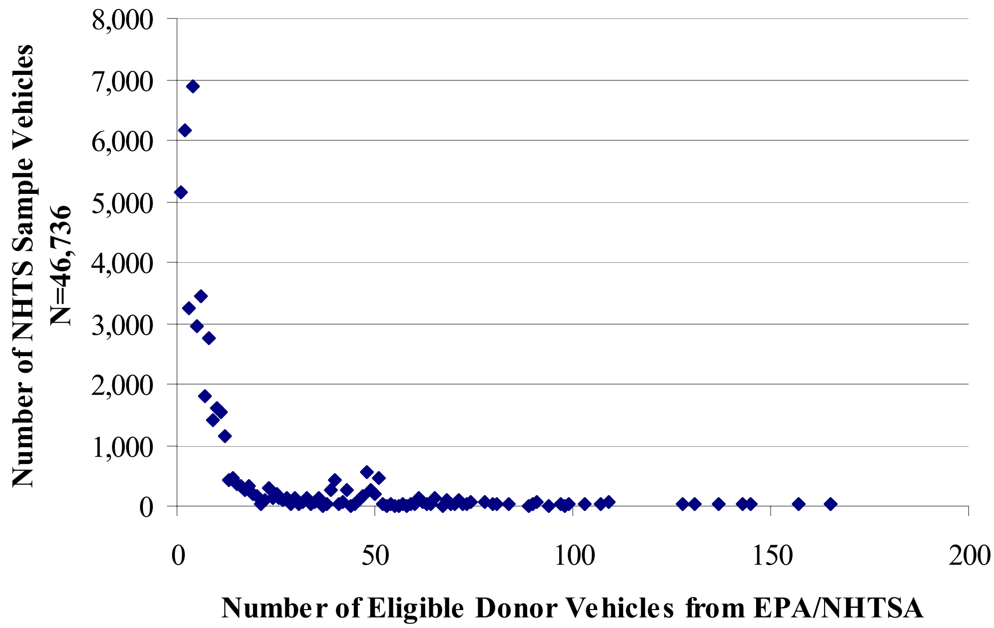
Table 5. Distribution of NHTS Sample Vehicles by Fuel Economy Imputation Flag, 2001

Imputation Flag for $MPG_{(EPA\ 55/45)}$	Number of Vehicles in NHTS Sample
100	3,707
101	123
102	44
103	33
104	27
105	53
200	36,629
201	1,716
202	484
203	322
204	213
205	72
300	37
301	4
302	1
303	4
400	681
401	45
402	65
403	31
404	10
405	6
500	2,309
501	45
502	38
503	29
504	13
505	22
600	1,856
999	4,659
Total	**53,278**

Source: U.S. Department of Transportation, Federal Highway Administration, *National Household Travel Survey 2001*, Version 3 release, (Washington, DC).

While the distribution of imputation flags is helpful, further evidence is needed to quantify the quality of this procedure. Figure 6 charts the 1-to-many "matching" relationship for the 46,763 "matched" sample vehicles, or 53,278 less 4,659 (for 999 flag) less 1,856 (for 600 flag).

Figure 6. Distribution of NHTS Sample Vehicles "Matched" with Vehicles "Donated" by NHTSA File Records



Source: U.S. Department of Transportation, Federal Highway Administration, *National Household Travel Survey 2001*, Version 3 release, (Washington, DC).

To make the "match" distribution display more revealing, values from the above figure are tabulated to present range categories of donor vehicles in Table 6.

Table 6. Distribution of NHTS Sample Vehicles "Matched" by Range of Donor Vehicles

Range of Eligible Donor Vehicles	Number of Vehicles in NHTS Sample
1	5,155
2 to 10	30,273
11 to 20	5,199
21 to 30	1,254
31 to 40	1,146
41 to 50	1,657
51 or more	2,079
Total	46,763

Source: National Household Travel Survey 2001, Version 3 release, Federal Highway Administration, U.S. Department of Transportation (Washington, DC).

K-6. QUALITY OF SPECIFIC SUPPLEMENTAL DATA ITEMS

K-6.1 VEHICLE FUEL PRICE AND EXPENDITURES

In the 2001 NHTS, fuel price data were not collected via fuel purchase diaries, compared to previous EIA studies (e.g., RTECS). Instead, fuel prices were determined from EIA price series. Unfortunately, there is no way to validate the price methodology used because EIA lacks the necessary fuel purchase diaries.

Other prices series do exist. For example, the Bureau of Labor Statistics (BLS) Retail Pump Average Gasoline Prices and the Lundberg Survey, Inc. offer alternate price series. However, there was a general consistency with using a price series from one statistical agency.

K-6.2 GASOLINE EQUIVALENT GALLON

The following table provides the gasoline equivalent gallon conversion used in this appendix. All conversion values, to the extent possible, have been made to mirror the conversion values used in deriving equivalent-gallon fuel economy estimates found in the NHTSA CAFE files.

Table 7. Gasoline Equivalent Gallon Conversion Values

Transportation Fuel	Gasoline Equivalent Gallon
Diesel	1 diesel gallon = 1 gasoline equivalent gallon
Electricity	33,705 Watt-hours = 1 gasoline equivalent gallon
Compressed Natural Gas	121.5 cubic feet = 1 gasoline equivalent gallon

Sources: 40 CFR Parts 80, 85, 86, 88, and 600 and 10 CFR Part 474.

K-6.3 GREET MODEL

Of course, there are other conversion factors available, depending on the various fuel-specific factors. For the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model, the US Department of Energy, Argonne National Laboratory uses the following:

Table 8. Lower and Higher Heating Values for Select Transportation Fuels Based on the GREET Model

Transportation Fuel	LHV (net) Btu per gallon	HHV (gross) Btu per gallon	Density Grams per gallon	Carbon Content (% by wt)	Sulfur Content (ppm by wt)
Conv.Gasoline	115,500	125,000	2,791	85.5%	200
Ref. Gasoline	112,265	121,456	2,795	82.9%	30
Diesel	128,500	138,700	3,240	87.0%	250
Methanol	57,000	65,000	2,996	37.5%	0
Ethanol	76,000	84,500	2,996	52.2%	0

Table 8. Lower and Higher Heating Values for Select Transportation Fuels Based on the GREET Model

Transportation Fuel	LHV (net) Btu per gallon	HHV (gross) Btu per gallon	Density Grams per gallon	Carbon Content (% by wt)	Sulfur Content (ppm by wt)
Natural gas	928	1,031	21	74.0%	7
Electricity	3,412	Btu/kWh			

Source: M. Wang, GREET 1.5 -- *Transportation Fuel-Cycle Model*, Volume 1: Methodologies, Development, Use, and Results, Center for Transportation Research, Argonne National Laboratory, ANL/ESD-39, Vol.1, Aug. 1999. M. Wang, GREET 1.5 -- Transportation Fuel-Cycle Model, Volume 2: Appendices of Data and Results, Center for Transportation Research, Argonne National Laboratory, ANL/ESD-39, Vol.2, Aug. 1999. Notes: 1) Gasoline results are for the mix of 70% conventional gasoline and 30% reformulated gasoline. 2) LPG results are for the mix of 40% LPG produced from crude and 60% from natural gas. 3) Electricity results are for the current U.S. average electricity generation mix.

K-6.4 TRANSPORTATION ENERGY DATA BOOK: EDITION 22 — 2002

Likewise, the Energy Information Administration, US Department of Energy (according to the latest *Transportation Energy Data Book*) applies the following approximate heat content for various fuels:

Table 9. Lower and Higher Heating Values for Various Transportation Fuels

Transportation Fuel	HHV (gross) equivalent to LHV (net)
Automotive gasoline	125,000 Btu/gal (gross) = 115,400 Btu/ gal(net)
Diesel motor fuel	138,700 Btu/gal (gross) = 128,700 Btu/gal (net)
Biodiesel	126,206 Btu/gal (gross) = 117,093 Btu/gal (net)
Methanol	64,600 Btu/gal (gross) = 56,560 Btu/gal (net)
Ethanol	84,600 Btu/gal (gross) = 75,670 Btu/gal (net)
Gasohol	120,900 Btu/gal (gross) = 112,417 Btu/gal (net)
Aviation gasoline	120,200 Btu/gal (gross) = 112,000 Btu/gal (net)
Propane	91,300 Btu/gal (gross) = 83,500 Btu/gal (net)
Butane	103,000 Btu/gal (gross) = 93,000 Btu/gal (net)
Jet fuel (naphtha)	127,500 Btu/gal (gross) = 118,700 Btu/gal (net)
Jet fuel (kerosene)	135,000 Btu/gal (gross) = 128,100 Btu/gal (net)
Lubricants	144,400 Btu/gal (gross) = 130,900 Btu/gal (net)
Waxes	131,800 Btu/gal (gross) = 120,200 Btu/gal (net)
Natural Gas	
Wet	1,109 Btu/ft^3
Dry	1,027 Btu/ft^3
Compressed	20,551 Btu/pound
	960 Btu/ft^3
Liquid	90,800 Btu/gal (gross) = 87,600 Btu/gal (net)

Table 9. Lower and Higher Heating Values for Various Transportation Fuels

Transportation Fuel	HHV (gross) equivalent to LHV (net)
Fuel Oils	
Residual	149,700 Btu/gal (gross) = 138,400 Btu/gal (net)
Distillate	138,700 Btu/gal (gross) = 131,800 Btu/gal (net)

Source: U.S. Department of Energy, Oakridge National Laboratory, Center for Transportation Analysis, *Transportation Energy Data Book Edition 22*, Washington, DC, 2002, Table B.1, ORNL-6967.

According to the latest *Data Book*,

> *The heat content of a fuel is the quantity of energy released by burning a unit amount of that fuel. However, this value is not absolute and can vary according to several factors. For example, empirical formulae for determining the heating value of liquid fuels depend on the fuels' American Petroleum Institute (API) gravity. The API gravity varies depending on the percent by weight of the chemical constituents and impurities in the fuel, both of which are affected by the combination of raw materials used to produce the fuel and by the type of manufacturing process. Temperature and climatic conditions are also factors.*
>
> *Because of these variations, the heating values in above table may differ from values in other publications. The figures in the Edition 22 report are representative or average values, not absolute ones. The gross heating values used here agree with those used by the Energy Information Administration (EIA).*
>
> *Heating values fall into two categories, gross and net. If the products of fuel combustion are cooled back to the initial fuel-air or fuel-oxidizer mixture temperature and the water formed during combustion is condensed, the energy released by the process is the higher (gross) heating value. If the products of combustion are cooled to the initial fuel-air temperature, but the water is considered to remain as a vapor, the energy released by the process is lower (net) heating value. Usually the difference between the gross and net heating values for fuels used in transportation is around 5 to 8 percent; however, it is important to be consistent in their use.*

EIA strongly encourages a consistent use of heating values.

APPENDIX K. FUEL ECONOMY AND FUEL COST

SUPPLEMENTAL DATA AND SUMMARY TABLES

K-7. VARIABLE NAMES AND CODEBOOK

1. **EIADMPG** – EIA derived/adjusted miles per gallon estimate. Because of alternate-fuel vehicles, this is a 5-digit (###.#) derived estimate. Note this value represents an adjusted **EPATMPG** variable (see below).

2. **EPATMPG** – EPA estimate of 55/45 combined total MPG, unadjusted for discount factors. This is a 5-digit (###.#) estimate obtained from EPA test data.

3. **GSCOST** – should be a 6-digit (###.##) Fuel cost estimated in cents per gallon (diesel or gasoline) in local area, based on the sample household location.

4. **BTUCOST** – should be a 6-digit (###.##) Fuel cost estimated in units of cents per gasoline equivalent gallon for electric or compressed natural gas vehicles, rather than cents per physical gallon.

5. **BESTMILE** – should be a 6-digit (######) Estimated annual miles this car was driven (derived by ORNL). These values represent ORNL's (see APPENDIX J of the User's Guide) estimate of miles driven for a sample vehicle.

6. **GSTOTCST** – 4-digit (####) Total dollar cost of fuel per year for gasoline and diesel vehicles (derived from **GSCST** and **GSYRGAL**).

7. **BTUTCOST** – 4-digit (####) Total dollar cost of fuel per year (derived from **BTUCOST** and **BTUYEAR**). This value is available for non-gasoline and -diesel vehicles.

8. **GSYRGAL** – 4-digit (####) estimate of the number of gallons of gasoline consumed per year. This value is derived from **BESTMILE** and **EIADMPG**.

9. **BTUYEAR** – 4-digit (####) estimate of the amount of gasoline equivalent gallons consumed per year. This value is derived from **BESTMILE** and **EIADMPG** and is available for non-diesel and -gasoline vehicles.

10. **FUELTYPE** – 1-digit (#) classification code for fuel consumed in a sample vehicle, where 1 represents diesel, 2 represents natural gas, 3 represents electricity, and 4 represents motor gasoline.

An imputation flag, **EPATMPGF**, is available for **EPATMPG.**

In the case where an individual variable value was not obtained, a –9 value has been inserted to denote "Not Ascertain." While it is possible to impute for such values, EIA has kept with the conservative approach used in the NHTS when dealing with item imputations.

> *Please note that no information is provide for 2002 model year vehicles in the Fuel Economy and Fuel Cost addendum of this release (i.e., Version 3 of the 2001 National Household Travel Survey). Because 2002 model year information was not available at the time of processing this release, EIA and USDOT plan to release Fuel Economy and Fuel Cost for 2002 vehicles as a value-added addendum.*

EPATMPGF denotes (i.e., internally audited) the path taken to impute a composite EPA value. This flag is defined as follows:

- 10# represents a NHTS sample vehicle that had a single model name "matching" to eligible NHTSA file records using four linking variables: vehicle manufacturer, vehicle model, vehicle model year, and vehicle type.

- 20# represents a NHTS sample vehicle that had multiple model names "matching" to eligible NHTSA file records using four linking variables: vehicle manufacturer, vehicle model, vehicle model year, and vehicle type.

- 30# represents a NHTS sample vehicle that had a single model name "matching" to eligible NHTSA file records using three linking variables: vehicle manufacturer, vehicle model, and vehicle model year.

- 40# represents a NHTS sample vehicle that had multiple model names "matching" to eligible NHTSA file records using three linking variables: vehicle manufacturer, vehicle model, and vehicle model year.

- 50# represents a NHTS sample vehicle that "matched" to eligible NHTSA file records using three linking variables: vehicle manufacturer, vehicle type, and vehicle model year.

- 60# represents a "match" based on EIA expert analysis using subject matter experience, in conjunction with past RTECS. Additionally, this imputation flag value represents motorcycles (VEHTYPE = 07), where $MPG_{(EPA\ 55/45)}$ has been fixed at 50 mile per gallon of gasoline based on the U.S. Department of Transportation, *National Transportation Statistics 2000*.[25]

- 999 represents an imputation flag where no eligible NHTSA file records were found to "match" a NHTS sample vehicle. It is important to point out that 2002 model year

[25] Source: Table 4-11. Passenger Car and Motorcycle Fuel Consumption and Travel, *National Transportation Statistics 2000* Bureau of Transportation Statistics, U.S. Department of Transportation. (Washington, DC).

vehicles were not included in the NHTSA files because those data had not been released before the Version 3 release of the NHTS occurred.

In the above listing, # is a number between 0 and 5. This number, #, represents a year increment. Due to the errors in respondents reporting accurate model year or, to a lesser extent, due to deficiencies in the NHTSA files, it was necessary to incrementally increase or decrease (not simultaneously increase and decrease) the model year for "matching" to successively larger range of years. If, for example, an eligible match was not found for a NHTS sample vehicle having the following attributes: Volkswagen, Scirocco, 1990, Automobile. Toggling of model years, by a single year increase followed by a single year decrease of the reported model year, resulted in a match with a Volkswagen, Scirocco, 1988, Automobile. In this example, the Volkswagen, Scirocco, 1990, Automobile, while seemingly a respondent reporting error, would receive an imputation flag of "102" due to the "match" with the NHTSA file record corresponding to a Volkswagen, Scirocco, 1988, Automobile.

Table 10. Number of Vehicles, Vehicle Miles, Motor Fuel Consumption and Expenditures, 2001

Census Division	Vehicle Type	Number of Vehicles (million)	Sample Count of Vehicles	Vehicle-Miles Traveled (billion)	Motor Fuel Consumption (billion GEG)	Motor Fuel Consumption (billion liters)	Motor Fuel Expenditures (billion dollars)
NE	Passenger Car	6.1	1,548	72	3.0	11.4	4.2
	Van	0.9	237	12	0.6	2.3	0.8
	SUV	1.1	320	17	0.9	3.6	1.3
	Pickup Truck	1.3	371	17	1.0	3.8	1.4
	Motorcycle	0.2	53	1	(S)	(S)	(S)
NE Total		**9.6**	**2,529**	**119**	**5.6**	**21.2**	**7.7**
MA	Passenger Car	13.8	3,651	155	6.6	25.1	8.8
	Van	2.2	621	30	1.5	5.8	2.0
	SUV	2.5	728	34	2.0	7.5	2.6
	Pickup Truck	1.9	630	24	1.4	5.3	1.9
	Motorcycle	0.3	94	1	(S)	0.1	(S)
MA Total		**20.7**	**5,724**	**244**	**11.5**	**43.7**	**15.3**
ENC	Passenger Car	18.4	4,854	216	9.3	35.2	12.6
	Van	3.5	984	47	2.4	9.2	3.3
	SUV	3.3	940	48	2.8	10.5	3.8
	Pickup Truck	5.3	1,560	66	3.9	14.7	5.2
	Motorcycle	0.6	185	2	(S)	0.1	(S)
ENC Total		**31.0**	**8,523**	**378**	**18.4**	**69.7**	**24.9**
WNC	Passenger Car	7.8	2,281	95	4.1	15.4	5.4
	Van	1.4	433	19	1.0	3.7	1.3
	SUV	1.5	481	20	1.2	4.5	1.6
	Pickup Truck	2.9	918	38	2.2	8.3	2.9
	Motorcycle	0.3	83	(S)	(S)	(S)	(S)
WNC Total		**14.0**	**4,196**	**172**	**8.5**	**32.0**	**11.3**
SA	Passenger Car	22.4	5,048	271	11.5	43.6	14.4
	Van	3.4	836	46	2.4	9.2	3.1
	SUV	4.5	1,093	64	3.7	14.0	4.6
	Pickup Truck	6.2	1,607	77	4.4	16.7	5.5
	Motorcycle	0.6	161	2	(S)	0.1	(S)
SA Total		**37.1**	**8,745**	**461**	**22.1**	**83.7**	**27.6**
ESC	Passenger Car	6.0	1,481	72	3.1	11.9	4.0
	Van	1.0	245	13	0.7	2.6	0.9
	SUV	1.3	315	18	1.1	4.0	1.3
	Pickup Truck	2.9	752	40	2.3	8.6	2.9
	Motorcycle	0.2	56	(S)	(S)	(S)	(S)
ESC Total		**11.3**	**2,849**	**143**	**7.2**	**27.1**	**9.1**
WSC	Passenger Car	9.8	2,165	118	5.1	19.2	6.4

Table 10. Number of Vehicles, Vehicle Miles, Motor Fuel Consumption and Expenditures, 2001

Census Division	Vehicle Type	Number of Vehicles (million)	Sample Count of Vehicles	Vehicle-Miles Traveled (billion)	Motor Fuel Consumption (billion GEG)	Motor Fuel Consumption (billion liters)	Motor Fuel Expenditures (billion dollars)
	Van	1.4	324	17	0.9	3.5	1.2
	SUV	2.4	589	35	2.1	7.9	2.6
	Pickup Truck	4.5	1,129	65	3.7	14.2	4.7
	Motorcycle	0.2	54	1	(S)	0.1	(S)
WSC Total		**18.3**	**4,261**	**236**	**11.9**	**44.9**	**14.9**
Mountain	Passenger Car	5.9	1,742	65	2.8	10.5	3.9
	Van	0.9	265	13	0.7	2.5	0.9
	SUV	1.7	481	22	1.3	5.0	1.9
	Pickup Truck	2.5	766	29	1.7	6.3	2.3
	Motorcycle	0.2	76	1	(S)	0.1	(S)
Mountain Total		**11.1**	**3,330**	**129**	**6.4**	**24.3**	**9.0**
Pacific	Passenger Car	16.6	3,930	188	7.9	29.9	11.4
	Van	2.4	575	30	1.6	6.0	2.3
	SUV	3.5	910	50	3.0	11.2	4.3
	Pickup Truck	4.8	1,268	58	3.3	12.4	4.7
	Motorcycle	0.5	150	2	(S)	0.2	0.1
Pacific Total		**27.8**	**6,833**	**328**	**15.7**	**59.6**	**22.7**
Total		**181.0**	**46,990**	**2,210**	**107.3**	**406.1**	**142.6**

(s) = Data rounds to zero in the units given.

Note: Data included in this table represent ONLY those vehicles having non-negative values for vehicle-miles traveled (BESTMILE) and fuel economy (EIADMPG) in the Version 3 release of the 2001 National Household Travel Survey sponsored by the U.S. Department of Transportation. NE denotes New England; MA denotes Middle Atlantic; ENC denotes East North Central; WNC denotes West North Central; SA denotes South Atlantic; ESC denotes East South Central; and, WSC denotes West South Central. GEG represents a gasoline equivalent gallon.

Source: Energy Information Administration, Office of Energy Markets and End Use, value-added addendum to Version 3 release of the 2001 National Household Travel Survey by the U.S. Department of Transportation (Washington DC).

Table 11. United States per Vehicle-Miles Traveled, Vehicle Fuel Consumption and Expenditures, 2001

Census Division	Vehicle Type	Number of Vehicles (million)	Sample Count of Vehicles	Average per Vehicle: Motor Fuel Consumption (GEG)	Average per Vehicle: Motor Fuel Expenditures (dollars)	Average per Vehicle: Vehicle-Miles Traveled (thousands)	Miles per Equivalent Gallon	Liters per 100 km
NE	Passenger Car	6.1	1,548	493	684	11.8	23.9	9.9
	Van	0.9	237	691	958	13.6	19.7	12.0
	SUV	1.1	320	849	1,174	14.8	17.5	13.5
	Pickup Truck	1.3	371	763	1,051	13.2	17.3	13.6
	Motorcycle	0.2	53	66	91	3.3	50.0	4.7
NE Total		**9.6**	**2,529**	**582**	**805**	**12.4**	**21.3**	**11.1**
MA	Passenger Car	13.8	3,651	482	637	11.3	23.5	10.0
	Van	2.2	621	704	931	13.7	19.5	12.1
	SUV	2.5	728	782	1,034	13.6	17.4	13.5
	Pickup Truck	1.9	630	723	956	12.3	17.0	13.9
	Motorcycle	0.3	94	44	59	2.2	50.0	4.7
MA Total		**20.7**	**5,724**	**558**	**737**	**11.8**	**21.1**	**11.1**
ENC	Passenger Car	18.4	4,854	506	686	11.8	23.2	10.1
	Van	3.5	984	702	950	13.5	19.3	12.2
	SUV	3.3	940	834	1,130	14.3	17.2	13.7
	Pickup Truck	5.3	1,560	734	992	12.5	17.1	13.8
	Motorcycle	0.6	185	51	70	2.6	50.0	4.7
ENC Total		**31.0**	**8,523**	**593**	**803**	**12.2**	**20.5**	**11.5**
WNC	Passenger Car	7.8	2,281	520	695	12.1	23.4	10.1
	Van	1.4	433	692	926	13.4	19.3	12.2
	SUV	1.5	481	783	1,045	13.0	16.7	14.1
	Pickup Truck	2.9	918	747	996	12.8	17.1	13.8
	Motorcycle	0.3	83	30	41	1.5	50.0	4.7
WNC Total		**14.0**	**4,196**	**604**	**807**	**12.3**	**20.4**	**11.6**
SA	Passenger Car	22.4	5,048	515	644	12.1	23.5	10.0
	Van	3.4	836	718	903	13.7	19.1	12.3
	SUV	4.5	1,093	829	1,036	14.2	17.2	13.7
	Pickup Truck	6.2	1,607	709	881	12.4	17.5	13.5
	Motorcycle	0.6	161	61	76	3.0	50.0	4.7
SA Total		**37.1**	**8,745**	**597**	**746**	**12.4**	**20.8**	**11.3**
ESC	Passenger Car	6.0	1,481	521	661	12.0	23.0	10.2
	Van	1.0	245	707	896	13.4	19.0	12.4
	SUV	1.3	315	844	1,068	14.2	16.9	14.0
	Pickup Truck	2.9	752	793	1,005	13.9	17.5	13.5
	Motorcycle	0.2	56	45	58	2.3	50.0	4.7
ESC Total		**11.3**	**2,849**	**633**	**803**	**12.7**	**20.0**	**11.8**
WSC	Passenger Car	9.8	2,165	519	654	12.0	23.2	10.2

Table 11. United States per Vehicle-Miles Traveled, Vehicle Fuel Consumption and Expenditures, 2001

Census Division	Vehicle Type	Number of Vehicles (million)	Sample Count of Vehicles	Average per Vehicle: Motor Fuel Consumption (GEG)	Average per Vehicle: Motor Fuel Expenditures (dollars)	Average per Vehicle: Vehicle-Miles Traveled (thousands)	Miles per Equivalent Gallon	Liters per 100 km
	Van	1.4	324	681	857	12.9	18.9	12.5
	SUV	2.4	589	870	1,095	14.5	16.7	14.1
	Pickup Truck	4.5	1,129	828	1,042	14.4	17.3	13.6
	Motorcycle	0.2	54	73	93	3.7	50.0	4.7
WSC Total		**18.3**	**4,261**	**648**	**816**	**12.9**	**19.9**	**11.8**
Mountain	Passenger Car	5.9	1,742	465	655	10.9	23.4	10.1
	Van	0.9	265	764	1,065	14.9	19.5	12.1
	SUV	1.7	481	799	1,124	13.4	16.7	14.1
	Pickup Truck	2.5	766	677	953	11.6	17.2	13.7
	Motorcycle	0.2	76	76	108	3.8	50.0	4.7
Mountain Total		**11.1**	**3,330**	**577**	**812**	**11.6**	**20.1**	**11.7**
Pacific	Passenger Car	16.6	3,930	475	685	11.3	23.8	9.9
	Van	2.4	575	665	958	12.6	18.9	12.4
	SUV	3.5	910	844	1,216	14.3	17.0	13.9
	Pickup Truck	4.8	1,268	680	983	12.1	17.8	13.2
	Motorcycle	0.5	150	74	108	3.7	50.0	4.7
Pacific Total		**27.8**	**6,833**	**565**	**815**	**11.8**	**20.8**	**11.3**
Total		**181.0**	**46,990**	**593**	**788**	**12.2**	**20.6**	**11.4**

Note: Data included in this table represent ONLY those vehicles having non-negative values for vehicle-miles traveled (BESTMILE) and fuel economy (EIADMPG) in the Version 3 release of the 2001 National Household Travel Survey sponsored by the U.S. Department of Transportation. NE denotes New England; MA denotes Middle Atlantic; ENC denotes East North Central; WNC denotes West North Central; SA denotes South Atlantic; ESC denotes East South Central; and, WSC denotes West South Central. GEG represents a gasoline equivalent gallon.

Source: Energy Information Administration, Office of Energy Markets and End Use, value-added addendum to Version 3 release of the 2001 National Household Travel Survey by the U.S. Department of Transportation (Washington DC).

Table 12. Simple Arithmetic Average of On-Road Shortfall Adjustment Based on EPA Discount Factors

Statistic: Average of On-Road Adjustment		Model Year				
Manufacturer	Class	1998	1999	2000	2001	**Total**
ACURA	COMPACT CARS	0.867			0.868	0.867
	MIDSIZE CARS	0.857	0.859	0.866	0.867	0.863
	SPEC PURP VEH - S.U.V. - 4WD		0.878		0.842	0.860
	SPECIAL PURPOSE VEHICLE 4WD	0.878				0.878
	SUBCOMPACT CARS	0.857	0.854	0.853	0.852	0.854
	TWO SEATERS	0.858	0.859	0.873	0.856	0.862
ACURA Total		0.860	0.858	0.862	0.857	0.859
ASTON MARTIN	MINICOMPACT CARS			0.851		0.851
	TWO SEATERS	0.850				0.850
ASTON MARTIN Total		0.850		0.851		0.850
AUDI	COMPACT CARS	0.851	0.853	0.857	0.861	0.856
	LARGE CARS			0.835	0.863	0.849
	MIDSIZE CARS	0.861	0.863	0.853	0.863	0.860
	MIDSIZE STATION WAGONS		0.859	0.874	0.876	0.870
	MINICOMPACT CARS	0.858		0.847	0.849	0.850
	SMALL STATION WAGONS	0.865	0.854	0.862	0.869	0.863
	SPEC PURP VEH - S.U.V. - 4WD				0.853	0.853
	TWO SEATERS				0.865	0.865
AUDI Total		0.857	0.856	0.856	0.862	0.858
BENTLEY	COMPACT CARS	0.865	0.865	0.859	0.869	0.865
	LARGE CARS	0.873	0.869			0.871
	MIDSIZE CARS	0.866	0.869	0.857	0.869	0.865
	SUBCOMPACT CARS	0.871	0.871	0.866	0.864	0.868
BENTLEY Total		0.869	0.869	0.862	0.866	0.867
BMW	COMPACT CARS	0.855	0.858	0.859	0.858	0.858
	LARGE CARS	0.860	0.860	0.860	0.860	0.860
	MIDSIZE CARS	0.839	0.840	0.840	0.840	0.840
	MINICOMPACT CARS	0.859	0.857	0.847	0.857	0.856
	SMALL STATION WAGONS		0.862	0.861	0.861	0.861
	SPEC PURP VEH - S.U.V. - 4WD			0.856	0.851	0.853
	SUBCOMPACT CARS	0.855	0.857	0.858	0.859	0.857
	TWO SEATERS	0.850	0.847	0.845	0.860	0.850
BMW Total		0.855	0.855	0.854	0.858	0.856
BUICK	COMPACT CARS	0.859				0.859
	LARGE CARS	0.858	0.855	0.860	0.867	0.861
	MIDSIZE CARS	0.859	0.856	0.863	0.853	0.858
BUICK Total		0.859	0.856	0.862	0.862	0.859
CADILLAC	LARGE CARS	0.845	0.855	0.872	0.845	0.852
	MIDSIZE CARS	0.855	0.850	0.862	0.849	0.854
	SPEC PURP VEH - S.U.V. - 4WD		0.865	0.869		0.867

Table 12. Simple Arithmetic Average of On-Road Shortfall Adjustment Based on EPA Discount Factors

Statistic: Average of On-Road Adjustment		Model Year				
Manufacturer	Class	1998	1999		2001	**Total**
CADILLAC Total		0.850	0.855	0.865	0.848	0.855
CHEVROLET	COMPACT CARS	0.846	0.846	0.858	0.863	0.856
	LARGE CARS			0.861	0.853	0.858
	MIDSIZE CARS	0.854	0.855	0.865	0.846	0.855
	SMALL PICKUP TRUCKS 2WD	0.870	0.847	0.857	0.848	0.856
	SPEC PURP VEH - MINIVAN - 2WD		0.843	0.839	0.866	0.850
	SPEC PURP VEH - S.U.V. - 2WD		0.847	0.850	0.851	0.849
	SPEC PURP VEH - S.U.V. - 4WD		0.855	0.854	0.853	0.854
	SPECIAL PURPOSE VEHICLE 2WD	0.855				0.855
	SPECIAL PURPOSE VEHICLE 4WD	0.846				0.846
	STANDARD PICKUP TRUCKS 2WD	0.859	0.851	0.853	0.848	0.854
	STANDARD PICKUP TRUCKS 4WD	0.850	0.854	0.846	0.857	0.852
	SUBCOMPACT CARS	0.856	0.855	0.854	0.855	0.855
	TWO SEATERS	0.864	0.851	0.877	0.853	0.861
	VANS, CARGO TYPE	0.853	0.851	0.845	0.853	0.851
	VANS, PASSENGER TYPE	0.841	0.848	0.859	0.854	0.851
CHEVROLET Total		0.854	0.852	0.854	0.854	0.853
CHRYSLER	COMPACT CARS	0.850	0.853	0.850	0.854	0.852
	LARGE CARS	0.851	0.851	0.854	0.867	0.856
	MIDSIZE CARS	0.850	0.864	0.858	0.860	0.858
	SPEC PURP VEH - MINIVAN - 2WD		0.847	0.864	0.858	0.856
	SPEC PURP VEH - MINIVAN - 4WD		0.878	0.874	0.860	0.871
	SPEC PURP VEH - S.U.V. - 2WD				0.850	0.850
	SPECIAL PURPOSE VEHICLE 2WD	0.848				0.848
	SPECIAL PURPOSE VEHICLE 4WD	0.880				0.880
CHRYSLER Total		0.851	0.854	0.858	0.858	0.855
DAEWOO	COMPACT CARS	0.860	0.859	0.859	0.851	0.857
	MIDSIZE CARS	0.853	0.866	0.866	0.864	0.861
	SMALL STATION WAGONS	0.859	0.855	0.855	0.847	0.855
DAEWOO Total		0.858	0.859	0.859	0.852	0.857
DODGE	COMPACT CARS	0.847	0.852	0.850	0.856	0.851
	LARGE CARS	0.852	0.845	0.849	0.856	0.851
	MIDSIZE CARS	0.858	0.855	0.855	0.860	0.857
	SPEC PURP VEH - MINIVAN - 2WD		0.847	0.860	0.857	0.854
	SPEC PURP VEH - MINIVAN - 4WD		0.864	0.855	0.842	0.854
	SPEC PURP VEH - S.U.V. - 2WD		0.869	0.867	0.844	0.862
	SPEC PURP VEH - S.U.V. - 4WD		0.859	0.841	0.873	0.858
	SPECIAL PURPOSE VEHICLE 2WD	0.847				0.847
	SPECIAL PURPOSE VEHICLE 4WD	0.854				0.854
	STANDARD PICKUP TRUCKS 2WD	0.851	0.851	0.855	0.857	0.854
	STANDARD PICKUP TRUCKS 4WD	0.863	0.847	0.855	0.860	0.856
	TWO SEATERS	0.886		0.868	0.855	0.870

Table 12. Simple Arithmetic Average of On-Road Shortfall Adjustment Based on EPA Discount Factors

Statistic: Average of On-Road Adjustment		Model Year				
Manufacturer	Class	1998	1999	2000	2001	**Total**
	VANS, CARGO TYPE	0.852	0.837	0.849	0.865	0.852
	VANS, PASSENGER TYPE	0.856	0.844	0.850	0.857	0.852
DODGE Total		0.854	0.850	0.855	0.858	0.854
EAGLE	SUBCOMPACT CARS	0.851				0.851
EAGLE Total		0.851				0.851
FERRARI	SUBCOMPACT CARS	0.846	0.846	0.846	0.846	0.846
	TWO SEATERS	0.852	0.859	0.858	0.858	0.857
FERRARI Total		0.850	0.854	0.853	0.853	0.853
FORD	COMPACT CARS	0.858	0.862	0.852	0.849	0.855
	LARGE CARS	0.877	0.861	0.860	0.849	0.858
	MIDSIZE CARS	0.855	0.857			0.856
	MIDSIZE STATION WAGONS	0.843	0.853	0.864	0.857	0.858
	SMALL STATION WAGONS	0.864	0.868			0.866
	SPEC PURP VEH - MINIVAN - 2WD		0.854	0.852	0.856	0.853
	SPEC PURP VEH - S.U.V. - 2WD		0.859	0.863	0.852	0.858
	SPEC PURP VEH - S.U.V. - 4WD		0.863	0.859	0.850	0.856
	SPECIAL PURPOSE VEHICLE 2WD	0.864		0.867		0.865
	SPECIAL PURPOSE VEHICLE 4WD	0.864				0.864
	STANDARD PICKUP TRUCKS 2WD	0.854	0.857	0.859	0.855	0.856
	STANDARD PICKUP TRUCKS 4WD	0.854	0.860	0.861	0.852	0.857
	SUBCOMPACT CARS	0.859	0.857	0.857	0.855	0.857
	VANS, CARGO TYPE	0.848	0.853	0.860	0.862	0.856
	VANS, PASSENGER TYPE	0.853	0.855	0.860	0.843	0.853
FORD Total		0.857	0.858	0.859	0.853	0.857
GMC	SMALL PICKUP TRUCKS 2WD	0.870	0.847	0.858	0.848	0.856
	SPEC PURP VEH - S.U.V. - 2WD		0.844	0.849	0.846	0.847
	SPEC PURP VEH - S.U.V. - 4WD		0.862	0.858	0.852	0.857
	SPECIAL PURPOSE VEHICLE 2WD	0.858				0.858
	SPECIAL PURPOSE VEHICLE 4WD	0.844				0.844
	STANDARD PICKUP TRUCKS 2WD	0.859	0.851	0.851	0.840	0.852
	STANDARD PICKUP TRUCKS 4WD	0.850	0.854	0.846	0.855	0.851
	VANS, CARGO TYPE	0.853	0.851	0.845	0.854	0.851
	VANS, PASSENGER TYPE	0.841	0.848	0.859	0.854	0.851
GMC Total		0.854	0.851	0.852	0.851	0.852
HONDA	COMPACT CARS				0.853	0.853
	MIDSIZE CARS	0.856	0.852	0.851	0.852	0.853
	MIDSIZE STATION WAGONS	0.844				0.844
	SPEC PURP VEH - MINIVAN - 2WD		0.870	0.874	0.837	0.860
	SPEC PURP VEH - S.U.V. - 2WD		0.855	0.852	0.850	0.852
	SPEC PURP VEH - S.U.V. - 4WD		0.855	0.850	0.849	0.850
	SPECIAL PURPOSE VEHICLE 2WD	0.850				0.850
	SPECIAL PURPOSE VEHICLE 4WD	0.856				0.856

Table 12. Simple Arithmetic Average of On-Road Shortfall Adjustment Based on EPA Discount Factors

Statistic: Average of On-Road Adjustment		Model Year				
Manufacturer	Class	1998	1999	2000	2001	**Total**
	SUBCOMPACT CARS	0.852	0.854	0.853	0.848	0.852
	TWO SEATERS			0.846	0.848	0.847
HONDA Total		0.853	0.855	0.852	0.850	0.852
HYUNDAI	COMPACT CARS	0.857	0.849	0.848	0.861	0.855
	MIDSIZE CARS	0.865	0.861	0.849	0.857	0.858
	SMALL STATION WAGONS	0.860	0.854	0.868		0.860
	SPEC PURP VEH - S.U.V. - 2WD				0.870	0.870
	SPEC PURP VEH - S.U.V. - 4WD				0.834	0.834
	SUBCOMPACT CARS	0.848	0.864	0.866	0.856	0.859
HYUNDAI Total		0.858	0.859	0.855	0.859	0.858
IMPCO	SUBCOMPACT CARS			0.854	0.857	0.856
IMPCO Total				0.854	0.857	0.856
INFINITI	COMPACT CARS		0.854	0.865	0.865	0.861
	MIDSIZE CARS	0.848	0.850	0.869	0.863	0.856
	SPEC PURP VEH - S.U.V. - 2WD				0.866	0.866
	SPEC PURP VEH - S.U.V. - 4WD		0.831	0.841	0.875	0.849
	SPECIAL PURPOSE VEHICLE 4WD	0.831				0.831
INFINITI Total		0.844	0.848	0.862	0.866	0.856
ISUZU	MIDSIZE STATION WAGONS	0.844	0.857			0.850
	SMALL PICKUP TRUCKS 2WD	0.869	0.853	0.854	0.849	0.857
	SPEC PURP VEH - S.U.V. - 2WD		0.849	0.854	0.851	0.852
	SPEC PURP VEH - S.U.V. - 4WD		0.852	0.848	0.852	0.851
	SPECIAL PURPOSE VEHICLE 2WD	0.852				0.852
	SPECIAL PURPOSE VEHICLE 4WD	0.857				0.857
	STANDARD PICKUP TRUCKS 4WD	0.862	0.845	0.849	0.876	0.855
ISUZU Total		0.858	0.851	0.852	0.853	0.853
JAGUAR	COMPACT CARS	0.854	0.863	0.845	0.859	0.855
	MIDSIZE CARS	0.836	0.874	0.850	0.857	0.855
	MINICOMPACT CARS	0.835	0.890	0.859	0.869	0.863
	SUBCOMPACT CARS	0.851	0.870	0.888	0.869	0.872
JAGUAR Total		0.844	0.872	0.858	0.862	0.860
JEEP	SPEC PURP VEH - S.U.V. - 2WD		0.854	0.855	0.862	0.856
	SPEC PURP VEH - S.U.V. - 4WD		0.858	0.852	0.855	0.855
	SPECIAL PURPOSE VEHICLE 2WD	0.858				0.858
	SPECIAL PURPOSE VEHICLE 4WD	0.851				0.851
JEEP Total		0.853	0.856	0.853	0.857	0.855
KIA	COMPACT CARS	0.855	0.855	0.860	0.854	0.855
	SPEC PURP VEH - S.U.V. - 2WD		0.861	0.834	0.856	0.850
	SPEC PURP VEH - S.U.V. - 4WD		0.861	0.856	0.856	0.858
	SPECIAL PURPOSE VEHICLE 2WD	0.861				0.861
	SPECIAL PURPOSE VEHICLE 4WD	0.861				0.861

Table 12. Simple Arithmetic Average of On-Road Shortfall Adjustment Based on EPA Discount Factors

Statistic: Average of On-Road Adjustment		Model Year				
Manufacturer	Class	1998	1999	2000	2001	**Total**
KIA Total		0.859	0.859	0.850	0.855	0.856
LAMBORGHINI	TWO SEATERS	0.841	0.841		0.822	0.835
LAMBORGHINI Total		0.841	0.841		0.822	0.835
LAND ROVER	SPEC PURP VEH - S.U.V. - 4WD		0.846	0.860	0.865	0.856
	SPECIAL PURPOSE VEHICLE 4WD	0.847				0.847
LAND ROVER Total		0.847	0.846	0.860	0.865	0.854
LEXUS	COMPACT CARS	0.857	0.840	0.865	0.865	0.857
	LARGE CARS				0.867	0.867
	MIDSIZE CARS	0.854	0.859	0.857	0.852	0.856
	MIDSIZE STATION WAGONS		0.857	0.861	0.850	0.856
	SPEC PURP VEH - S.U.V. - 4WD		0.877	0.877	0.850	0.868
	SPECIAL PURPOSE VEHICLE 4WD	0.877				0.877
	SUBCOMPACT CARS	0.861	0.863	0.867	0.861	0.863
LEXUS Total		0.860	0.859	0.863	0.856	0.860
LINCOLN	SPEC PURP VEH - S.U.V. - 2WD		0.854	0.868	0.880	0.864
	SPEC PURP VEH - S.U.V. - 4WD		0.854	0.862	0.848	0.854
	SPECIAL PURPOSE VEHICLE 2WD	0.826				0.826
	SPECIAL PURPOSE VEHICLE 4WD	0.880				0.880
LINCOLN Total		0.853	0.854	0.865	0.864	0.858
LINCOLN-MERCURY	COMPACT CARS	0.855	0.856	0.853	0.850	0.854
	LARGE CARS	0.877	0.846	0.851	0.844	0.854
	MIDSIZE CARS	0.845	0.869	0.862	0.856	0.858
	MIDSIZE STATION WAGONS	0.843	0.863	0.867	0.861	0.858
	SMALL STATION WAGONS	0.864	0.868			0.866
LINCOLN-MERCURY Total		0.857	0.858	0.857	0.853	0.856
LOTUS	TWO SEATERS	0.850		0.874		0.862
LOTUS Total		0.850		0.874		0.862
MAZDA	COMPACT CARS	0.856	0.854	0.853	0.851	0.854
	MIDSIZE CARS	0.856	0.856	0.856	0.851	0.855
	SPEC PURP VEH - MINIVAN - 2WD			0.866	0.861	0.863
	SPEC PURP VEH - S.U.V. - 2WD				0.840	0.840
	SPEC PURP VEH - S.U.V. - 4WD				0.861	0.861
	SPECIAL PURPOSE VEHICLE 2WD	0.838				0.838
	SPECIAL PURPOSE VEHICLE 4WD	0.835				0.835
	STANDARD PICKUP TRUCKS 2WD	0.854	0.858	0.869	0.850	0.858
	STANDARD PICKUP TRUCKS 4WD	0.851	0.861	0.824	0.856	0.844
	TWO SEATERS		0.853	0.862	0.848	0.854
MAZDA Total		0.853	0.857	0.852	0.851	0.853
MERCEDES-BENZ	COMPACT CARS	0.856	0.858	0.857	0.858	0.857
	LARGE CARS	0.868	0.866	0.872	0.854	0.866
	MIDSIZE CARS	0.859	0.857	0.850	0.853	0.854

Table 12. Simple Arithmetic Average of On-Road Shortfall Adjustment Based on EPA Discount Factors

Statistic: Average of On-Road Adjustment		Model Year				
Manufacturer	Class	1998	1999	2000	2001	**Total**
	MIDSIZE STATION WAGONS	0.866	0.854	0.859	0.843	0.855
	MINICOMPACT CARS		0.840	0.854	0.854	0.851
	SPEC PURP VEH - S.U.V. - 4WD		0.836	0.859	0.836	0.845
	SPECIAL PURPOSE VEHICLE 4WD	0.832				0.832
	SUBCOMPACT CARS	0.855	0.869	0.869	0.864	0.866
	TWO SEATERS	0.858	0.859	0.853	0.852	0.854
MERCEDES-BENZ Total		0.860	0.858	0.857	0.852	0.857
MERCURY	SPEC PURP VEH - MINIVAN - 2WD		0.875	0.834	0.861	0.856
	SPEC PURP VEH - S.U.V. - 2WD		0.853	0.856	0.848	0.852
	SPEC PURP VEH - S.U.V. - 4WD		0.868	0.863	0.844	0.858
	SPECIAL PURPOSE VEHICLE 2WD	0.867				0.867
	SPECIAL PURPOSE VEHICLE 4WD	0.874				0.874
MERCURY Total		0.869	0.863	0.854	0.849	0.859
MITSUBISHI	COMPACT CARS	0.845			0.854	0.851
	MIDSIZE CARS	0.845	0.851	0.854	0.848	0.850
	MINICOMPACT CARS	0.847	0.857		0.856	0.853
	SPEC PURP VEH - S.U.V. - 2WD		0.862	0.865	0.871	0.865
	SPEC PURP VEH - S.U.V. - 4WD		0.860	0.845	0.864	0.856
	SPECIAL PURPOSE VEHICLE 2WD	0.840				0.840
	SPECIAL PURPOSE VEHICLE 4WD	0.846				0.846
	SUBCOMPACT CARS	0.853	0.851	0.844	0.855	0.851
MITSUBISHI Total		0.849	0.856	0.850	0.857	0.853
NISSAN	COMPACT CARS	0.852	0.854	0.852	0.854	0.853
	MIDSIZE CARS	0.866	0.854	0.865	0.855	0.860
	MINICOMPACT CARS	0.839				0.839
	SPEC PURP VEH - MINIVAN - 2WD		0.866	0.870	0.845	0.860
	SPEC PURP VEH - S.U.V. - 2WD		0.851	0.852	0.849	0.850
	SPEC PURP VEH - S.U.V. - 4WD		0.846	0.844	0.858	0.850
	SPECIAL PURPOSE VEHICLE 2WD	0.858				0.858
	SPECIAL PURPOSE VEHICLE 4WD	0.846				0.846
	STANDARD PICKUP TRUCKS 2WD	0.844	0.849	0.843	0.849	0.847
	STANDARD PICKUP TRUCKS 4WD	0.853	0.851	0.843	0.848	0.848
	SUBCOMPACT CARS	0.860	0.860			0.860
NISSAN Total		0.853	0.854	0.850	0.851	0.852
OLDSMOBILE	COMPACT CARS	0.860	0.856	0.857	0.860	0.858
	LARGE CARS	0.859	0.859			0.859
	MIDSIZE CARS	0.852	0.857	0.857	0.855	0.855
	SPEC PURP VEH - MINIVAN - 2WD		0.843	0.839	0.866	0.850
	SPEC PURP VEH - S.U.V. - 4WD		0.871	0.843	0.854	0.856
	SPECIAL PURPOSE VEHICLE 2WD	0.866				0.866
	SPECIAL PURPOSE VEHICLE 4WD	0.839				0.839
OLDSMOBILE Total		0.855	0.857	0.852	0.858	0.856

Table 12. Simple Arithmetic Average of On-Road Shortfall Adjustment Based on EPA Discount Factors

Statistic: Average of On-Road Adjustment		Model Year				
Manufacturer	Class	1998	1999	2000	2001	**Total**
PLYMOUTH	COMPACT CARS	0.853	0.859	0.852	0.864	0.857
	MIDSIZE CARS	0.855	0.848	0.854		0.852
	SPEC PURP VEH - MINIVAN - 2WD		0.846	0.864		0.855
	SPECIAL PURPOSE VEHICLE 2WD	0.849				0.849
	TWO SEATERS		0.840	0.838	0.845	0.841
PLYMOUTH Total		0.852	0.848	0.857	0.858	0.853
PONTIAC	COMPACT CARS	0.852	0.856	0.857	0.860	0.856
	LARGE CARS	0.863	0.861	0.857	0.867	0.863
	MIDSIZE CARS	0.859	0.858	0.862	0.852	0.858
	SPEC PURP VEH - MINIVAN - 2WD		0.843	0.839	0.866	0.850
	SPEC PURP VEH - S.U.V. - 2WD				0.866	0.866
	SPEC PURP VEH - S.U.V. - 4WD				0.862	0.862
	SPECIAL PURPOSE VEHICLE 2WD	0.866				0.866
	SUBCOMPACT CARS	0.859	0.851	0.855	0.864	0.857
PONTIAC Total		0.859	0.853	0.856	0.862	0.858
PORSCHE	MINICOMPACT CARS	0.852	0.850	0.849	0.852	0.851
	TWO SEATERS	0.855	0.855	0.845	0.845	0.848
PORSCHE Total		0.853	0.852	0.847	0.849	0.850
QVALE	MINICOMPACT CARS			0.834		0.834
QVALE Total				0.834		0.834
R-R MTR CARS LTD.	LARGE CARS	0.873	0.869		0.869	0.871
	MIDSIZE CARS	0.866	0.864		0.869	0.867
	SUBCOMPACT CARS			0.854	0.854	0.854
R-R MTR CARS LTD. Total		0.870	0.866	0.854	0.865	0.865
SAAB	LARGE CARS	0.866				0.866
	MIDSIZE CARS	0.850	0.851	0.859	0.853	0.854
	MIDSIZE STATION WAGONS			0.853	0.846	0.850
	SUBCOMPACT CARS	0.848	0.852	0.854	0.852	0.851
SAAB Total		0.852	0.852	0.856	0.851	0.853
SATURN	COMPACT CARS	0.860	0.856	0.857	0.857	0.858
	MIDSIZE CARS			0.846	0.851	0.848
	MIDSIZE STATION WAGONS			0.844	0.849	0.847
	SMALL STATION WAGONS	0.862	0.858	0.854	0.853	0.857
	SUBCOMPACT CARS	0.860	0.856	0.857	0.856	0.857
SATURN Total		0.861	0.857	0.853	0.854	0.856
SUBARU	COMPACT CARS	0.854	0.856	0.860	0.861	0.857
	MIDSIZE STATION WAGONS	0.849	0.858	0.861	0.862	0.856
	SMALL STATION WAGONS	0.854	0.851		0.846	0.850
	SPEC PURP VEH - S.U.V. - 4WD			0.860	0.860	0.860
	SPECIAL PURPOSE VEHICLE 4WD	0.853	0.863			0.858
	SUBCOMPACT CARS	0.855	0.852	0.848	0.847	0.851

Table 12. Simple Arithmetic Average of On-Road Shortfall Adjustment Based on EPA Discount Factors

Statistic: Average of On-Road Adjustment		Model Year				
Manufacturer	Class	1998	1999		2001	**Total**
SUBARU Total		0.853	0.856	0.857	0.854	0.855
SUZUKI	SMALL STATION WAGONS	0.852	0.852	0.855	0.858	0.854
	SPEC PURP VEH - S.U.V. - 2WD		0.851	0.851	0.852	0.852
	SPEC PURP VEH - S.U.V. - 4WD		0.851	0.851	0.853	0.851
	SPECIAL PURPOSE VEHICLE 2WD	0.854				0.854
	SPECIAL PURPOSE VEHICLE 4WD	0.854				0.854
	SUBCOMPACT CARS	0.856	0.856	0.856	0.857	0.856
	TWO SEATERS	0.849				0.849
SUZUKI Total		0.853	0.852	0.853	0.854	0.853
TOYOTA	COMPACT CARS	0.853	0.861	0.857	0.850	0.855
	LARGE CARS	0.846	0.855	0.853	0.862	0.854
	MIDSIZE CARS	0.860	0.867	0.860	0.845	0.858
	MINICOMPACT CARS	0.854	0.852			0.853
	SMALL PICKUP TRUCKS 2WD	0.856				0.856
	SPEC PURP VEH - MINIVAN - 2WD		0.873	0.873	0.849	0.865
	SPEC PURP VEH - S.U.V. - 2WD		0.852	0.848	0.854	0.851
	SPEC PURP VEH - S.U.V. - 4WD		0.857	0.860	0.850	0.856
	SPECIAL PURPOSE VEHICLE 2WD	0.859				0.859
	SPECIAL PURPOSE VEHICLE 4WD	0.855				0.855
	STANDARD PICKUP TRUCKS 2WD	0.842	0.844	0.851	0.846	0.847
	STANDARD PICKUP TRUCKS 4WD	0.839	0.850	0.843	0.845	0.844
	SUBCOMPACT CARS	0.849	0.854	0.860	0.849	0.853
	TWO SEATERS			0.849	0.849	0.849
TOYOTA Total		0.852	0.855	0.854	0.849	0.853
VOLKSWAGEN	COMPACT CARS	0.852	0.856	0.853	0.854	0.854
	MIDSIZE CARS	0.849	0.846	0.859	0.854	0.851
	MIDSIZE STATION WAGONS	0.849	0.846	0.859	0.858	0.853
	SPEC PURP VEH - MINIVAN - 2WD		0.870	0.870		0.870
	SPECIAL PURPOSE VEHICLE 2WD		0.863	0.863		0.863
	SUBCOMPACT CARS	0.854	0.855	0.849	0.852	0.852
VOLKSWAGEN Total		0.851	0.854	0.854	0.854	0.853
VOLVO	COMPACT CARS	0.851	0.857	0.856	0.847	0.851
	MIDSIZE CARS	0.857	0.859	0.854	0.845	0.856
	MIDSIZE STATION WAGONS	0.861	0.859	0.854	0.860	0.858
	SMALL STATION WAGONS	0.837		0.858	0.866	0.853
	SPEC PURP VEH - S.U.V. - 4WD				0.871	0.871
	SUBCOMPACT CARS	0.853	0.852	0.858	0.854	0.854
VOLVO Total		0.855	0.858	0.855	0.853	0.855
Total		0.855	0.855	0.855	0.855	0.855

Source: US Department of Energy and US Environmental Protection Agency, www.fueleconomy.gov website.

K-9. U.S CENSUS REGIONS AND DIVISIONS