APPENDIX K

ESTIMATION METHODOLOGIES FOR FUEL ECONOMY AND FUEL COST

Introduction and Overview

The methodology EIA used to estimate the vehicle fuel economy (given in terms of miles per gasoline equivalent gallon (MPG)), vehicle fuel consumption, and vehicle fuel expenditures 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; and the EIA's retail pump price series[1] for 2001 and 2002.

The following sections of this appendix describe the estimation procedures used for calculating 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.

[1] 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."

Term	Definition
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.[2] 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.

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.

[2] 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.

The estimation of these statistics (vehicle fuel economy, vehicle fuel consumption, and fuel expenditures) occurred in several steps (see Figure 1).

1) The basic input for the process was the VMT estimate for each NHTS vehicle in the national sample (see Appendix J).

2) Second, the annual on-road fuel economy, given in terms of MPG, was estimated using the characteristics of the vehicle from the household interview[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 (i.e., an unadjusted 45 percent highway and 55 percent city weighted estimate) values were adjusted to account for the difference between EPA test values and on-road values.

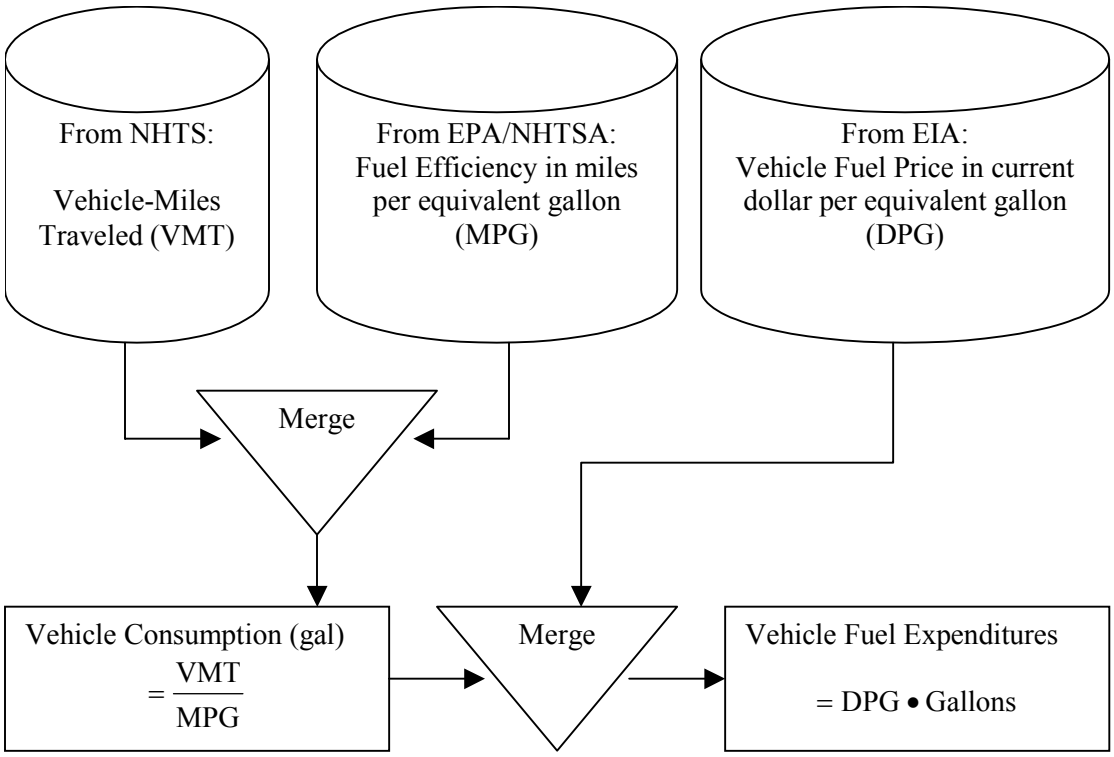
3) Third, estimated vehicle fuel consumption was derived by dividing the VMT by the estimated MPG.

4) 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 fuel price information was obtained from the EIAs fuel price series, with the notable exception of fuel tax rates for gasoline. Information on gas tax rates were obtained from FHWA's *Highway Statistic* reports.

[3] Vehicle Identification Numbers (VIN) were not collected in the 2001 NHTS. Instead, vehicles were classified using 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.

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.

Vehicle Fuel Economy

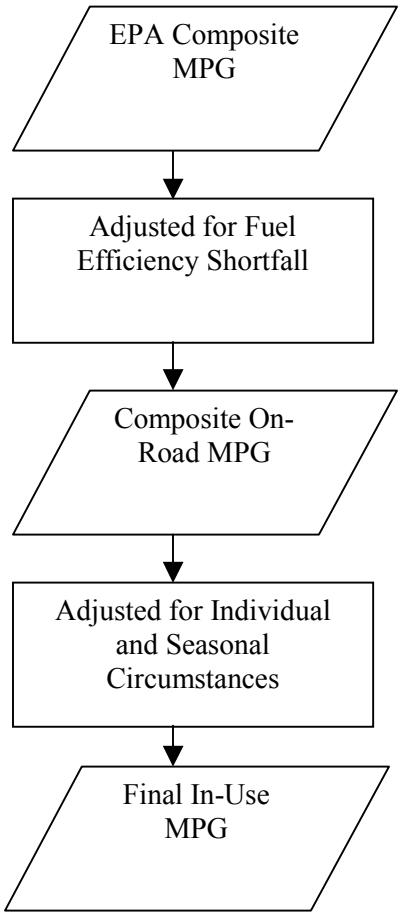
Fuel economy (MPG) was estimated for each NHTS sample vehicle in order to estimate each vehicle's fuel consumption for the survey year. Fuel consumption was estimated by dividing the VMT for time of possession (a fixed 12-month period starting on May 1, 2001 and ending April 30, 2002[4]) by the MPG. MPG values were estimated using EPA laboratory test MPG that were adjusted to account for differences between actual on-road MPG and the EPA test MPG. This difference is known as MPG "shortfall". 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).[5] For the 2001 NHTS, the

[4] The 2001 NHTS was conducted over the 14-month period from March 2001 to May 2002. For estimating annual VMT a fixed twelve-month period was calculated.

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

adequacy of shortfall adjustments has been extended for 1994 through 2002's motor vehicle model years. The process 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. (see Figure 2)

Figure 2. Miles per Gasoline Equivalent Gallon Adjustment Procedures



EPA test MPG was assigned by linking the NHTS vehicle file to 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. The NHTS vehicles were matched based on the make, model, vehicle type, and model year characteristics collected in the NHTS interview.

Although merging (or statistical linking) the NHTS vehicles to the NHTSA Corporate Average Fuel Economy files were restricted to those four attributes, the NHSTA file actually includes a wealth of detail. Vehicle 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, which helped when imputing of some vehicle attributes was required.

Hence, 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. This is referred to as a 1-to-many record linkage. 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 attributes to those required to assign an appropriate fuel price to a sample vehicle.

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[6] is defined as:

$$MPG_{(EPA\ 55/45)} = \frac{1}{0.55 \bullet \frac{1}{MPG_{(EPA\ city)}} + 0.45 \bullet \frac{1}{MPG_{(EPA\ hwy)}}} \qquad (1)$$

where:

[6] 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.

$MPG_{(EPA\ 55/45)}$ denotes the composite MPG; $MPG_{(EPA\ city)}$ denotes the fuel economy when vehicle use pattern is city driving only; and, $MPG_{(EPA\ hwy)}$ 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, as described in the following sections.

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

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.

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 vehicle type technology.

Either of these procedures could have been used to approximate an adjusted $MPG_{(EPA\ 55/45)}$ 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 was 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 when applied to cars. Therefore, a single discount adjustment factor was used.

Shortfall Adjustment Based on Discount Factors

EPA's discount factors have widespread appeal because of their simplicity (Hellman and Murrell, 1985[7]; Hellman and Murrell, 1984[8]). The factors are 10 percent for city MPG and 22 percent for highway MPG. That is, for any vehicle i,

[7] 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.

[8] 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.

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

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.

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 (Average Miles Driven per Day) 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.

The In-Use MPG

The “In-use MPG” rates are adjusted for individual driving circumstances, such as:

- 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.

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.

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).[9] In 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. 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.

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.

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

[9] 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.

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.

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:

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

Annual Vehicle Fuel Consumption

In the 2001 NHTS, annual fuel consumption was calculated by dividing the annual VMT by the annual MPG. The derivation of the “annualized” VMT is given in ORNL Appendix.

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 ith vehicle during the jth month.

Consumption is calculated over 12 months, based on the assumption that the sample vehicle is assumed to exist for a complete 12-month duration in a sample household. 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 ith vehicle during the jth month and mpg_{ij} denotes fuel economy in miles per gasoline equivalent gallon for the ith vehicle during the jth month. Now, the 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 ith 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 jth month, estimate for the ith 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 ith 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:

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

Thus, annual consumption equals:

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

Vehicle Fuel Expenditures

Fuel prices, by month, were obtained from the following Energy Information Administration survey questionnaires:

- Form EIA-782A[10] "Refiners'/Gas Plant Operators' Monthly Petroleum Product Sales Report."
- Form EIA-782B[11] "Resellers'/Retailers' Monthly Petroleum Product Sales Report."
- Form EIA-888[12] "On-Highway Diesel Fuel Price Survey."
- Form EIA-895[13] "Monthly Quantity and Value of Natural Gas Report."
- Form EIA-826[14] "Monthly Electric Utility Sales and Revenue Report with State Distributions."

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

[10] 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.

[11] 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.

[12] 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.

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

[14] 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..

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.

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 sampled vehicle, gasoline prices were assigned a monthly fuel price that represents the State's volume-weighted average of gasoline by type.

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.

More detail about the supplemental energy-related data for the 2001 NHTS can be found in the methodology paper on the EIA website:

http://www.eia.doe.gov/emeu/rtecs/nhts_survey/2001/index.html

Variable Names

1. **EIADMPG** – RECOMMENDED MPG MEASURE. 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 ORNL APPENDIX 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.

This appendix describes the methods developed to estimate: (1) vehicle fuel economy (in terms of miles per gasoline equivalent gallon (MPG)), (2) vehicle fuel consumption, and (3) vehicle fuel expenditures. The MPG was estimated for most of the vehicles in the 2001 NHTS NATIONAL SAMPLE, while fuel consumption and fuel expenditures were estimated for vehicles whose *BESTMILE* was estimated. The methods and the estimates were developed using the January 2003 data. Since then, some of the critical data used in the development of the *BESTMILE* estimates were modified during the editing process for the January 2004 Version of the NHTS data. Due to the time constraints, the fuel economy and fuel consumption estimates were not updated to reflect January 04 data. Fuel economy and fuel consumption for vehicles where the underlying data changed between the January 2003 Version and the

January 2004 Version were set to “Not Ascertained,” and the associated data flag *,BEST_FLG*, was set to “No Best Estimate, underlying values changed in editing.” Numbers found in this appendix reflect the January 2003 NATIONAL SAMPLE data, and may not be identical to those found in the January 2004 data.

Summary Tables

Table 3. 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

Table 3. 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)
	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
	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 4. 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

Table 4. 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
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
	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).