Fuel Tax Attribution Process Review and Documentation

Prepared for

Office of Highway Information Systems

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Prepared by

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Table of Contents

Acronym List

ATV All-terrain Vehicle

CPI Consumer Price Index

DOE Department of Energy

DOT Department of Transportation

EIA Energy Information Administration

EPA Environmental Protection Agency

EPACT Energy Policy Act of 1992

FAA Federal Aviation Administration

FHWA Federal Highway Administration

GAO General Accounting Office

GSA General Services Administration

HTF Highway Trust Fund

IFTA International Fuel Tax Agreement

IRS Internal Revenue Service

LPG Liquefied Petroleum Gases

MPG Miles per Gallon

NMMA National Marine Manufacturers Association

NHS National Highway System

ORNL Oak Ridge National Laboratory

SCM State, County, and Municipal

TEA-21 Transportation Equity Act for the 21st Century

USCG U.S. Coast Guard

USDA U.S. Department of Agriculture

USFWS U.S. Fish and Wildlife Service

VIUS Vehicle Inventory and Use Survey

VMT Vehicle Miles Traveled

Tables:

MF-1 Motor fuel tax collections for all states

MF-2 Volume of motor fuel exempt from and subject to state taxation

MF-3 State motor fuel taxes and related receipts

MF-21 Highway use by fuel type

MF-24 Private and commercial non-highway use of gasoline

MF-27 Highway use of motor fuel

MF-33E FHWA estimates of amount of gasohol used in each state

MF-33GA Monthly gross gasoline volume reported by state

MF-33SF Monthly gross special fuel use reported by state

MF-121T Tax Rates on Motor Fuel (by state and type of fuel in cents per gallon)

MV-7 Publicly Owned Vehicles

FE-9 Federal Highway Trust Fund receipts attributable to highway users in each year

FE-221 Comparison of Federal Highway Trust Fund Highway Account receipts attributable to the states and Federal-aid apportionments and allocations from the Highway Account

FA-4E Apportionment of Federal funds to states

Executive Summary

Evaluation Framework

A detailed review of the fuel tax attribution methodology was conducted using an evaluation framework that identified four goal areas: legacy system performance, data process quality, risk management, and institutional issues as they relate to the fuel tax attribution process.

- The legacy system performance goal area evaluates the ability, efficiency, and reliability of the fuel tax attribution system to perform its intended functions of accepting, analyzing data, and delivering accurate and consistent state fuel tax attributions.
- The data processing quality goal area evaluates the quality and reliability of data analysis procedures applied in processing of motor fuel tax data from the states. This goal area evaluates the business rules (rules-of-thumb, assumptions, and formulas used in the estimation models) and how these rules affect the results of the attribution process.
- The risk management goal area relates to the policies and practices that ensure consistency and reliability in data quality, acquisition, analysis, and reporting Highway Trust Fund attributions.
- The institutional issues goal area identifies any institutional issues related to data acquisition and handling as well as attribution of fuel tax revenues. This includes institutional arrangements that affect the fuel tax data processing directly or indirectly.

Summary of Findings

The following are major findings of the evaluation presented by goal area.

System Performance

- The use of the Smart Input Tool greatly enhances the quality of fuel tax data by reducing the chances of input errors, improving the efficiency of the attribution process, and saving cost and time associated with data entry at both state and federal levels. Also, by improving the quality of data submitted by the states, the time and effort required to reconcile data discrepancies is reduced. The savings in turn improve efficiency of the fuel tax attribution process.

- The analytical processes, including the assumptions, business rules, and estimation models appear to be consistently applied and yield consistent Highway Trust Fund attributions. These findings suggest that the system is reliable in generating fair and consistent attributions based on the number of gallons reported by the states.
- Although there was insufficient information to draw any definitive conclusions, the available information indicates that the oversight review will potentially improve the quality of data (in terms of accuracy, completeness, and timeliness) submitted to FHWA and enhance efficiency of the fuel tax attribution system as a whole. The oversight review process will potentially save the time and effort needed to reconcile state and FHWA data discrepancies and ultimately reduce reliance on estimation models for imputing missing data.

Data Process Quality

- The review and documentation of the entire fuel tax data analysis process includes detailed descriptions of all steps, assumptions, business rules, and estimation models. The documentation includes flow charts and figures that allow one to understand the sequences of calculations and flow of data elements and outputs.
- The statistical analysis of historical fuel tax attribution data showed that the analytical procedures generally generate consistent and reliable results of HTF attributions that are highly dependent on the fuel consumption information reported. The results support the hypotheses that the business rules and estimation models are consistently applied from year to year and that the data provided by the states are of acceptable quality.
- A statistical measure for assessing reliability of the fuel tax attribution system was developed. This measure allows outliers to be identified and investigated if necessary.
- Some variables used in the estimation models are outdated and/or no longer relevant. These models need to be reviewed and updated with more current data.

Risk Management

- The implementation of the Smart Input Tool is a major improvement directed at reducing the risks associated with states submitting incomplete and inaccurate fuel tax data. The self-error checking feature helps control this risk to a large extent.
- The "Highway Community Exchange" on the Smart Input Tool community website provides a feedback mechanism for FHWA that allows users at the state level to

seek clarifications and guidance in using the tool as well as the opportunity to offer suggestions for improvements. This feature is consistent with standard practices of risk management.

- The results of the statistical analysis show that analytical procedures appear to be reliable and consistently applied and that the amount of fuel consumption is highly correlated with the amount of funds attributed to the states. This implies that the fund attributions are reasonably fair and consistent. Departures from the expected results can be easily identified and investigated in conformity with standard risk management procedures.

Institutional Issues

No major institutional issues have been identified that could significantly impact the fuel tax attribution process. It was noted that the FHWA is implementing a number of changes, some of which are institutional in nature, to help improve the fuel tax attribution process. Some institutional arrangements may be necessary to facilitate the operations of the oversight reviews. These institutional changes are expected to promote the efficiency of the fuel tax attribution process rather than impeding the process.

Conclusions

The improvements being implemented by FHWA as part of the continuous improvement model have significant positive impacts on the fuel tax attribution process. These impacts include standardizing and streamlining the data reporting by the states to reduce the risk associated with poor quality data. These improvements greatly enhance the quality and reliability of the entire fuel tax attribution process.

It can be concluded from the evaluation results that the analytical procedures are fairly reliable in generating consistent HTF attributions to the states.

Recommendations

The following are some recommendations to help improve the fuel tax data attribution process.

Conduct periodic evaluations. This evaluation was conducted at a time when the full effects of some of changes implemented had not been completely realized (e.g., Smart Input Tool). In addition, and some improvements had not been fully implemented (e.g., oversight). Thus, the initial indications of the impacts may not be the same in the long term. It is therefore recommended that, as part of the continuous improvement model, periodic evaluations be conducted to help assess the success of the improvements, identify shortcomings and design corrective measures.

Convert the spreadsheets into a simple model. The analysis procedures are currently in a number of spreadsheets that are linked. While the use of spreadsheets provides transparency in the analytical procedure, it can sometimes be cumbersome to execute.

Action items for further improvements: It is recommended that several actions identified to further improve the fuel tax attribution process be reviewed and implemented. These include:

- Development of a structured stand-alone *Instructions Manual* devoted to providing specific guidance on reporting fuel tax data.
- Introduction of data assessment process tool that enables states to assess the quality of their own prior to submission to FHWA.
- Use Information Exchange website to address issues related to fuel tax data and also serve as a feedback mechanism.
- Establishment of mentoring program to assist states that experience consistent data quality problems.
- Review, enhance, and update of estimation models. Data and assumptions used in developing some of the original models need to be reviewed to determine their validity.
- Enhancement of analytical framework including EVAL, GTA, MF-20 analyses to adapt to improvements in quality of fuel tax data and estimation models.
- Development of a framework for systematic monitoring and evaluation of FHWA's continuous improvement programs.

1.1 Background

In June of 2000, the General Accounting Office (GAO) submitted a report to the Committee on Transportation and Infrastructure, House of Representatives [1]. In this GAO report, it was recommended that the Secretary of Transportation direct the Administrator of the Federal Highway Administration (FHWA) to improve the reliability of the attribution process for "... *producing accurate, reliable data for use in distributing highway program funds to the states*."

As one of the activities FHWA conducted in response to GAO's recommendation, a *Federal Register* notice [2] was issued on August 17, 2000 . This notice described several FHWA proposed refinements to methodologies on motor fuel reporting by states and the attribution process. It also served as a request for comments on the revised methodology.

On the basis of this notice and subsequent comments received, a revised methodology for on-highway motor fuel data input from states will become effective when FHWA publishes written guidance, currently scheduled for March 2003. To better inform states on the new procedures, FHWA has prepared a document that describes the new processes for collecting data and attributing highway fuel usage entitled, "*Attribution and Apportionment of Federal Highway Tax Revenues: Process Refinements*" [3]. Attribution and apportionment processes conducted annually by the FHWA to distribute Federal Highway Trust Funds (HTF) monies to the states are clearly explained in this new booklet.

More than $12 billion annually in Transportation Equity Act for the 21st Century (TEA-21) funds are apportioned to the states based on state-reported motor fuel data and the results of the Federal Highway Administration (FHWA) Highway Trust Fund (HTF) attribution process. Furthermore, the minimum guarantee program guarantees each state's share of the sum of certain apportioned programs will be at least 90.5 percent of its share of highway account contributions. This program, which is based on state reported motor fuel as 100 percent factor, is the cornerstone factor in the federal aid highway program. The system to collect, analyze, and attribute HTF receipts to the states has evolved from a time when far less money relied on this data. To modernize this system, FHWA, in cooperation with the states, has reassessed the current motor fuel analyses system with a view toward bringing it up to the current state-of-the practice, making it at least as advanced as other comparable systems (i.e., nation-wide, complex systems that distribute more than $12 billion in Federal funds annually).

Under its Reassessment Action Plan, the FHWA has made a number of "ad hoc" improvements to its current system to eliminate processing errors and increase data quality. These include:

- Development of written business rules
- Duplicate data entry and data checking software enhancements
- State review of 1999 motor fuel data used for FY 2002 apportionments.

Further, the Reassessment Action Plan calls for longer-term strategic improvements to design and develop a new "smart system" that integrates system enhancements, model improvement, and state oversight. To date the following has been accomplished:

- Design, development, and implementation of a motor fuel data base management system (DBMS) beginning in November 2001
- Enhanced FHWA oversight of state data reporting, to begin in FY 2002
- Initial executive-level documentation fully completed

- Intermediate-level documentation fully completed
- Detailed documentation to parallel system development fully completed
- Executive briefing with Internal Revenue Service ExFIRS System developers in July 2001.

A discussion of the issues associated with the fuel tax attribution process is presented in Appendix A of this report.

1.2 Project Objectives

Recognizing the increasing importance of accurate, timely reporting of motor fuel and related attribution data in determining state-funding shares, the FHWA is reviewing the motor fuel data reporting system used to collect this information. As part of the continuous improvement process, FHWA has implemented certain changes directed at improving the quality and timeliness of fuel tax data reported by the states.

This project is designed to conduct an independent comprehensive review of FHWA's methodology for analyzing state motor fuel data and attribution of HTF receipts to the states. The primary objective of the review is to allow the FHWA to better ensure that the motor fuel attribution process yields reliable information and the "best possible" estimates for use in distributing Federal highway programs funds to the states. The review examines data quality, efficiency of the system in processing motor fuel data, consistency of data processing and risk management processes with standard and best practices, and any institutional issues. This project focuses on the following areas:

1. The impact of changes implemented by FHWA on the fuel tax data acquisition and analysis process - e.g., the use of (i) Smart Input tool by the states to submit fuel tax data, and (ii) oversight process to improve the quality of data submitted to the FHWA
2. The consistency and reliability of the procedures and models used in the data analysis leading to attribution include such questions as: "Are the business rules logical and consistency applied?" This includes a review of the FHWA's instructions or guidelines to the states regarding reporting of fuel tax data.

1.3 Organization of Report

The remainder of the report is divided into several chapters. Chapter two presents a documentation of the fuel tax data analysis process leading to attribution of fuel tax revenues to the states. The description is presented at two levels of detail. The first, a high-

level description, presents the major processes, inputs, outputs, and the relationships among them. The second is a detailed step-by-step description of the processes. This level includes descriptions of the estimation models that the FHWA uses in the fuel tax data analysis process.

Chapter three presents an evaluation of the impacts of the changes implemented as part of FHWA's continuous improvement model on the fuel tax attribution process. This includes a comparison of the new Smart Input Tool with the legacy paper-based data submission process. The potential impacts of state oversights are also evaluated. This chapter also presents action items directed at further improving the quality of furl tax data and efficiency of the attribution process.

Chapter four provides concluding remarks and recommendations.

2.1 Overview

This chapter presents a description of the fuel attribution process. The description of the attribution process is divided into two levels of detail. The first, or high level, provides the relationships among the major components of the process, including the data sources, analyses, and outputs. The second level, or detailed level, describes the detailed data flows in each analysis.

Basically, "attribution" is the process that FHWA carries out annually to determine a state's share of the overall on-highway motor fuel consumption. Results from this process are used in estimating amounts of the Highway Trust Fund (HTF) receipts to be attributed to highway users in each state. This information is then used in distributing funds to states through the apportionment process used in several major highway programs. The attribution process starts when highway-related tax revenue is collected by the Internal Revenue Service (IRS) and subsequently assigned to the appropriate tax categories - one of which is the motor fuel excise tax. The Federal motor fuel taxes are usually paid by oil companies at the point where the fuel is loaded into tanker trucks or rail cars at the terminal. Congress has determined that the tax money should be attributed to the state in which the fuel was actually consumed, which is not necessarily where the tax is paid (where it is loaded for shipment). However, the IRS has no information on where or how the fuel is actually consumed. Therefore, FHWA has to rely on its own attribution process to determine on-highway use of motor fuels within each state. The following sections describe the data analysis processes.

The main sources of data for the fuel tax attribution process are forms submitted by the states to the FHWA, as well as many estimating models that are mainly used to ensure that

the data for each state is being represented consistently, in addition to filling in any gaps in the data that exist for various, often unavoidable, reasons. Generally, the estimation models are updated and run in the May-June timeframe every year. FHWA completes these estimations before the beginning of the annual state-by-state analysis, which normally starts around July. These estimates actually represent the year prior to the analysis year since current-year data are usually not available in time. For example, 1999 data was used during the 2000 analysis year. Due to a time lag in the data collection and development of summary statistics, estimation models are run during May-June of calendar year x+1 to generate non-highway use of gasoline, public fuel use, and gasohol consumption for calendar year x. Figure 2-1 presents a timeline for the annual state-by-state motor fuel analysis procedures. It includes a three-year analysis cycle.

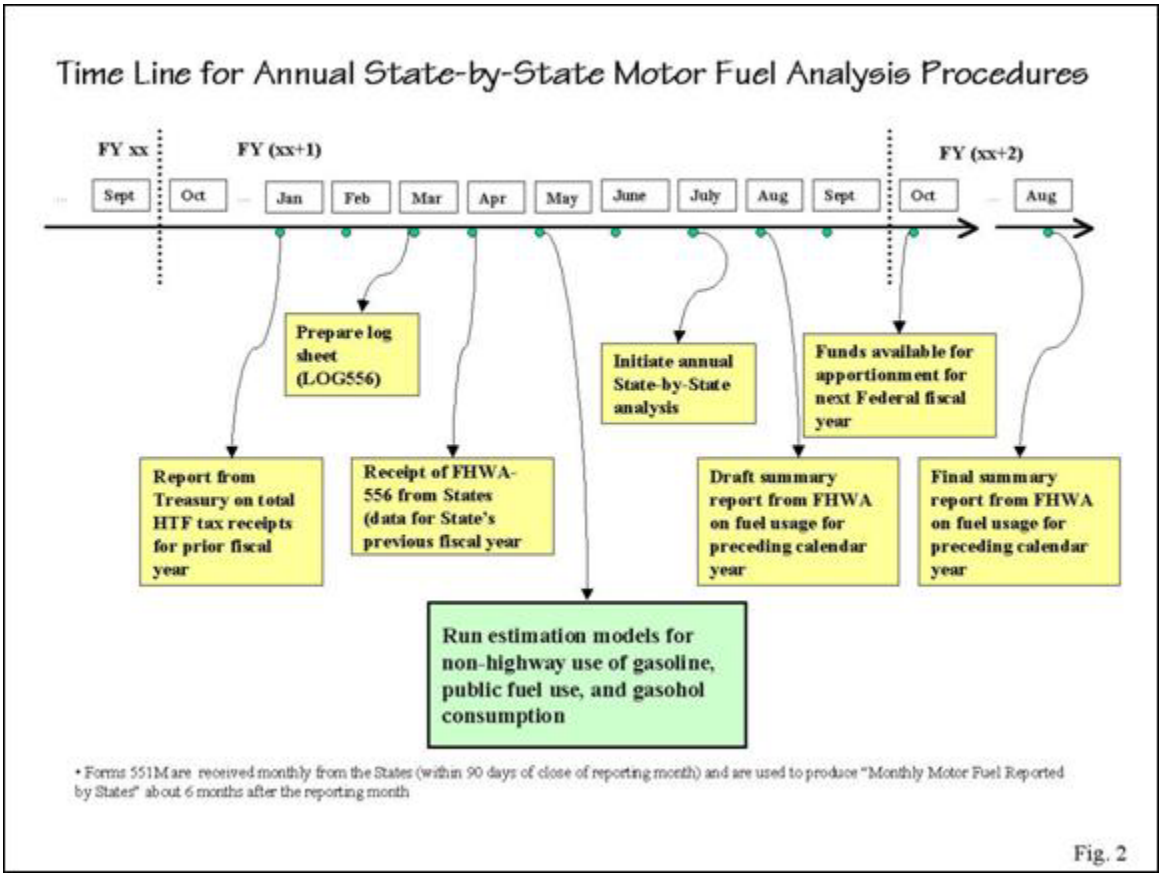


Figure 2-1. Timeline for Annual State-by-State Motor Fuel Analysis Procedures

2.2 Monthly Motor Fuel Reporting Procedures

Form FHWA-551M provides data for the monthly reporting of motor fuel volume. This form is completed by the state agency that collects the motor fuel tax. The form must be transmitted to the FHWA Washington Headquarters no later than 90 days after the close of

the month for which data are being reported. Information that is not available on a monthly schedule is included on the next monthly report submitted after the data become available. In the past (before January 2002), data arrives from the states in any of several forms: mailed-in paper reports, facsimile paper reports, e-mailed reports, or computer disk reports in either Lotus or Excel format. States report amounts of fuel consumed in gallons. The information states provide is organized primarily for the purpose of administering state fuel-tax programs. There are variations in individual state requirements; therefore, reported data are sometimes not comparable among states. In order to treat states equitably in motor fuel attribution and to ensure consistency, the FHWA often has to adjust parts of the state's submissions.

Once the preliminary adjustments are complete, resulting in one reviewed form for each month in the calendar year, the data are summarized in a report titled *Monthly Motor Fuel Reported by States*. This report is produced about six months after the month in which a transaction called "state taxation of motor fuel" or "taxable event" occurred. The data on hand from the states at the time of preparation for publication are included, and states that have not submitted data by that time are not included. The data are not consistent and complete at this early stage, and have had only minimal FHWA editing and no analysis. The data are, however, the most current, and therefore is the first place to identify potential trends, and the first place for states to check FHWA motor fuel entries for reason and consistency with their own records. The results are reported in the Highway Statistics Table MF-33GA, which shows gasoline volumes by month, and Table MF-33SF, which shows special fuels by month.

2.3 State-by-State Annual Analysis

Figure 2-2 summarizes a high-level overview of the data flow from the states to attribution. It shows the various data sources, estimation models, and outputs generated from each analysis.

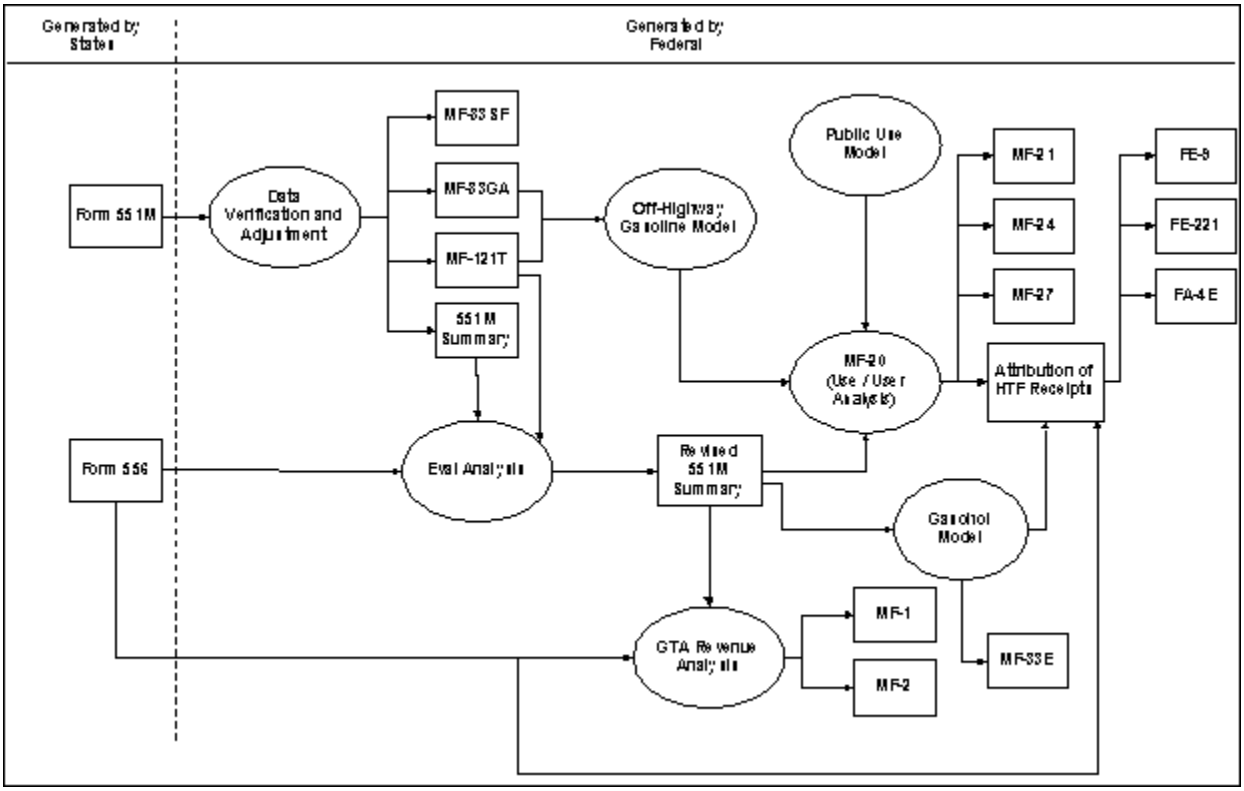


Figure 2-2. Flow Chart of Motor Fuel Data

2.3.1 Data Sources

The primary data sources on motor fuel use are the motor fuel gallons and motor fuel tax revenues reported regularly to the FHWA by each state's taxation or revenue department. States use Form FHWA-551M ("*Monthly Motor-Fuel Consumption*") to report gross volume fuel consumption to the FHWA, for gasoline, gasohol, highway diesel fuel, and highway liquefied petroleum gases (LPG) on a monthly basis.

States also report their annual motor fuel tax revenue data on FHWA-556 ("*State Motor-Fuel Tax Receipts And Initial Distribution by Collection Agencies*") once a year. This form is submitted by a state on a fiscal-year basis, which can be a calendar year or any one of several annual time periods. Each state's fiscal year is different. For example, a state's fiscal year may be defined as July 1 to June 30, or October 1 to September 30. This time period represents an annual interval in which the department responsible for the "state motor fuel taxes" reports "revenue received from motor fuel per-unit taxes" to FHWA. Other taxes dealing with transportation issues also may be reported. Data from Form 556 is used on the EVAL worksheet (discussed later) to compare state-reported revenue with state-reported gallons (the gallons reported are multiplied by the state's tax rate(s) for

comparison). FHWA Form 556 must be submitted to the FHWA by April 1 of the year following the analysis year.

In a few cases, state-reported data on Form 556 must be put through additional calculations to meet FHWA needs, just as some of the Form 551M data must be adjusted. For example, Illinois reports gross receipts by gasoline and special fuels, but this data needs to proceed through several additional steps to properly allocate these totals. Examples of other states that require special treatment of Form 556 include Florida and West Virginia . The following section outlines the adjustments.

2.3.2 Data Verification and Adjustment

As noted in Figure 2-2, the first step in the overall fuel tax attribution process is the states' completion of Form 551 each month. Once one of these forms is submitted, via disk, email, fax, or regular mail, and within 90 days of the close of the month for which the fuel volume data are reported to the Federal government, the FHWA reviews, verifies, and adjusts data where necessary.

The adjustments to data submitted on Form 551M are necessary for several reasons. The state-submitted data are not of themselves sufficient for FHWA to accurately distribute HTF monies to the states consistently and equitably. Tax legislation, tax forms, and administrative procedures vary significantly among the states. For example, exemptions or refunds for non-highway use or government use of motor fuels are handled quite differently in many states. Also, for some states, collection of certain data may not be required according to the legislative requirements. In order to ensure accurate treatment of all states during the analysis of motor fuel information, adjustments are made to the data to account for these discrepancies. Furthermore, some adjustments are necessary in order to estimate missing or non-reported data. It is important to note that adjustments are made to the annual data summaries only. The adjustments are not made to monthly summaries.

The spreadsheet version of the Form FHWA 551M currently used by FHWA is composed of thirteen worksheets for each state for any selected calendar year. Once the state data are written into the FHWA spreadsheets, the file is named MMF plus the two character state abbreviation and the two-digit year. One worksheet exists for each month, and the 13th worksheet presents the summary sheet that contains totals from the other 12 sheets. The summary sheet sums all the monthly worksheet cells of Form FHWA-551M from page one into annual totals. Once the data on Form 551M have been verified and adjusted, three summary tables are generated in addition to the 551M Summary (Figure 2-3):

- MF-33SF - special fuels volume by month

- MF-33GA - gasoline volume by month
- MF-121T - tax rates for gasoline and other fuels.

Detailed descriptions of the annual summary analysis are presented in Section 2.4 of this report. When assured that all entries in the summary are properly accounted for, the evaluation process (EVAL) is performed.

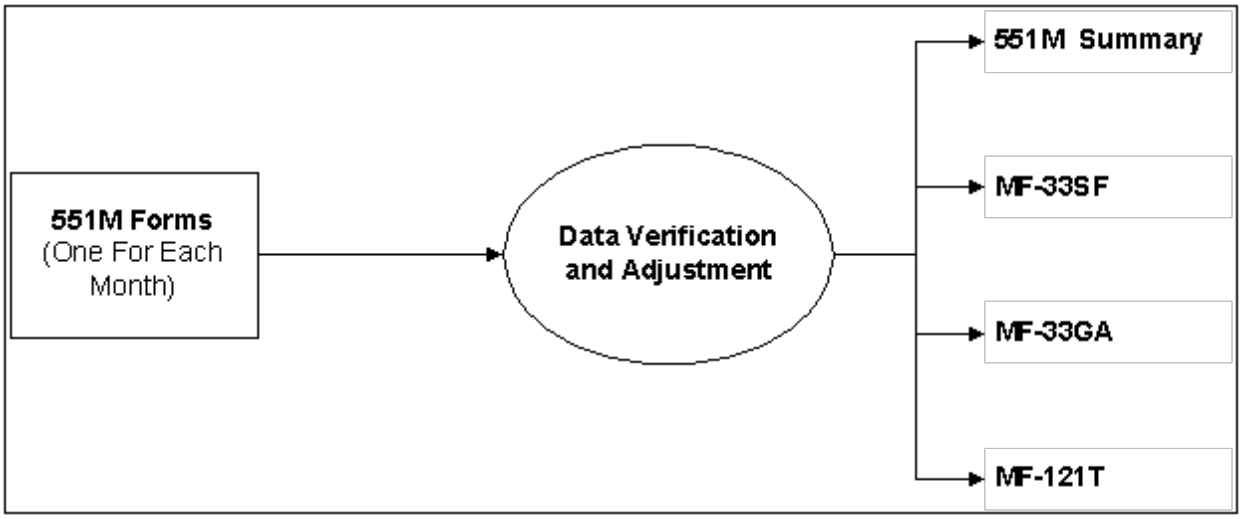


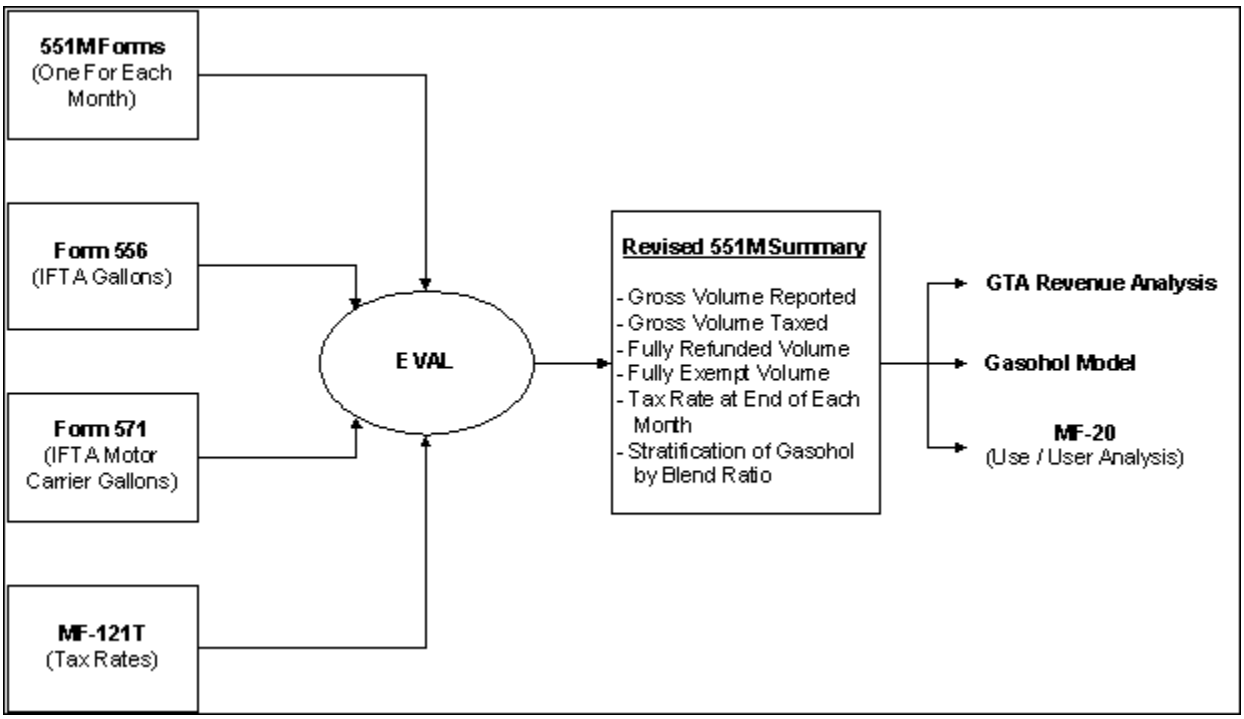
Figure 2-3. Data Verification and Adjustment

2.3.3 Evaluation Analysis

Before state-reported fuel data from the 551M Summary can be used in the fuel attribution process, it must be checked for accuracy and rationality through a process known as EVAL (Figure 2-2). This is a critical step in the fuel tax attribution process since it establishes the consistency and validity of the data submitted by the states. In the evaluation process, states whose tax rates have changed during the year and those with multiple tax rates are checked to ensure the appropriate tax rates are used in the analysis. The evaluation process involves using the tax rates from MF-121T and the 551M Summary sheet generated in the preceding step to compare with the revenue reported on Form 556. Using IFTA gallons information from Form 556 and Form 571, the annual data are reviewed and adjusted as necessary for each state to ensure adequate fuel data quality (Figure 2-4). This is performed to ensure reported consumption (in gallons) and receipts (in dollars) are within acceptable limits. The calculated tax revenue, based on the reported volume data, must not vary from the reported receipts by more than 10 percent. Additional adjustments may be required when significant differences are identified. Depending on the scale of these differences, the state may be contacted and a written explanation will be requested. The MF-20 analysis (and subsequent steps in the fuel attribution process) cannot proceed

until the correlation between receipts and gallons (times the tax rate) is within the acceptable limits.

FHWA analysts work with a state until there is a less than 5 percent difference in the receipts reported on the Form 556 versus the gallons (times tax rate) reported on 551M. The output of the evaluation is a revised 551M summary that is used in the GTA revenue analysis, the gasohol model, and in the Use/User Analysis (Figure 2-4). This Revised Form 551M Summary, distinguished from the Form 551M Summary, is the output of data verification and adjustment. Detailed descriptions of the step-by-step process involved in the evaluation analysis are presented in Section 2.4 of this report.



Note: Form 571 is submitted by only a few states in reporting their IFTA gallons; most states report their IFTA gallons on the 551M Form.

Figure 2-4. 551M Summary

2.3.4 GTA Revenue Analysis

A similar process to EVAL is the Gallons Taxed Analysis (GTA) process that uses revenue data from Form 556 and fuel consumption data (in gallons) from the Revised 551M Summary to compare the two sets of information. This analysis completes forms MF-51 and MF-56, which together are referred to as GTA. The results of this comparison are then published in Highway Statistics Tables MF-1 (motor fuel tax receipts for all states) and MF-2 (volume of motor fuel exempt from and subject to state taxation). This process, however,

does not have a direct effect on the fuel attribution process. A detailed description of the analysis steps is presented in Section 2.4 of this report.

The next step in the fuel tax data analysis process is to estimate public and non-highway use of fuel. This step is presented in the following section.

2.3.5 Estimation Models Used in FHWA Attribution Process

A number of mathematical and statistical formulas, as well as supplemental information from many other sources, are utilized in analyzing the motor fuel data. The complexity of this process reflects the wide variation among state taxation structures and methodologies for defining, capturing, and reporting data to the FHWA. The FHWA performs three estimation procedures for the following motor fuel usage components:

- Non-highway gasoline consumption
- Government use of gasoline
- On-highway use of gasohol (three grades).

Each of these components is estimated by utilizing models. These estimation models and their data sources are described in detail in Section 2.5 of this report.

The Federal fuel taxes, which make up more than 80 percent of the HTF receipts, are imposed when the fuel is first removed from bulk storage and the tax is paid by the seller. Generally, these taxpayers are the oil companies. Although paid initially by a company, the costs of these fuel taxes become part of the purchase price of the products and are ultimately paid by the highway users. Using oil company tax data in attribution process would be problematic, however, because the state in which the motor fuel tax is paid does not reflect where it will be shipped, stored, or used. Consequently, FHWA must estimate the HTF contributions from highway users by looking at tax revenue data in each state.

Typically, state revenue departments have data on motor fuels that are exempted, refunded, or taxed at other rates. From this type of data, FHWA may be able to identify the use of the fuel and, therefore, its place in attribution of HTF. Unfortunately, in many cases, this data does not exist at the state level and FHWA must estimate fuel usage from other sources.

Furthermore, as stated previously, motor fuel tax programs vary from state to state. Often, the states' motor fuel information systems and the data that are submitted to FHWA are not comparable. Some states exempt or refund taxes collected for all fuel used by agencies of the Federal government. A few states tax Federal highway use of motor fuel while others also tax non-highway fuel uses by Federal agencies. Similarly, rules on tax exemptions or

refunds for motor fuel used by state, county, and municipal government agencies also differ significantly among states. Rather than imposing the data collection and reporting burden on the states, FHWA has opted to estimate some of these data.

In the case of gasohol usage, very few states recognize the Federal definitions of gasohol (i.e., alcohol content of 5.7 - 7.7, 7.7 - 10 percent, and >10 percent). Some states define gasohol as reformulated gasoline (RFG), not as a gasohol blend. Furthermore, most states tax gasohol at the same rate as gasoline, and the tax receipts are combined for these fuel types. Consequently, states are not able to furnish data with the level of detail required by FHWA. A modeling approach is therefore needed so that FHWA can determine the distribution of total gasohol consumption by the three Federal gasohol tax categories.

The estimation process developed by FHWA has been designed to accurately represent states on highway fuel use, and to produce meaningful results to fulfill attribution process needs. When FHWA estimates and state-submitted data are available, FHWA makes judgments about the relative quality of the data and selects one or the other, or some combination of the two data sets. The following sections provide overviews of the estimation models. The outputs from the off-highway use of gasoline and public use estimation models are used together with the revised Form 551M Summary to conduct the Use/User Analysis (MF-20).

2.3.5.1 Off-Highway (or Non-Highway) Gasoline Model

Tables MF-33GA and MF-121T (monthly gasoline reported by states and tax rates on motor fuel by state, respectively) generated from the data verification process are used as inputs to the Off-Highway Gasoline Model. The off-highway estimation model has six modules (Figure 2-5):

- Agriculture module - estimates non-highway use of gasoline for agriculture purposes
- Aviation module - estimates aviation use of gasoline
- Boat module - estimates gasoline in recreational boats
- Construction module - estimates gasoline by construction equipment
- Industrial/commercial module - estimates gasoline use for commercial and industrial purposes
- Recreational module - estimates recreational trail use of gasoline.

Three of these modules (agricultural, construction, and industrial/commercial) are further divided into two categories: non-highway use of gasoline by trucks and non-highway use of

gasoline by other equipment. The purpose of the off-highway model is to estimate non-highway use of gasoline (both private and commercial) for individual states. This estimation is performed as part of an effort to separate on-highway gasoline use from non-highway use since only on-highway use is applicable to the FHWA apportionment process.

Fuel consumption for small equipment (e.g., lawnmowers, chain saws) is not included due to a lack of reliable data. FHWA plans to review recent work by the U.S. Environmental Protection Agency (EPA) on off-road small engines to determine the feasibility of using this information in enhancing the non-highway fuel consumption models with this additional data. The EPA has recently created a model ("NONROAD"), which is a comprehensive, national model for estimating and predicting non-road emission inventory, including 80 basic and 260 specific types of small gasoline engines. The most recent version of this model released (June 2000) is still in draft format while the data collection and analysis efforts continue at EPA.

Output data from the Off-Highway model is then used in the Use/User Analysis and in generating Table MF-24 (private and commercial non-highway use of gasoline) of *Highway Statistics* [4]. The steps involved are described in detail in Section 2.5 of this report.

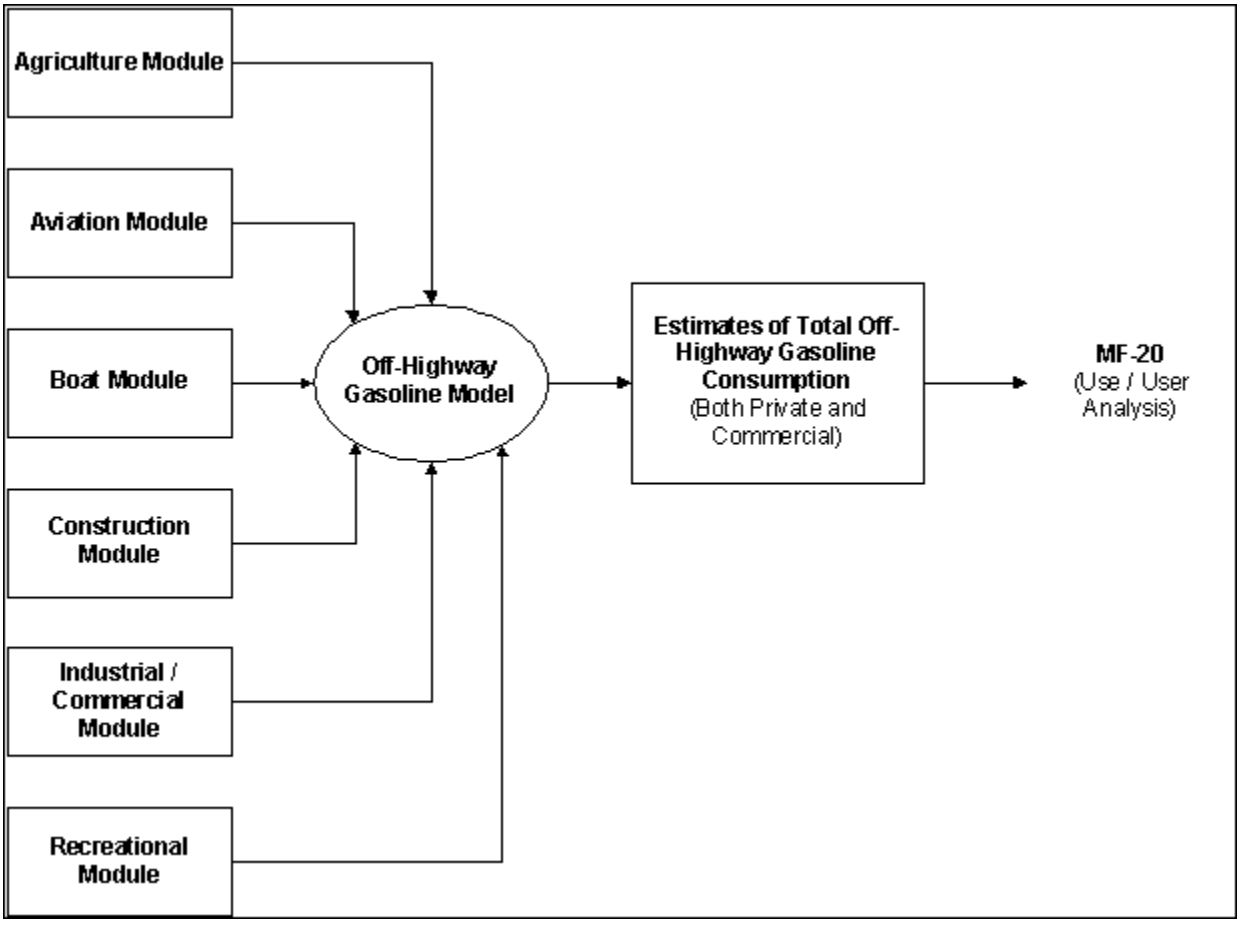


Figure 2-5. Off-Highway Gasoline Model

2.3.5.2 Public Sector Consumption Model

The Public Use Model is used to estimate public sector consumption of gasoline. This model uses information from Highway Statistics Table MV-7, the GSA's Federal Motor Fleet Report, percentages of fuel consumption, and population and land area data, to estimate gasoline consumption by the public sector (Figure 2-6). The public sector includes Federal, state, county, and municipal governments. At the Federal level, only civilian use of motor fuel is considered (off-highway military use is exempted from Federal tax liability). This model creates consistent data for each state that would otherwise be inconsistent due to differing state taxation policies. The final estimation of public sector fuel consumption is then used in the Use/User Analysis. The steps involved are described in detail in Section 2.5 of this report.

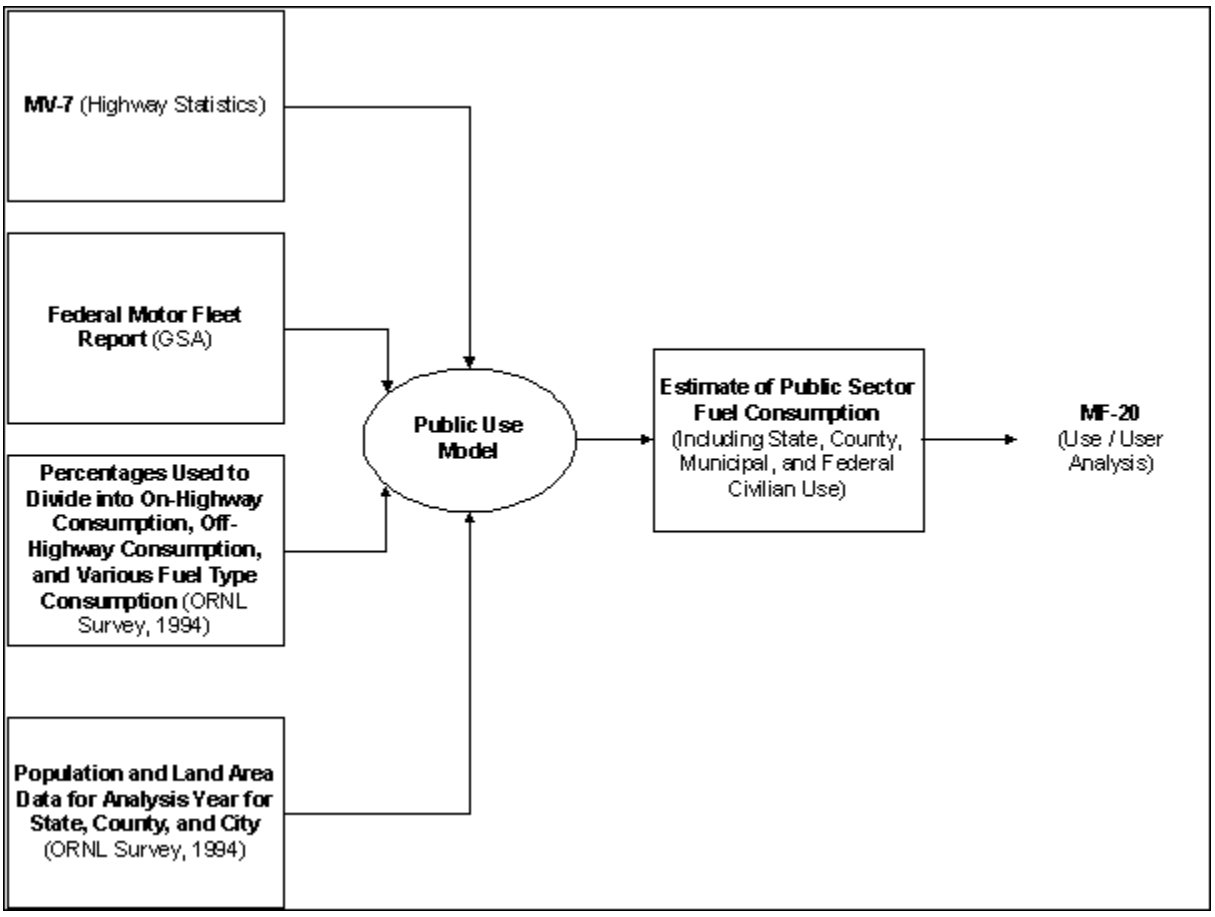


Figure 2-6. Public Use Model

2.3.6 Gasohol Model

The Gasohol Model uses information from the Revised 551M Summary as well as from an IRS Module to estimate gasohol consumption for each state, in terms of three blends defined by the Energy Policy Act of 1992 (EPACT) and recognized by the IRS and FHWA: 10 percent, 7.7 percent, and 5.7 percent ethanol by volume (Figure 2-7). IRS taxes the three different blends of gasohol at different tax rates. This model serves to provide comparable estimates of each blend for each state since the states have a variety of methods of reporting gasohol consumption amounts. Some states report only one type of ethanol, while others do not report any gasohol consumption at all; Washington State is the only state that defines the three types of gasohol in legislation identical to those defined in the Federal legislation. Since highway-funding attribution is based on Federal motor fuel tax revenue, FHWA has to determine gasohol revenues attributed to each state using the Federal definition of the three types of gasohol. Data generated from this process is used in the Attribution of HTF receipts as well as in *Highway Statistics* Table MF-33E (i.e., FHWA estimation of amount of gasohol used in each state) (Figure 2-2). Section 2.5 presents detailed descriptions of the model.

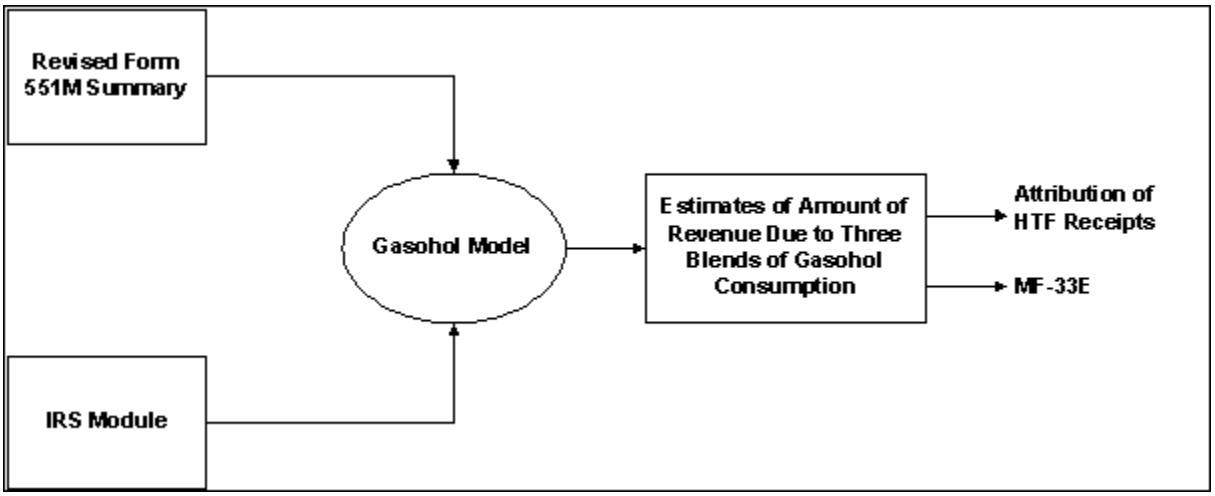


Figure 2-7. Gasohol Model

2.3.7 Use/User Analysis (MF-20 Analysis)

As can be seen in Figure 2-8, data from the Revised 551M Summary as well as the Public Use Model and the Off-Highway Model are inputs for the Use/User Analysis (MF-20). Figure 2-8 provides an overview of the inputs and outputs of the MF-20 analysis. The purpose of the MF-20 analysis is to subdivide fuel consumption into several categories, denoting both the use and the users of the fuel consumed: fuel type (gasoline, gasohol and special fuels), use (highway and non-highway), and tax status (e.g., exempt, refunded, at-other-rate). The

most important subdivision is highway versus non-highway. The distinction between "public" versus "private and commercial" is secondary.

As a rule, the non-highway gallons consumed shown on the MF-20 form/worksheet should not be greater than the FHWA-estimated values from the models. The results of this process, including fuel consumption categorized by fuel type, use, and tax status, then feed into the Attribution of HTR process. In addition, the results generate two *Highway Statistics* tables:

- MF-21 - highway use by fuel type (all motor fuels)
- MF-24 - private and commercial non-highway use of gasoline and gasohol.

This step immediately precedes the attribution of fuel taxes, and final adjustments to the data reported by the states are made in the MF-20 analysis. It involves several sub-steps including comparing model estimates with state-reported values, imputing missing data, and adjusting Native American fuel consumption.

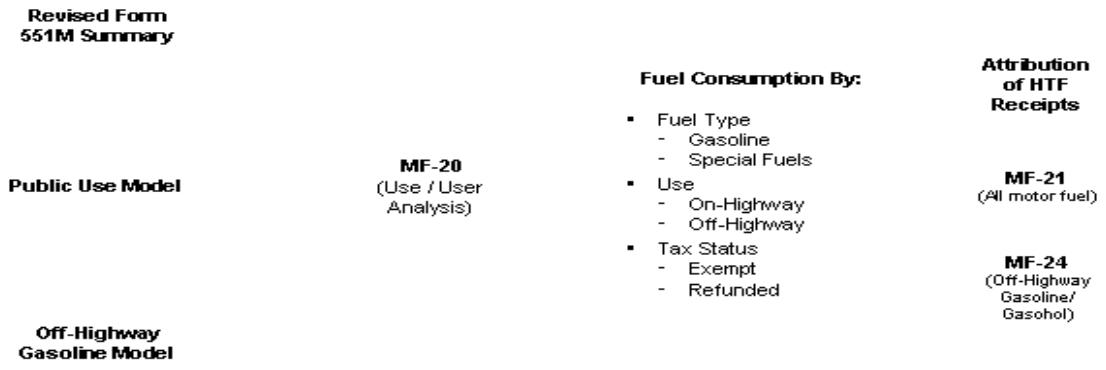


Figure 2-8. MF-20 (Use/User Analysis)

2.3.8 Attribution of HTR

The final step in the fuel tax attribution process is the calculation of the HTF Receipts. Figure 2-9 shows the inputs and outputs of this final step. Using outputs of the gasohol model, the Use/User Analysis and Form 556, the highway fuel usage for each state is aggregated and the apportionment amount, based on the percent of fuel used, is calculated for each state. In other words, for each state, the total tax receipts received for each type of fuel are multiplied by the percent of total fuel consumed to determine the amount of attribution the state will receive. This calculation is done for gasohol and special fuels as well as gasoline. In addition to determining the fuel attribution, the data from this process is reported in *Highway Statistics* tables:

- FE-9 - Federal HTF receipts attributable to highway users in each year
- FE-221 - Comparison of Federal highway trust fund highway account receipts attributable to the states and Federal aid apportionments
- FA-4E - Apportionment of Federal funds to states
- MF-27 - Highway use of motor fuel.

2.4 Detailed Descriptions of Steps in Each Process

This section presents detailed descriptions of the steps in each of the processes discussed in Section 2.3. The descriptions include diagrams that show data flows at the highest level of detail. The business rules applied in the various stages of the analysis process are shown in italics.

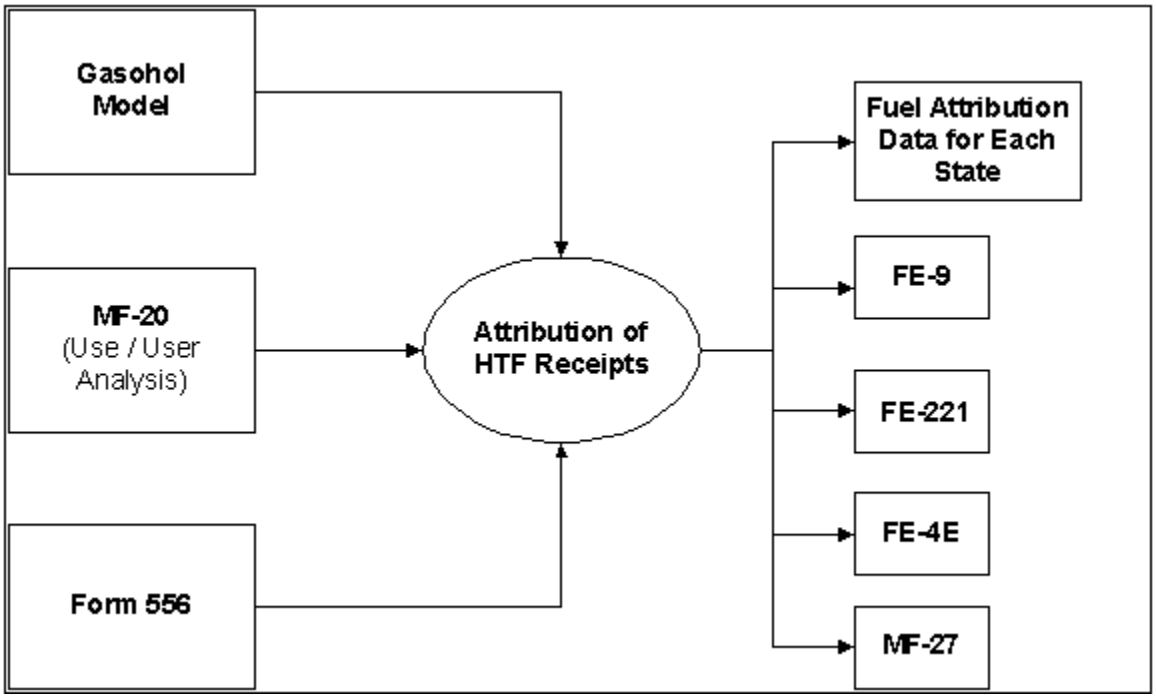


Figure 2-9. Attribution of HTF Receipts

2.4.1 Summarizing Fuel Tax Data from the States

Naming Conventions

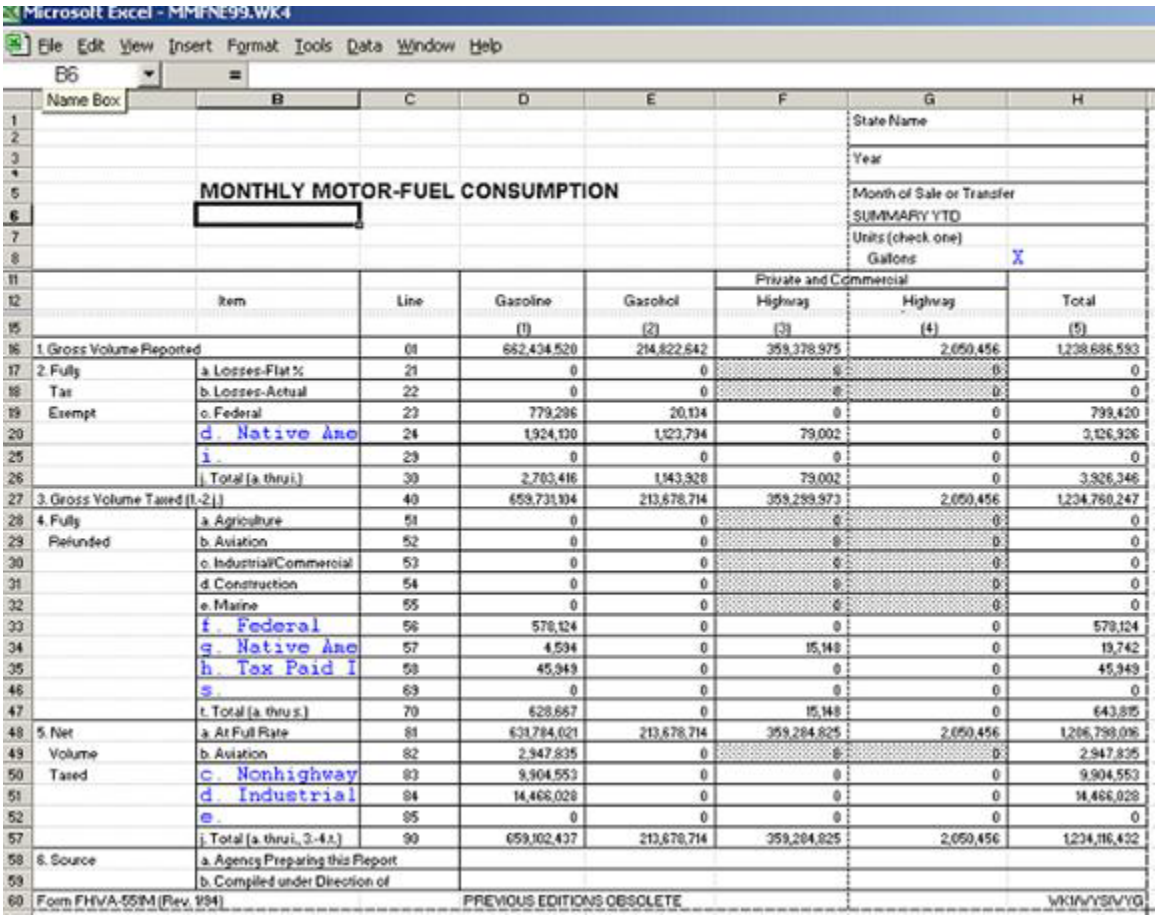
The following are naming conventions used for the files used in the fuel data analysis. The two major folders containing motor fuel files are called MF (motor fuel) and MMF (monthly motor fuel). Within the MF folder are sections representing a series of years, where a two-digit name represents the last two digits of the year, so 84 represents 1984, 00 represents

2000, etc. Within the folder for a given year, state's files are indicated by its two character postal code (i.e., Colorado is CO and Connecticut is CT). The rest of the characters represent the type of data analysis worksheets (EVAL, MF20, and GTA).

In the MMF folder, the organization is slightly different. The MMF folder has a large set of files in which the name begins with MMF, indicating monthly data. The next two places in the filename indicate the state's name, identified by its two character postal code. In the next two places, the year is indicated by the two-digit system described above. A subfolder of MMF, entitled "Tables," contains the worksheets that develop the tables to be published in *Monthly Motor Fuel Reported by States* and *Highway Statistics*. The table filenames indicate the type of table and the motor fuel information being displayed. For example, 33GA00.wk4 contains the data for Table MF-33GA, and displays monthly data on gasoline for the year 2000, and 33SF00.WK4 contains monthly data for Table MF-33SF, and displays data on special fuels for the year 2000.

Data Source

Form FHWA-551M provides data for the monthly reporting of motor fuel volume. Form FHWA-551M is completed by the state agency that collects the motor fuel tax. The form must be transmitted to the FHWA Washington Headquarters no later than 90 days after the close of the month for which data are being reported. Information that is not available on a monthly schedule is included on the next monthly report submitted after the data becomes available. In the past (before January 2002), data arrives from states in any of several forms: mailed-in paper reports, facsimile paper reports, e-mailed reports, or computer disk reports in either Lotus or Excel format. States report units in gallons on this form (Figure 2-10).



Microsoft Excel - MMFNE99.WK4

File Edit View Insert Format Tools Data Window Help

B6 =

Name Box

MONTHLY MOTOR-FUEL CONSUMPTION

State Name

Year

Month of Sale or Transfer

SUMMARY YTD

Units (check one)

Gallons X

	Item		Line	Gasoline	Gasohol	Private and Commercial Highway	Highway	Total
				(1)	(2)	(3)	(4)	(5)
16	1. Gross Volume Reported		01	662,434,520	214,822,642	359,378,975	2,050,456	1,238,686,593
17	2. Fully	a. Losses-Flat %	21	0	0	0	0	0
18	Tax	b. Losses-Actual	22	0	0	0	0	0
19	Exempt	c. Federal	23	779,286	20,134	0	0	799,420
20		d. Native Ame	24	1,924,130	1,123,794	79,002	0	3,126,926
25		i.	29	0	0	0	0	0
26		j. Total (a. thru i.)	30	2,703,416	1,143,928	79,002	0	3,926,346
27	3. Gross Volume Taxed (1.-2.j.)		40	659,731,104	213,678,714	359,299,973	2,050,456	1,234,760,247
28	4. Fully	a. Agriculture	51	0	0	0	0	0
29	Refunded	b. Aviation	52	0	0	0	0	0
30		c. Industrial/Commercial	53	0	0	0	0	0
31		d. Construction	54	0	0	0	0	0
32		e. Marine	55	0	0	0	0	0
33		f. Federal	56	578,124	0	0	0	578,124
34		g. Native Ame	57	4,594	0	15,148	0	19,742
35		h. Tax Paid I	58	45,949	0	0	0	45,949
46		s.	69	0	0	0	0	0
47		t. Total (a. thru s.)	70	628,667	0	15,148	0	643,815
48	5. Net	a. At Full Rate	81	631,784,021	213,678,714	359,284,825	2,050,456	1,206,798,016
49	Volume	b. Aviation	82	2,947,835	0	0	0	2,947,835
50	Taxed	c. Nonhighway	83	9,904,553	0	0	0	9,904,553
51		d. Industrial	84	14,466,028	0	0	0	14,466,028
52		e.	85	0	0	0	0	0
57		j. Total (a. thru i., 3.-4.t.)	90	659,002,437	213,678,714	359,284,825	2,050,456	1,234,016,432
58	6. Source	a. Agency Preparing this Report						
59		b. Compiled under Direction of						
60	Form FHWA-551M (Rev. 1/94)			PREVIOUS EDITIONS OBSOLETE				WKWYSIVYG

Figure 2-10. Sample Form 551

Editing State Data Reports

At this stage of the motor fuel reporting process, the purpose of the data entry is to record the state-reported data as it is received. As noted in the introduction in Chapter 2 of "Guide to Reporting Highway Statistics," the state data may be modified later to achieve uniform measurement of the data because of differing definitions and treatment of data under each state's legislation and administrative procedures.

Generally, state motor fuel taxes are levied on road users, and refunds of the taxes paid or exemptions to the tax are given for non-highway use of motor fuel. However, not all states offer refunds or exemptions for all classes of non-highway use, and not all available refunds are actually claimed. Thus, often the net volume of fuel taxed is not the same as the volume consumed on highways. Volume of motor fuel consumed on the highways in each state is the primary data parameter of interest for FHWA purposes. It is necessary to make various adjustments to the tax-status information provided by the states to show fuel volume on a use basis when consistency of motor fuel data are essential for attribution and

publication in *Highway Statistics*. The purpose of the adjustments is to level the playing field so that all states are treated equitably in attribution.

During the data entry process, the FHWA assesses the data being entered, using some analytical judgment. For example, FHWA has chosen to show only private and commercial highway (i.e., excluding public) use of special fuels in its consumption tables. Many states, however, report non-highway and public uses of special fuel. The FHWA currently deducts any identifiable non-highway or public use of special fuels in the state-reported figures. In the near future, FHWA will be changing this policy. FHWA instructions will ask the states not to report identified non-highway diesel. State reporting of data that is not needed by FHWA serves no useful purpose and therefore should be eliminated.

By FHWA definition, transit use, regardless of the ownership of the transit system, is treated as private and commercial use of special fuels. Many states do not report their use of transit special fuels. At this stage, the FHWA analyst corrects the state's data by including transit use when these data are available from other sources, if at all. Under current FHWA practice, an FHWA analyst enters some states' transit data (CO, MA) from this source. In future changes to the reporting instructions, FHWA will instruct states to obtain data on transit motor fuel use in their state from this source, and to report this data if the state does not have its own sources for transit motor fuel use data.

Aviation gasoline is another fuel tracked by an independent source. Since aviation gasoline is treated differently than normal gasoline (it is a higher-octane fuel and is stored separately to maintain purity), Department of Energy (DOE) tracks its inventory. The data series can be found in *Petroleum Marketing Annual*, Table 49, "Prime Supplier Sales Volumes of Aviation Fuels, Propane, and Residual Fuel Oil by PAD District and State." Data for a full calendar year should be available by March of the following year. A few states will have data for some months withheld from this table because of disclosure provisions. For a few states (usually four or five) data will be withheld for the entire year. For these states, estimation procedures are discussed in Section 2.5.

Annual State Data Analysis

Once the monthly motor fuel data are verified, adjusted, and considered complete for the calendar year for a state, the FHWA-551M annual summary for the state is generated. This summary provides annual data for each state. The data are checked to ensure that all components are included, since the data for some states may be incomplete (for example, International Fuel Tax Agreement [IFTA] data may not be complete, even though all monthly data may be available, because most IFTA data are reported quarterly). The following steps

are taken for states with available FHWA Form-551Ms in reviewing the entries on the summary:

- All gasoline gallons listed under the exempt or refunded categories as exports or pre-tax dealer-to-dealer transfers from gross gallons reported (GGR) are deleted. Exports are considered to be those gallons sold to dealers out of the reporting state and will be reported in the receiving state. Similarly, the receiving dealer, for tax purposes, reports dealer-to-dealer transfers within the state. Diesel fuel, diesel exports, non-highway use, and public use (Federal, state, county, and municipal) data are deleted. Any diesel gallons used for public or private transit operations are kept in the report. The FHWA employee entering the data on the monthly 551M often performs these steps.
- *As a rule, if the flat percentage loss allowance is an excess of one percent of the gross gallons reported for the sum of gasoline and gasohol, a one percent maximum allowance is entered in the MF-20 model estimate worksheet, which is to be used in the attribution analysis*. The data as reported by the state is still used in other tables where the purpose is to show state data, not attribution data. This rule is not applicable to states whose flat percentage loss allowance is less than one percent.
- All states now report IFTA gallons of gasoline and diesel fuel for motor carriers. While some of this data will be reported monthly (IFTA data reported by carriers based in the subject state are often available for reporting monthly), large amounts of IFTA data are filed quarterly (typically these data are IFTA reporting from other states to the subject state), and therefore show up as a spike in the monthly data. In spite of this irregularity, the FHWA leaves the quarterly data in the month it is reported. States are also required to report net gallons; that is, gallons reported by their home state carriers, minus the gallons represented by home state carrier travel in other states, plus gallons of non-home state carriers that travel in the subject state.

For a few states, IFTA motor carrier gallons are not reported on the Form 551M or included in the summary. If adjustment is indicated on the previous year's file for the state in question, the appropriate gallons to GGR diesel and gasoline are added on to the current year's summary before proceeding. In a few cases, the state must be contacted to obtain IFTA gallons. In others, the states show their revenues on the Form 556. For these, the state divides the revenue by their IFTA tax rate in order to determine the number of gallons. IFTA gallons also may be shown in supplementary documents, noted on page 2 of the 556, or included on FHWA Form 571.

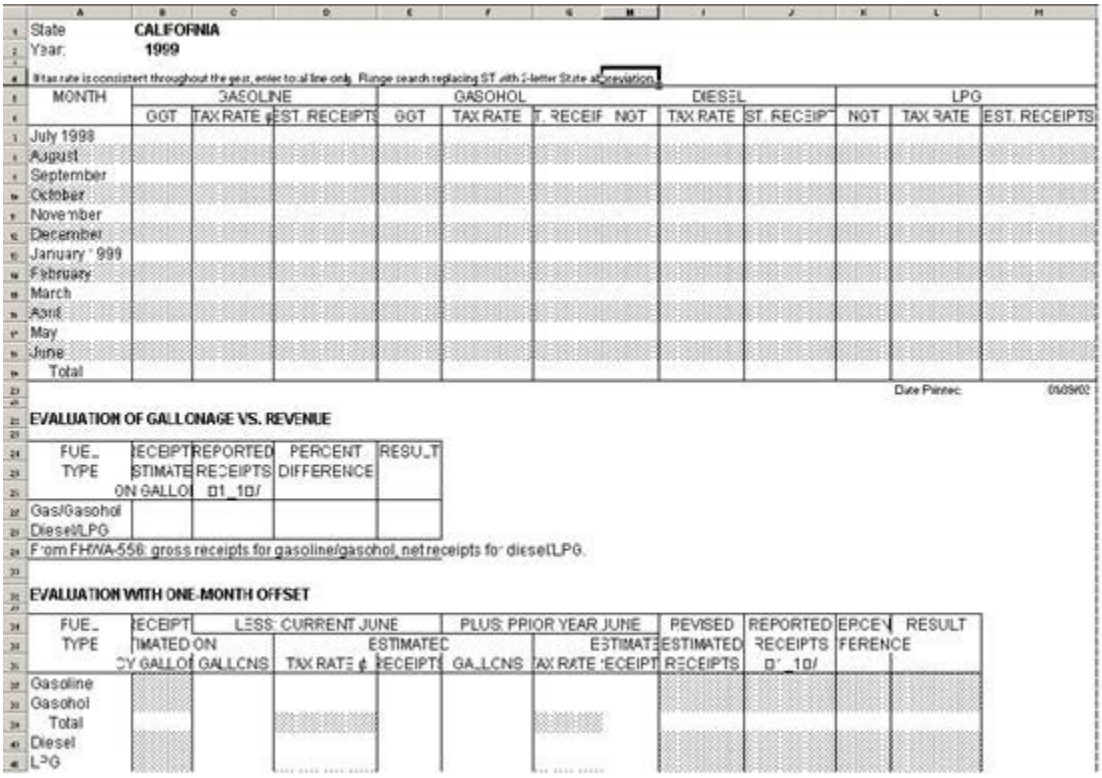
When reported on Form 571, the revenue is shown on the GTA worksheet, and gallons calculated, based on the revenue, are transferred to the 551M summary and the transfer noted on Form 571, so that the Motor Vehicle staff does not include it with the motor carrier receipts.

The state-reported data are also checked to ensure that it includes only aviation gasoline. The FHWA is only concerned with the gasoline used in piston-engine airplanes (e.g., Piper cubs), not jet fuel or turbo-prop fuel, which is kerosene.

After a calendar year's worth of state forms have been verified, the data can then be used in FHWA Tables MF-33GA, MF-121T, and MF-33SF. The 12-months' data are also summarized in a sheet titled, "551M Summary." Annual data reported in the 551M Summary includes gross volume reported, gross volume taxed, fully refunded volume, fully exempt volume, tax rate at the end of each, and stratification of gasohol consumption by blend ratio. This summary is then used in the Gasohol Model, GTA analysis, and in the Use/User Analysis (MF-20).

2.4.2 Procedure for Completing EVAL Worksheet

A template is used to create a blank EVAL spreadsheet (Figure 2-11). Two versions of EVAL template exist - one for calendar year and one for fiscal year. The template is chosen based on the state's fiscal year (as shown on the previous year's EVAL or the state's Form 556). Only one rate is entered on the total gallons row if the tax rates do not change through the year. If the state's tax rates change one or more times during the year, the tax rates are entered for each month. The appropriate revenue receipts from the FHWA Form-556 are then entered (instructions to do so are written on the blank EVAL). Next, gasoline gross gallons taxed (and gasohol, if the state reports any) times the tax rate is compared to gross gasoline and gasohol revenue. Also, diesel net gallons taxed (and special fuels, if the state reports any) times the tax rate is compared to net diesel revenue.



State CALIFORNIA
Year: 1999

If tax rate is consistent throughout the year, enter to all line only. Purge search replacing ST with 2-letter State abbreviation.

MONTH	GASOLINE			GASOHOL			DIESEL		LPG		
	GGT	TAX RATE ¢	EST. RECEIPTS	GGT	TAX RATE	T. RECEIF	NGT	TAX RATE	ST. RECEIPT	NGT	TAX RATE	EST. RECEIPTS
July 1998												
August												
September												
October												
November												
December												
January 1999												
February												
March												
April												
May												
June												
Total												

Date Printed: 01/09/02

EVALUATION OF GALLONAGE VS. REVENUE

FUEL TYPE	RECEIPTS ESTIMATED ON GALLONS	REPORTED RECEIPTS 01_10/	PERCENT DIFFERENCE	RESULT
Gas/Gasohol				
Diesel/LPG				

From FHWA-556: gross receipts for gasoline/gasohol, net receipts for diesel/LPG.

EVALUATION WITH ONE-MONTH OFFSET

FUEL TYPE	RECEIPTS ESTIMATED ON CY GALLONS	LESS: CURRENT JUNE		PLUS: PRIOR YEAR JUNE		REVISED ESTIMATED RECEIPTS	REPORTED RECEIPTS 01_10/	PERCENT DIFFERENCE	RESULT
		GALLONS	ESTIMATED TAX RATE ¢	ESTIMATED RECEIPTS	GALLONS	ESTIMATED TAX RATE	ESTIMATED RECEIPTS			
Gasoline										
Gasohol										
Total										
Diesel										
LPG										

Figure 2-11. Sample EVAL Form

In many states, IFTA gallons from Form-556 are derived by dividing total diesel revenue by the diesel tax rate, and therefore, must match the EVAL results closely. Although this may be considered circular reasoning, and therefore invalid for data verification, it is necessary in order for some states to be able to provide reasonable IFTA numbers.

Care is taken to use the correct tax rates in the evaluation. For example, the FHWA adds an environmental fee for Nebraska to the tax rate in Table MF-121T. However, Nebraska does not report revenue from the environmental fee on Form-556. This means that the environmental fee is not included in the tax rate for the EVAL calculation. Because there is no distribution of revenue to the cleanup fund shown on the bottom half of the FHWA Form-556, FHWA can conclude that there is no environmental revenue on the FHWA-556. Michigan (multiple rate structure), New York , West Virginia , and Florida (State Comprehensive Enhanced Transportation System [SCETS] tax) are other states with complicated tax structures, requiring special consideration.

The evaluation results of the previous year are generally used as a guide, noting the following:

- IFTA motor carrier receipts listed under "other receipts" instead of "gallon-based receipts" on the 556 Form.
- The receipts for the months are calculated at each rate if the fuel tax rate changed during the year (e.g., if rate changed effective July 1, estimate January-June at old rate and July-December at new rate).
- The motor fuel sales tax receipts are not included with gallon receipts.
- Gasohol and gasoline figures are calculated separately when they are taxed at different rates. The same rule applies to diesel and LPG.

As a rule, the EVAL process is considered complete if the estimated gallon receipts are within a plus or minus five percent of the reported receipts. If not, any items included in either the 556 receipts or the 551M gallons are checked to see if they have not been accounted for in the other form. If the difference remains outside the acceptable range after all adjustments have been made, the monthly gallons data are offset by one month and then re-estimated using the cells at the bottom of the EVAL worksheet. Sometimes a lag exists between gallon data and receipts data. If offsetting does not make the difference within five percent, a decision is made as to whether or not the state should be contacted. If the difference is 10 percent or greater, the state must be contacted by telephone or memo for a written explanation.

Once the correlation between the reported receipts and gallons is within acceptable limits, a revised 551M summary is produced. The EVAL worksheet is saved as xxEVAL, where xx is the two-letter state abbreviation. This is then used in the Use/User and GTA Revenue analyses and also as an input into the Gasohol model.

2.4.3 Steps in the Use/User Analysis (MF-20)

The MF-20 process is divided into three parts. The first part is a sub table worksheet that contains the possible fuel types under the categories of exempt, refunded, and taxed at other rate. The second part is a worksheet used to enter the values estimated from the models and to determine which number should prevail (either the estimated number or the state-reported number). Sometimes the estimated numbers are used to derive missing data points that a state has not reported. The third part is the analysis worksheet where the calculations are done.

The following are steps in running the MF-20 analysis program:

1. Open all MF-20 spreadsheet template and enter state identification information in response to prompts, including prior year on-highway gallons of gasoline/gasohol

and special fuels (e.g., state name, state abbreviation, analysis year, and prior year's gallons).

2. After all identification information has been entered, select the sub table worksheet from the menu and enter data from the Summary 551M. Most sub table items are marked to indicate where they will end up on the main analysis sheet. This helps the FHWA decide where to enter refund/exemption types that are not explicitly included on the list. Following are some general guidelines:

    - "Industrial and Commercial" includes mining (called production of natural resources in some states), well drilling, manufacturing, cleaning and dying, and use in generators and stationary engines.
    - "Construction" includes both building and non-building construction. Fuel used to power the mixing units of concrete mixers is also included.
    - These definitions in some states result in an overlap between their Industrial and Commercial and Construction categories. If a state over reports Industrial and Commercial, the excess is used to offset Construction (and vice versa). When in doubt, FHWA discusses this with the state to determine a resolution.

3. Find the MF-20 worksheet for the applicable state, which already shows the FHWA-generated estimates for the off-highway and public uses, and enter state data in the appropriate cells.

4. Enter, from the state 551M Summary sheet, amounts exempt, refunded, or taxed at other rate. Except for aviation and Federal civilian highway use, limit the sum of these categories to the total provided in the FHWA estimates.

As a rule, if the amount the state reports is less than the FHWA estimate, place the difference in the prevailing rate column. If a state's Federal use amount is greater than the FHWA estimate (which represents Federal civilian on-highway use), the excess will automatically be deducted in the MF-20 as Federal government non-highway (it is assumed to be for military or non-highway uses). Also enter the allowable one percent loss, discussed earlier, if state-reported data exceeds one-percent. If the state reported losses is less than one percent, enter the state-reported number.

5. Occasionally, FHWA may find an item reported by a state for which there is no corresponding category in the sub table:

    - First determine whether this item represents non-highway or highway gallons.

- Then place the gallons into a similar category in the sub table. Be sure that motor fuel gallons representing highway use are ultimately transferred to section 5A of the MF-20 main table (for gasoline, line 5A[1] for special fuel, line 5A[2]).

6. There are a few states reporting Native American motor fuel gallons, and FHWA now shows these gallons in categories as follows. When filling out the MF-20 sub table, FHWA includes Native American diesel gallons that states report as tax exempt in place of the category entitled Supply Tank Diesel (Highway).
    - To do this, over-ride spreadsheet protection, type in Native American Diesel (Highway), and enter the number of gallons in the appropriate place.
    - If the state fully refunds Native American diesel gallons, then replace the category Municipal Buses-Diesel by typing in Native American-Diesel, and enter the data.
    - For Native American gasoline, replace the category charity highway gasoline with Native American Highway Gasoline, and enter the data.
    - Make sure to reset the protection to its original setting before closing the file.
    - Note that Native American government highway use is Federal tax refunded just as are the other government highway uses, and the gallons should be included as state, county, municipal, and Native American government highway uses in each state where they are applicable.
7. As noted on the sub table, items designated by an asterisk in the sub table do not automatically copy to the main table, i.e., losses-percent, marine, gasoline, fully refunded agriculture gasoline, and aviation gasoline. These are entered directly in the main table.

Some additional items to note regarding the MF-20 analysis worksheet:

- The first part of the MF-20 to be completed is the MF-20 sub-table. The values of the MF-20 come from the 551M yearly summary table. This is a manual process of transferring items from the 551M Form into the MF-20 sub-table. This is necessary because states often name items differently than they are named in the table. Also, sometimes items from the 551M need to be combined to one item on this table. Figure 2-12 is a sample of the MF-20 sub table.

- The final calculation in the MF-20 form is the "Total Use" calculation. This number is derived using a complex set of cell links and combination of other calculations. The "Highway Gasoline Private and Commercial" is calculated.

STATE:	STATE NAME	
YEAR:	0000	
SUBTABLE 1 (* MEANS NOT USED IN MAIN TABLE)		
GROSS GALLONS REPORTED (000)		
GASOLINE	0	
GASOHOL	0	
DIESEL	0	
LPG	0	
		0
TAX EXEMPT (000)		
FEDERAL GASOLINE	0	
FEDERAL DIESEL (Deducted)	0	
LOSSES-PERCENT* (Gasoline)	0	
LOSSES-ACTUAL (Gasoline)	0	
SCM GASOLINE	0	
SCM DIESEL (Deducted)	0	
CHARITY HIGHWAY GASOLINE	0	
SUPPLY TANK DIESEL (Highway)	0	
DISTRIBUTOR NONHIGHWAY GASOLINE	0	
MISCELLANEOUS NONHIGHWAY GASOLINE	0	HEATING GAS, POWER PLANT GAS
NONHWY & DIESEL PLANT LOSSES (Deducted)	0	
DIPLOMATIC GASOLINE (Public Use Highway)	0	
OTHER GASOLINE (Nonhighway)	0	
MILITARY GASOLINE (Deducted)	0	
LOSSES-DIESEL (Deducted)	0	
MARINA GASOLINE (Nonhwy)*	0	
DISTRIBUTOR GASOLINE (Nonhighway)	0	
TRANSIT-GASOLINE (P&C)	0	
TRANSIT-DIESEL (P&C)	0	
AVIATION GASOLINE (Nonhwy)*	0	
FULL REFUND (000)		
AVIATION GASOLINE (Nonhwy)*	0	
AGRICULTURE GASOLINE (Nonhwy)*	0	
INDUSTRIAL/COMMERCIAL GASOLINE (Nonhwy)	0	
CONSTRUCTION GASOLINE (Nonhwy)	0	
MARINE GASOLINE (Nonhwy)*	0	
RAIL GASOLINE (I&C NONHWY)	0	STATIONARY ENGINES, WASTE MANAGEMENT
HEATING FUEL - DIESEL (Deducted)	0	RAIL DIESEL
LAWNMOWER GASOLINE (Misc. Nonhwy)	0	
MISCELLANEOUS NONHIGHWAY GASOLINE	0	
OTHER COMMERCIAL GASOLINE (I&C Nonhwy)	0	
TAXI GASOLINE (P&C Hwy)	0	
LOGGING GASOLINE (I&C Nonhwy)	0	
MINING GASOLINE (I&C Nonhwy)	0	MINERAL EXTRACT
CONCRETE GASOLINE (Construction Nonhwy)	0	
MAINTENANCE GASOLINE (Misc. Nonhwy)	0	
SCM GASOLINE	0	
SCM DIESEL (Deducted)	0	
TURNPIKE-GASOLINE	0	
TURNPIKE-DIESEL	0	DIESEL IN RV MOTORHOMES (NH HIG)
PAROCHIAL SCHOOL GASOLINE (SCM Highway)	0	
FRANCHISE GASOLINE (Highway)	0	
MOTOR CARRIER-GASOLINE (Deducted)	0	
MOTOR CARRIER-DIESEL (Deducted)	0	
FEDERAL GASOLINE (Highway)	0	
FEDERAL DIESEL (Deducted)	0	
CHARITY GASOLINE (Highway)	0	
U.S. GOVERNMENT GASOLINE	0	
MUNICIPAL BUSES - DIESEL	0	
DIPLOMATIC & CONSULAR GASOLINE (Federal Highway)	0	
U.S. NONHIGHWAY (Deducted)	0	
PRIVATE ROADS GASOLINE (Misc. Nonhwy)	0	
COMMUTER VAN GASOLINE	0	
OVERPAYMENTS-GASOLINE (Deducted)	0	
OVERPAYMENTS-DIESEL (Deducted)	0	
LOSSES-GASOLINE	0	
LOSSES-DIESEL (Deducted)	0	
DIESEL DEALER NONHIGHWAY (Deducted)	0	
SCHOOL & INSTITUTIONAL GASOLINE (SCM Highway)	0	
RETAIL DEALER 1% LOSS (Gasoline)	0	
PRIVATE PROPERTY GASOLINE (Misc. Nonhwy)	0	
STREET EQUIPMENT GASOLINE (Misc. Nonhwy)	0	
CLEANER/DYING GASOLINE (I&C Nonhwy)	0	
FIRE GASOLINE (SCM)	0	
AMBULANCE GASOLINE (SCM)	0	
BOAT GASOLINE (Misc. Nonhwy)	0	
RURAL MAIL GASOLINE (Federal)	0	
WELL DRILLERS GASOLINE (I&C Nonhwy)	0	
COMMON CARRIERS DIESEL (Deducted)	0	
HAULING NATURAL RESOURCES GASOLINE (I&C Nonhwy)	0	
PROD. OF NATURAL RESOURCES GASOLINE (I&C Nonhwy)	0	
OFF-ROAD RECREATIONAL VEHICLES GASOLINE (Misc. Nonhwy)	0	SNOWMOBILES, JEEPS, DIRT BIKES, ATV's
TAXED AT OTHER RATES (000)		
AGRICULTURE GASOLINE (Nonhwy)	0	
AVIATION GASOLINE* (Nonhwy)	0	
INDUSTRIAL & COMMERCIAL GASOLINE (Nonhwy)	0	
CONSTRUCTION GASOLINE (Nonhwy)	0	
MARINE GASOLINE (Nonhwy)	0	
MUNICIPAL GASOLINE (Highway)	0	
BUS GASOLINE (P&C)	0	
AIRPORT LIVERY GASOLINE (P&C Hwy)	0	
BUS DIESEL (P&C)	0	
SURROUNDING STATES GASOLINE (P&C Hwy)	0	
NONPROFIT ORGANIZATION GASOLINE (P&C Hwy)	0	
TAXI GASOLINE (P&C Hwy)	0	
OFF HIGHWAY GASOLINE (Misc. Nonhwy)	0	
OTHER GASOLINE (Misc. Nonhwy)	0	

Figure 2-12. Sample MF-20 Sub-Table

2.4.4 Steps of the GTA Analysis

The GTA process uses revenue data from Form 556 and fuel consumption data (in gallons) from the Revised 551M Summary to compare the two sets of information. This analysis completes forms MF-551 and MF-556, which together are referred to as "GTA." The steps for completing these forms are listed below. The results of this comparison are then published in *Highway Statistics* Tables MF-1 (motor fuel tax receipts for all states) and MF-2 (volume of motor fuel exempt from and subject to state taxation). This process, however, does not have a direct effect on the fuel attribution process. Figure 2-13 shows the worksheets for the GTA analysis.

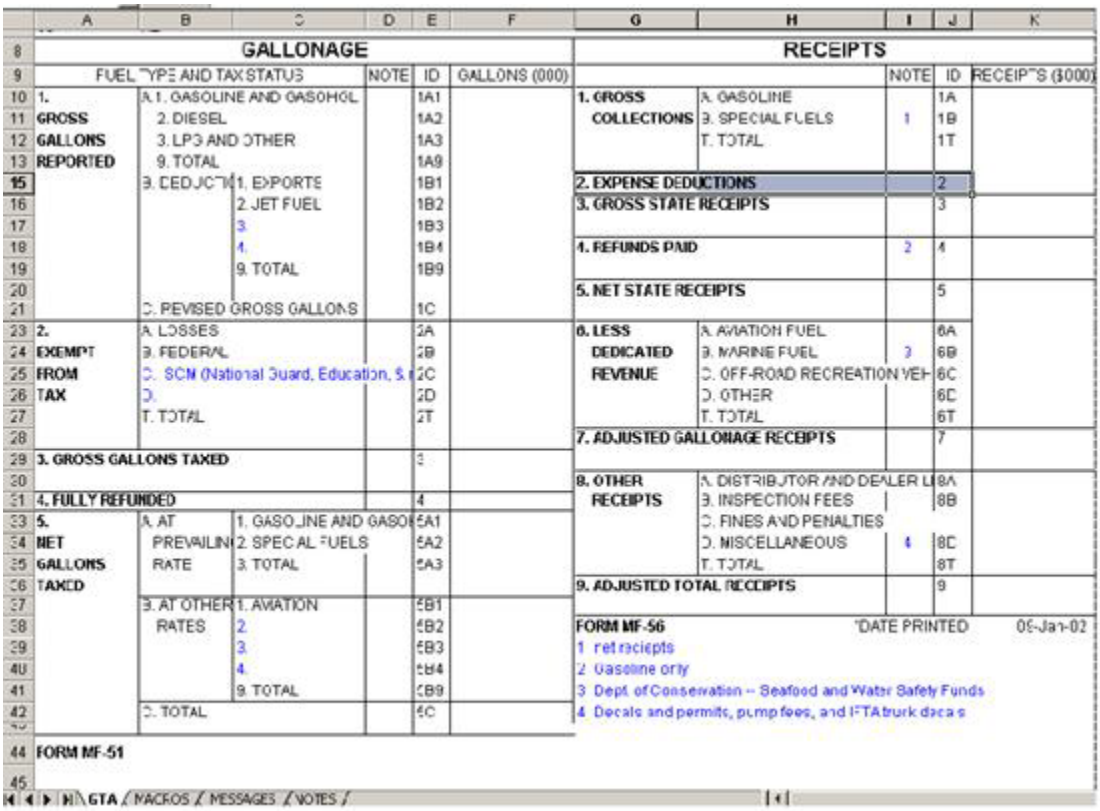


Figure 2-13. Sample GTA Worksheet

Steps to complete the GTA tables for a state:

1. Enter Gross Gallons Reported (cell 1A1 for gas, 1A2 for diesel, and 1A3 for LPG and the calculated sum in cell 1A9).
2. Enter revised Gross Gallons Reported. Total Deductions (1B9) is subtracted from Gross Gallons Reported. Currently no deductions are being used so it should be the same as Gross Gallons Reported.

3. Enter Gross Gallons Taxed (3). The Total Deductions (1B9) is subtracted from The Total Gross Gallons Reported (1A9). This number should be the same as Gross Gallons Reported.
4. Enter Fully Refunded (4).
5. Enter Total Net Gallons Taxed (5C). Fully Refunded (4) is subtracted from Gross Gallons Taxed (3).
6. Enter Net Gallons Taxed At Other Rates (cells 5B1- 5B9).
7. Enter Total Net Gallons Taxed At Prevailing Rate (5A3). Total Net Gallons Taxed At Other Rates (5B9) is subtracted from Total Net Gallons Taxed (5C).
8. Enter Special Fuels Net Gallons Taxed At Prevailing Rate (5A2).
9. Enter Gasoline and Gasohol Net Gallons Taxed At Prevailing Rate (5A1). Special Fuels Net Gallons Taxed At Prevailing Rate (5A2) is subtracted from Total Net Gallons Taxed At Prevailing Rate (5A3).

2.5 Detailed Description of Estimation Models

This section presents, in greater detail, the estimation procedures that FHWA uses in completing its annual attribution process. Specifically, this section describes the estimation models used in producing state-level consumption estimates for (1) non-highway use of gasoline; (2) Federal, state, county, and municipal governments (i.e., public sector) use of gasoline; and (3) on-highway use of gasohol. Figure 2-2 shows where the operations of these models occur in relation to the entire attribution process. As noted in Section 2.2, the estimation models are updated and run between May and June.

FHWA estimates the public use of gasoline for the same reason it estimates off-road uses of gasoline. Although the Federal tax code exempts public uses of gasoline, not all states do so; therefore, it would be inconsistent to use as-reported state data without adjustment. Additional inconsistencies and exceptions apply to states' reporting of gasohol, and so this type of fuel consumption requires modeling as well. The following sections describe the models' characteristics and positions within the sequence of fuel attribution processes.

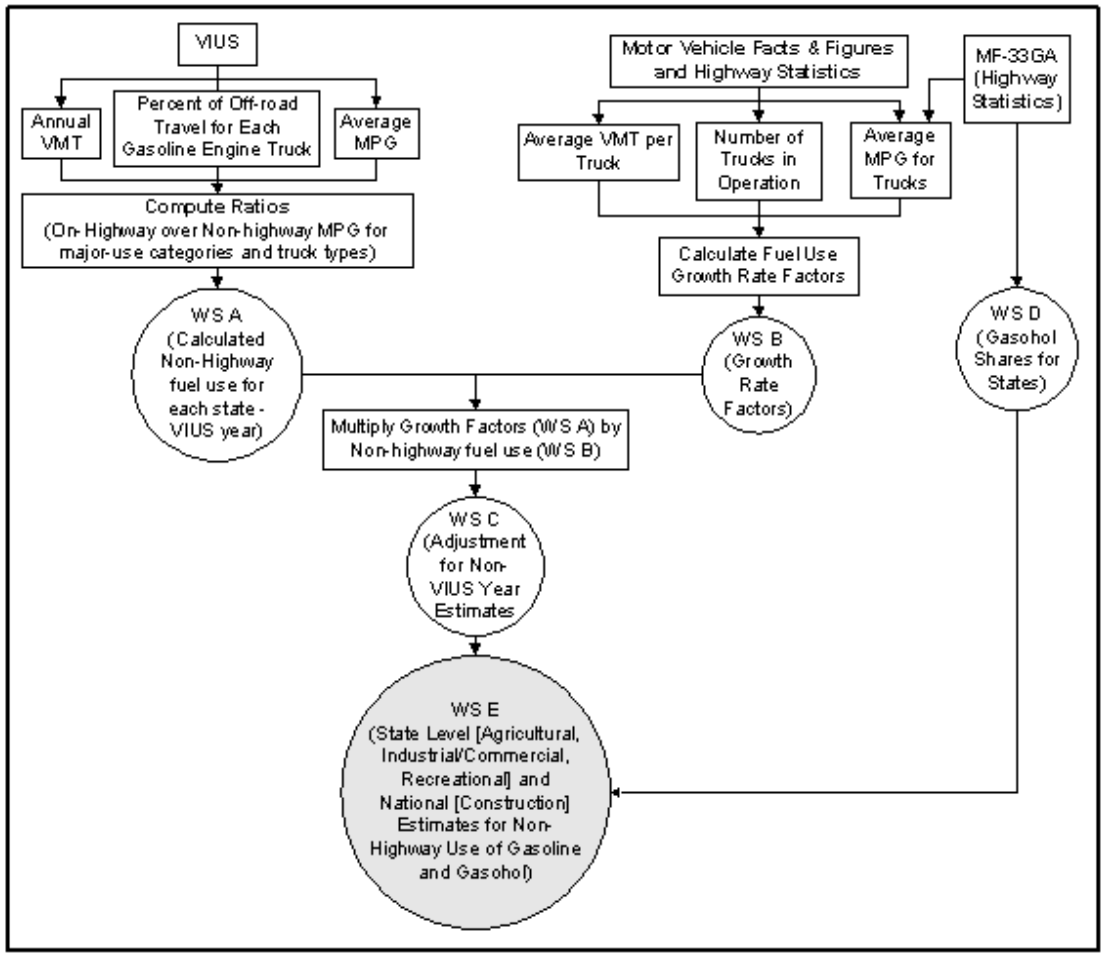
2.5.1 Off-Highway (a.k.a. Non-Highway) Gasoline Model

2.5.1.1 Off-Highway Gasoline by Trucks

The non-highway gasoline-consumption estimation model builds on estimation procedures developed by Oak Ridge National Laboratory (ORNL) for the FHWA in 1994 [5].

Data used in this model are compiled from various sources, including publications and data sets produced by Federal agencies (e.g., Census Bureau) and private organizations, such as the Motor Vehicle Manufacturers Association of the United States . The model was implemented as a Windows-based spreadsheet by ORNL, for ease of annual updates and use by FHWA. ORNL also developed a *User's Guide* for this spreadsheet system, which provides detailed information on the operations of this model [6].

The first step in the Off-Highway Gasoline Model estimates the non-highway use of gasoline by trucks. The "APPEND" module estimates non-highway use of gasoline by trucks. Figure 2-14 shows the data flow through the multiple worksheets in the APPEND module. Periodic updates of data, however, need to be manually completed by the FHWA. The results of the APPEND module are used in the AGRICULT, CONSTR, and IND modules. The major data sources and estimation procedures used in the APPEND module are described below.



Note: "**WS**" denotes a worksheet in the spreadsheet program.

Figure 2-14. Non-Highway Trucks Module ("APPEND")

Data Sources

The major data set used for estimating non-highway uses of gasoline by trucks is the Vehicle Inventory and Use Survey (VIUS), a national sample survey conducted every five years by the Bureau of the Census. VIUS is part of the Census of Transportation under the Economic Census. The most current data set available is for 1997. VIUS provides information on trucks owned by businesses and individuals, ranging from multi-trailer combination vehicles to pickups, vans, and minivans. Data elements contained in VIUS include vehicle type, engine type, annual vehicle-miles of travel (VMT), major use of vehicle (e.g., agricultural, construction, mining, manufacturing, retail wholesale), percent of annual mileage for off-road use, engine type (e.g., gasoline, diesel), state in which the vehicle is registered, average miles per gallon (MPG), and other vehicle characteristics. Because VIUS is a survey of vehicles selected based on a statistical sampling method, each record (which represents one vehicle in the survey) also includes an expansion factor that can be used to "inflate" the sample to its national representation (i.e., the universe). The necessary data are extracted from VIUS using a computer program developed by Battelle, and the database program, Microsoft Access [14].

Other data sources include *Motor Vehicle Facts and Figures* published by the Motor Vehicle Manufacturers Association of the United States and *Highway Statistics* by the FHWA. A fuel-use growth rate factor was computed using data on the number of trucks in operation obtained from *Motor Vehicle Facts* & *Figures* and averages of VMT per truck, as well as average MPG from *Highway Statistics*. The estimated growth factor is used to expand the VIUS estimate represents the analysis year. Details of data sources used in the estimation models are shown in Appendix B.

2.5.1.2 Estimation Method

Use the Latest VIUS

Before initiating the APPEND spreadsheet program, FHWA needs to ensure that the APPEND module contains the most recent version of VIUS data. As stated before, VIUS is only conducted once every five years. The next VIUS is scheduled for 2002 but the data will not likely be available before 2004. Therefore, current VIUS data components within the APPEND module will not require updates until the new data set is available.

At the moment, Worksheet-A contains information derived from the 1997 VIUS. This spreadsheet contains one table with five columns. One column identifies the state and the other columns are for the four selected major uses of trucks (i.e., agricultural, construction, industrial/ commercial, and personal). Values in these four columns

represent the total gasoline consumed by trucks operated off-road in the given state for each major-use category in 1997.

How VIUS Data was Used

The data content of Worksheet-A is not directly extracted from VIUS because VIUS does not provide a break down of gasoline and gasohol fuel use. Furthermore, it does not provide on-highway versus non-highway fuel efficiency of the trucks (i.e., MPG), nor the percent of off-road travel that occurred within a state. The state of registration is assumed to be where the off-road travel took place, even though in reality it does not always represent the state in which the truck operates. Using information on average MPG, annual VMT, and the percent of off-road travel for each gasoline-engine truck from the VIUS data set, ratios for on-highway over non-highway MPG for each selected major-use category and truck type are computed. These MPG ratios are then used to calculate non-highway fuel use for each state. Detailed descriptions of these methodologies are provided in the ORNL report [5].

Adjustment for Non-VIUS Year Estimates

When the analysis year is not the same as the VIUS year, VIUS-based non-highway estimates are adjusted so that changes that may have occurred during the interim years can be captured. As mentioned previously, a fuel-use growth rate factor is computed using information obtained from *Motor Vehicle Facts* & *Figures* and *Highway Statistics*. The estimated fuel-use growth factor is essentially a combined factor based on three growth rates: number of trucks in operation, average VMT per truck, and average MPG for trucks. These growth rates and the final fuel consumption growth factor are included in Worksheet-B of the APPEND module. The resulting table is generated by multiplying the growth factor from Worksheet-B and each of the elements in the Worksheet-A table, and is then stored in Worksheet-C of the APPEND module.

Separating Gasoline and Gasohol Consumption

Because gasoline-engine trucks can use either gasoline or gasohol and VIUS does not provide direct distinctions in fuel usage, a different data source is needed to further break down the non-highway fuel use into gasoline and gasohol uses for each state. This separation of gasoline and gasohol is conducted by using information gathered from Worksheets A, B, C, and data on gasohol consumption estimated from the gasohol model. The gasohol estimation model is discussed later in Section 2.5.3 of this report.

Worksheet-D of the APPEND module computes gasohol shares for states, in relation to total gasoline and gasohol consumed in the state. These estimates are calculated based on data obtained from Table MF-33GA in the most current edition of *Highway Statistics*. Worksheet-E of APPEND combines data from Worksheets A through D to obtain state-level

estimates for non-highway uses of gasoline and gasohol by three of the four major-use categories for trucks (i.e., agricultural, industrial and commercial, and recreational). The fourth estimate, for the truck fuel consumption for non-highway construction purposes, is not broken down by state. Rather, national totals on gasoline and gasohol consumption for non-highway construction use are provided in Worksheet-E. The model developer felt that such a design was necessary because VIUS does not provide information that is timely enough to reflect current construction activities within the states. The method used for allocating the total non-highway construction use of fuel to the states is presented in Section 2.5.1.4.

The second part of the Off-Highway Gasoline Model estimates the non-highway gasoline used by what is considered "other equipment." In addition to gasoline use by trucks while operated off-highway, other types of equipment used for non-highway purposes also consume gasoline. Five modules are included in this group. Each of these modules calculates the amount of gasoline consumed by certain types of equipment (other than trucks) for one of the five major-use categories: agriculture, construction, industrial/commercial, aviation, and marine. Gasoline consumption estimated from these modules are then combined with those computed from the APPEND module to generate the total non-highway gasoline gallons estimates by state. Descriptions of the five modules, including their data sources and procedures, are provided in the following sections.

2.5.1.3 Agriculture Module ("AGRICULT")

Data Sources

In addition to farm trucks, farm equipment (e.g., wheel tractors, cotton pickers) also consumes gasoline. Note that two assumptions are employed in this estimation procedure. The current model assumes that farm equipment is used solely for non-highway purposes and does not use gasohol [1] . This module uses data from the *Census of Agriculture* as its primary information source. Additional data sources include the *Farm Production Expenditures* summary report published annually by U.S. Department of Agriculture (USDA), *Petroleum Marketing Annual* from Energy Information Administration (EIA), U.S. Department of Energy (DOE), and *Highway Taxes and Fees* published by FHWA. Details of data sources used in this estimation model are shown in Appendix B.

Estimation Method

The estimation procedures for non-highway gasoline consumption by farm equipment are somewhat complicated. Figure 2-15 illustrates how data flows within this estimation process. Similar to VIUS, *Census of Agriculture* is also under a five-year data collection

cycle. The latest data was collected for 1997. To ensure that the module produces reliable estimates, it is necessary to periodically update the model with the most recent version of *Census of Agriculture* data. Information is also obtained from the *1991 Farm Production Expenditures* summary report. No updates of this source have been entered into the model due to the fact that no information at this level of detail has been available since 1992.

Worksheet-A of this module contains information on ratios of gasoline to total fuel expenditures derived from the *Census of Agriculture* and associated *Farm Production Expenditures* summary report. Total fuel expenditures taken from the most recently published summary report are then used to estimate expenditures on gasoline for the analysis year. In order to assure accuracy of the estimated ratios (i.e., gasoline to total fuels expenditures for fanning), agricultural fuel use by farm equipment is further divided into two agricultural fuel-distribution mechanisms: bulk storage tanks on farms and purchases made at retail stations.

Note that geographic detail for farm expenditures on fuels provided by the *Farm Production Expenditures* summary report is at the farm production region level, not at the state level. *Census of Agriculture* data are used to compute each state's share of total expenditure within each region in the Census year. This information is stored in Worksheet-B. Assuming state-shares for the analysis year stay the same as those in the Census year, Worksheet-B then applies results obtained from Worksheet-A to generate state-level expenditures by the two fuel-distribution methods for each state. Using gasoline price data obtained from EIA's *Petroleum Marketing Annual* and state fuel tax rates from Table MF-121T of the *Highway Taxes and Fees,* estimates on total gallons of gasoline used in agriculture by state, for the analysis year, are generated and stored in Worksheet-B as well.

Worksheet-C of the AGRICULT module contains estimated shares of non-highway gasoline use by agricultural farm equipment. These shares were estimated based on a statistical regression model developed using information collected under the *Census of Agriculture*. This regression model established a relationship between the non-highway agricultural gasoline use and the number of farm equipment units used by farmers within each state during the Census year. Again, by assuming the shares remain the same for the analysis year, the non-highway agricultural gasoline use by state can be estimated from the totals obtained from Worksheet-B.

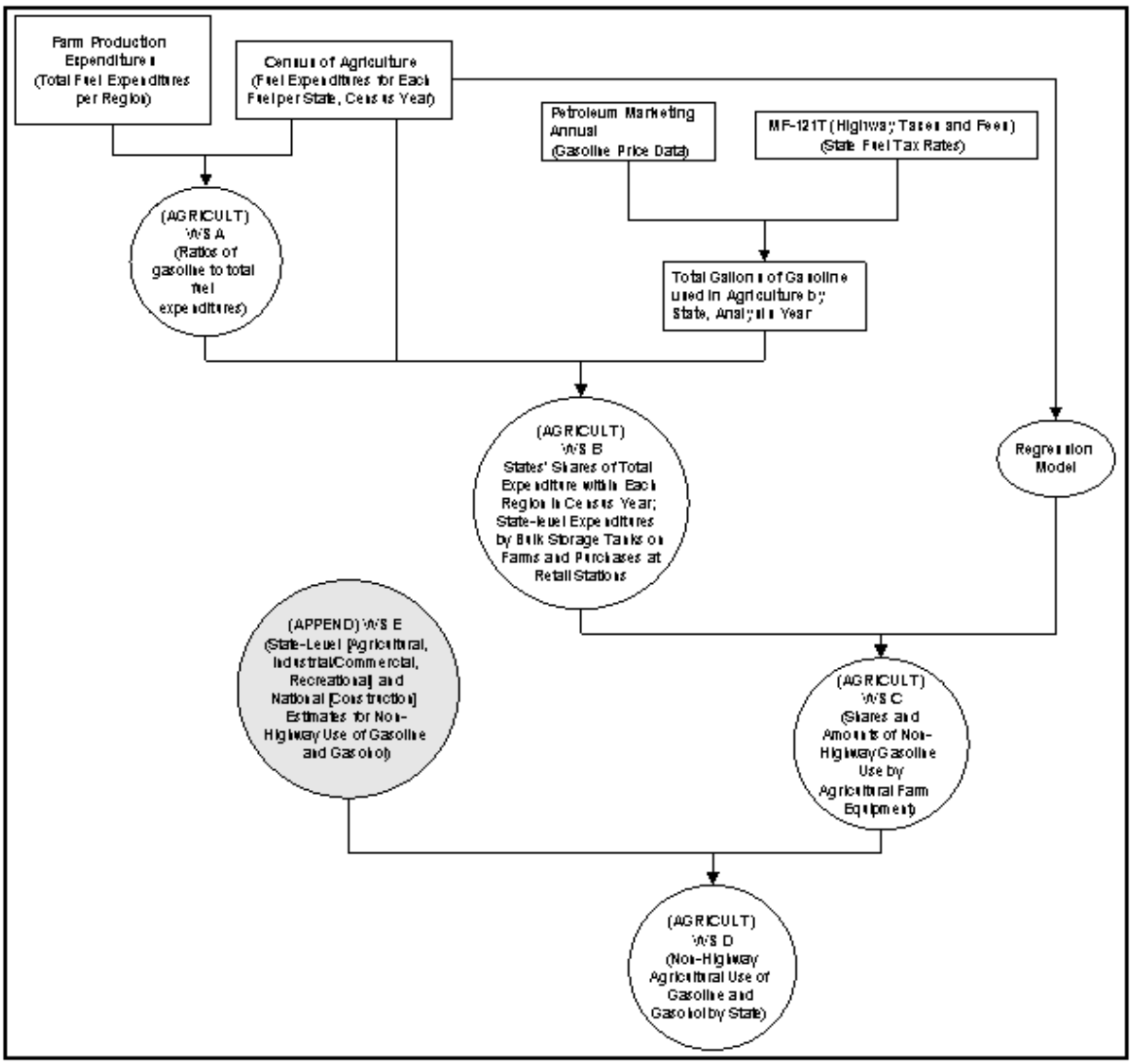


Figure 2-15. Agriculture Module ("AGRICULT")

By combining estimates for farm trucks from Worksheet E of the APPEND module and estimates for farm equipment from Worksheet-C of AGRICULT, the process of estimating the non-highway agricultural uses of gasoline and gasohol by state is finally completed. It should be noted that fuel use by trucks comprises the majority of this estimation. The resulting estimates are provided as Worksheet-D in the AGRICULT module.

2.5.1.4 Construction Module ("CONSTR")

Data Sources

Similar to agricultural fuel use, motor fuels are consumed by both equipment and vehicles used off-road for construction purposes. The majority of vehicles used for non-highway

construction purposes are expected to be trucks and vans, particularly single-unit heavy trucks. Therefore, this estimation is included under the VIUS framework. Construction equipment, such as asphalt pavers, non-vehicle concrete mixers, surfacing equipment, cranes, tractors, loaders, and backhoes, are not licensed for highway use and are generally powered by diesel fuel. Currently, FHWA motor fuel reporting does not include non-highway diesel usage. The EPA is working on a draft model so that these uses may be included in the Off-Highway gasoline model in the future.

Unlike agricultural fuel use, however, both gasoline and gasohol are considered in this model. Besides the VIUS data set used by APPEND, a major data source used in this CONSTR module is the *Statistical Abstract of the United States* published annually by the Census Bureau.

Estimation Method

As described earlier, the national totals of non-highway gasoline and gasohol consumption by trucks used for construction purposes are provided in the VIUS-based APPEND module. State-by-state estimates of construction use of gasoline and gasohol, however, are not produced by APPEND. Instead, dollar-values of non-residential construction contracts in each state obtained from the *Statistical Abstract of the United States* are used to distribute the VIUS-estimated total to the states. This is because the *Statistical Abstract* data on non-residential construction contracts are much more current than the VIUS data and, therefore, can better reflect current construction activities within the states.

The computation process in the CONSTR module is more straightforward than the AGRICULT module. Figure 2-16 shows the data flow in this estimation process. Data contained in this worksheet includes state-level values of non-residential construction contracts extracted from the most current *Statistical Abstract* publication. The module computes the state shares of the total non-residential construction contracts, takes the total non-highway gasoline and gasohol consumption estimates for construction uses from the APPEND module, and distributes the totals, according to these shares, among the states to obtain state-by-state estimates.

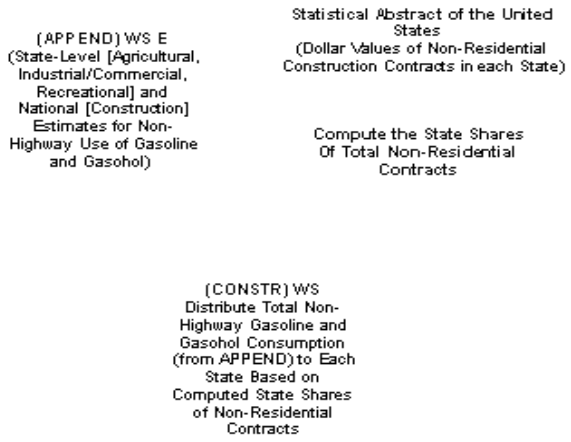


Figure 2-16. Construction Module ("CONSTR")

2.5.1.5 Industrial/Commercial Module (" IND ")

Data Sources

The majority of the vehicles used for non-highway industrial and commercial purposes are expected to be vans and trucks, mostly used for shipping products and materials. It should be noted that forklifts, sweepers, scrubbers, material-handling equipment, generators, pumps, and welding equipment also fit in this classification, but are not included in the model since no reliable data exists for this equipment. Again, VIUS is applied as a major data source by this module. Data regarding off-road use of trucks in manufacturing, mining, forestry, wholesale and retail trade business, utilities, services, rental, and for-hire transportation business are all included in this category.

Estimation Method

Non-highway use of fuel by the industrial and commercial sectors is estimated in the same general manner as for the agriculture and construction sectors (Figure 2-17). Motor fuels can be consumed by both equipment and trucks used off-road for industrial and commercial purposes. Industrial and commercial fuel use by trucks that operated off-road is already estimated in the VIUS-based APPEND module. Industrial and commercial equipment, such as forklifts, sweepers, scrubbers, material-handling equipment, generators, pumps, and welding equipment, also consume motor fuel. Unfortunately, due to the lack of available data on fuel used by engines in the above-mentioned equipment, the IND module only considers non-highway use of trucks in its current calculations. That is, the current version of IND module contains only a single worksheet with data taken

directly from the APPEND module. No other computation is needed. Further refinement of this module might be possible if new data sources can be identified.

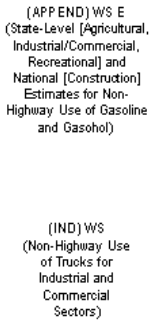


Figure 2-17. Industrial/Commercial Module (" IND ")

2.5.1.6 Aviation Module ("AVI")

Data Sources

Two major sources of aviation gasoline consumption data are used in this module. The first is the sale of aviation gasoline (in gallons) from *Petroleum Marketing Annual,* published by EIA. These data were collected monthly by EIA from all firms identified as suppliers who made the first sales of the products. Worksheet-B of the AVI module contains EIA data on aviation gasoline consumption for the analysis year. The second data source is data on hours flown by general aviation in each state from the *General Aviation and Air Taxi Activity Survey,* conducted annually by the Federal Aviation Administration (FAA). This information is included in Worksheet-A of this module.

Estimation Method

The estimation procedure for aviation use of gasoline is relatively straightforward. For most states, annual totals from the EIA aviation gasoline consumption data contained in Worksheet-B can be directly carried over to Worksheet-A (Figure 2-18). Due to confidentiality concerns, however, data for some of the states and Washington , D.C. are not disclosed by EIA. Some states withhold only certain months' data, while others (usually around four or five states) will be withheld for the entire year. These missing data (those withheld by EIA) are estimated by FHWA. A statistical regression model has been built into Worksheet-A of the AVI module. This regression model uses a relationship found between existing EIA data on "aviation gasoline consumption" and FAA data on "hours flown by general aviation by states" to estimate gasoline consumption for states that are not

disclosed by EIA. Completed estimates for aviation gasoline consumption by all states are included in Worksheet-A of the AVI module.

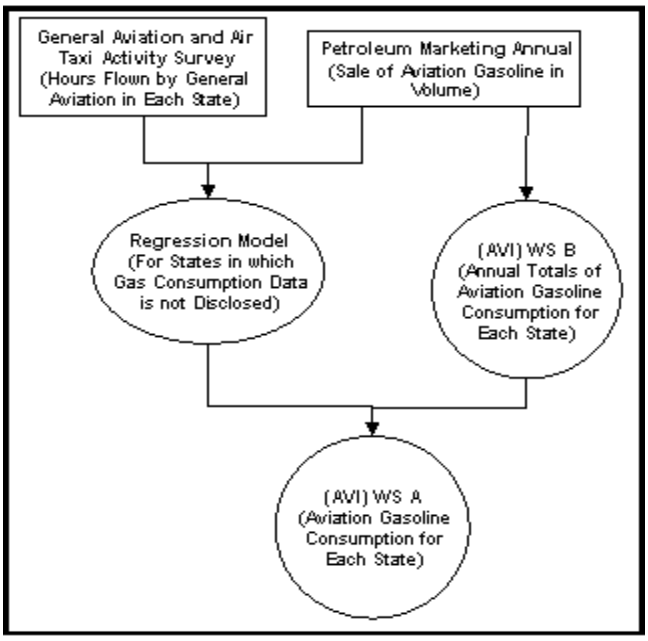


Figure 2-18. Aviation Module ("AVI")

2.5.1.7 Marine Module ("BOAT")

Data Sources

Since nearly all commercial vessels are powered by diesel fuel, the marine sector of interest for FHWA is recreational boating using outboard motors. Furthermore, it is assumed that recreational boating does not involve the use of gasohol. The fundamental issue here is to determine the number of powered boats in each state and the average amount of fuel each boat uses for recreational purposes.

The primary data source used in the BOAT module is a final report compiled from the *1991 National Recreational Boating Survey*. This was a major survey of boating co-sponsored by U.S. Coast Guard (USCG) and U.S. Fish and Wildlife Service. Additional data sources used in this module include *Boating Registration Statistics* published by National Marine Manufacturers Association (NMMA), *Boating Statistics* published annually by USCG, and the periodical of *Sales* & *Marketing Management*.

Estimation Method

Two worksheets are contained in this module (Figure 2-19). Worksheet-A begins with 1991 as the base-year for the modeling effort because data on the number of powered boats in

each state were obtained from the 1991 *National Recreational Boating Survey*. Using data extracted from the annual *Boating Statistics* on the number of registered boats by state for the base-year and the latest year, a growth rate for the number of registered boats between these two years can be computed for each state. These growth rates are then applied to the base-year to derive the estimated number of powered boats for the most current year for each state. These calculations, along with the 1991 data and associated estimates, are included in Worksheet-A of the BOAT module.

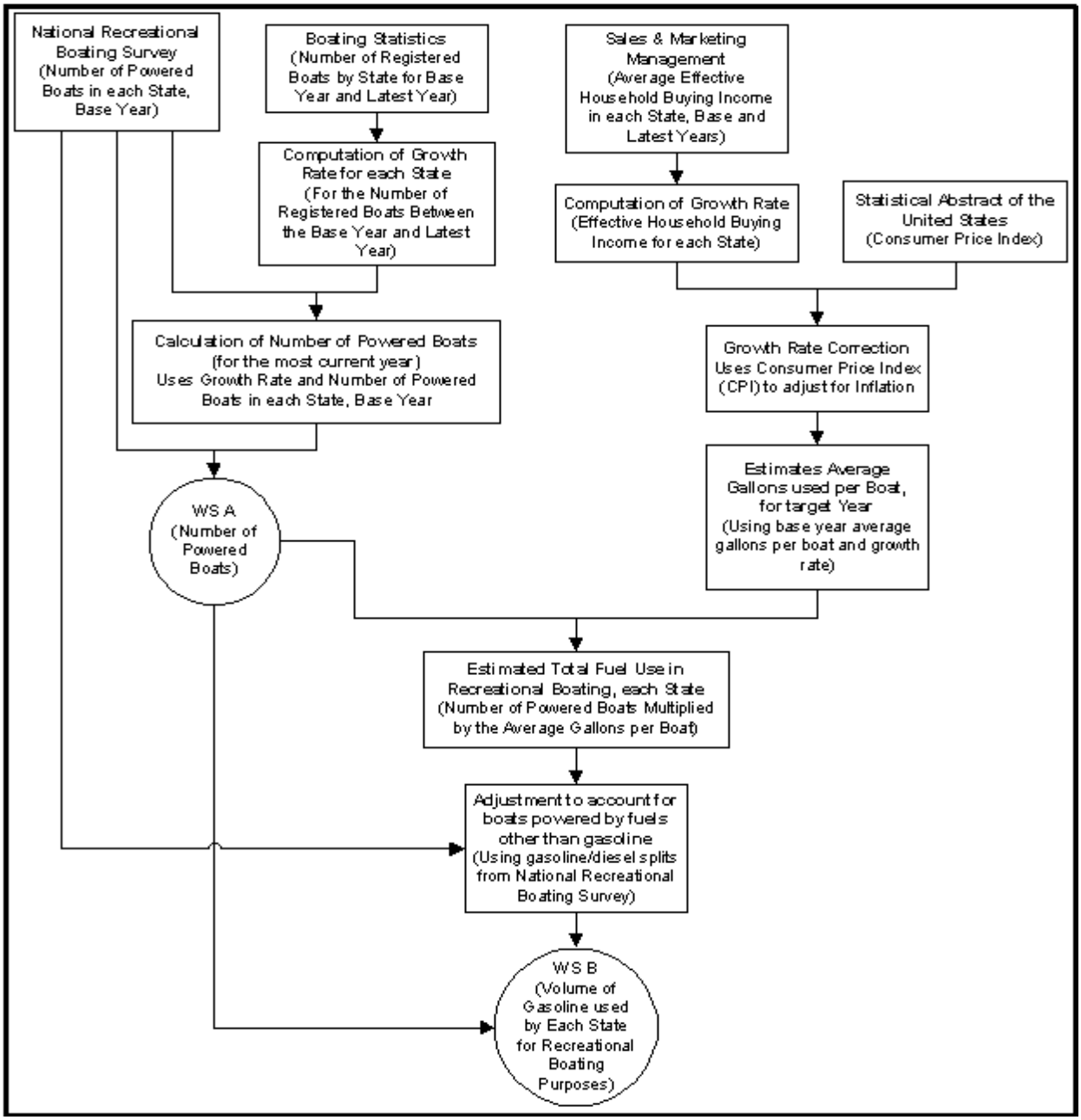


Figure 2-19. Marine Module ("BOAT")

Worksheet-B of this module takes results from Worksheet-A to estimate the amount of gasoline used by each state for recreational boating purposes. Using data on the average effective household buying income in each state for both 1991 and the latest year from *Sales & Marketing Management,* a growth rate of the effective household buying income can be computed for each state. These state-level growth rates are further corrected using the Consumer Price Index (CPI), taken from the *Statistical Abstract of the United States,* to adjust for inflation in each corresponding year. These adjusted growth rates are then applied to the base-year (i.e., 1991) average annual gallons used per boat to produce estimates for the target year (which is a year behind the analysis year).

Finally, the estimated average gallons used per boat is multiplied by the number of powered boats for each corresponding state to obtain an estimated total fuel use in recreational boating for each state. These estimates are adjusted one more time to account for those boats that are powered by fuels other than gasoline (i.e., diesel). This adjustment is made using information on the gasoline/diesel splits obtained from the *1991 National Recreational Boating Survey*. This completes the process of the BOAT module.

2.5.1.8 Recreational Module ("OFFROADF")

The third part in the estimation process does not fit into either the truck or other equipment categories. Referred to as the OFFROADF module, it estimates the recreational consumption of fuel (gasoline, gasohol, diesel, and special fuels) used by motorized vehicles on recreational trails or backcountry terrain (Figure 2-20). The off-road model used to estimate the total off-road recreational fuel consumption was also developed by ORNL. The method relies on information about the total number of the vehicles of a particular type (i.e., snowmobiles, off-road motorcycles, all-terrain vehicles, and light trucks used off-road) within a state and the average annual fuel used per vehicle. The off-road recreational fuel consumption is estimated by multiplying these two numbers together. Due to a lack of reliable data, currently FHWA does not estimate fuel consumption by small equipment (e.g., lawnmowers, snow blowers, chain saws).

These state-level fuel consumption estimates need to be further adjusted because vehicle registration data can be misleading for estimating fuel use by state. A vehicle very likely can be used in a different state from where it is registered. The adjustment to the state shares is based on a factor determined by the amount of rural land in each state. This model has been implemented in a spreadsheet file, OFFROADF, by ORNL. A detailed description of this procedure can be found in the 1999 ORNL report [7].

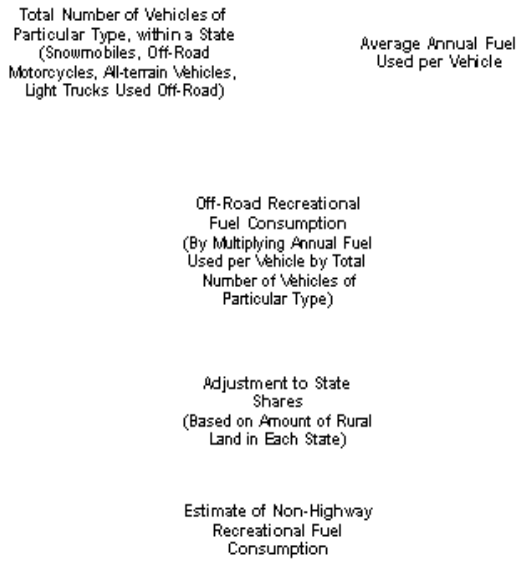


Figure 2-20. Recreational Module ("OFFROADF")

2.5.1.9 Summary Table

The summary table combines state-level estimates from the above modules into a single table (SUMMARY) to obtain total non-highway gasoline and gasohol consumption, as shown below in Figure 2-21. This includes estimates from Worksheet-D of AGRICULT module (agricultural) and worksheets from the other four modules: CONSTR (construction), IND (industrial and commercial), AVI (aviation), and BOAT (marine - recreational boating). It should be noted that the AGRICULT, CONSTR, and IND modules' estimates are mainly comprised of truck and heavy van fuel use. If a state-submitted number is also available for any of these major use categories, FHWA will evaluate quality of the reported data and compare it to the model-estimated value before accepting the state-reported number.

This completes the process of estimating non-highway gasoline consumption. FHWA uses results generated from this annual exercise to compile information presented in Table MF-24 of the annual *Highway Statistics*. The process of estimating gasoline use by Federal, state, county, and municipal entities requires the FHWA to conduct a different set of analyses, as discussed in the next section.

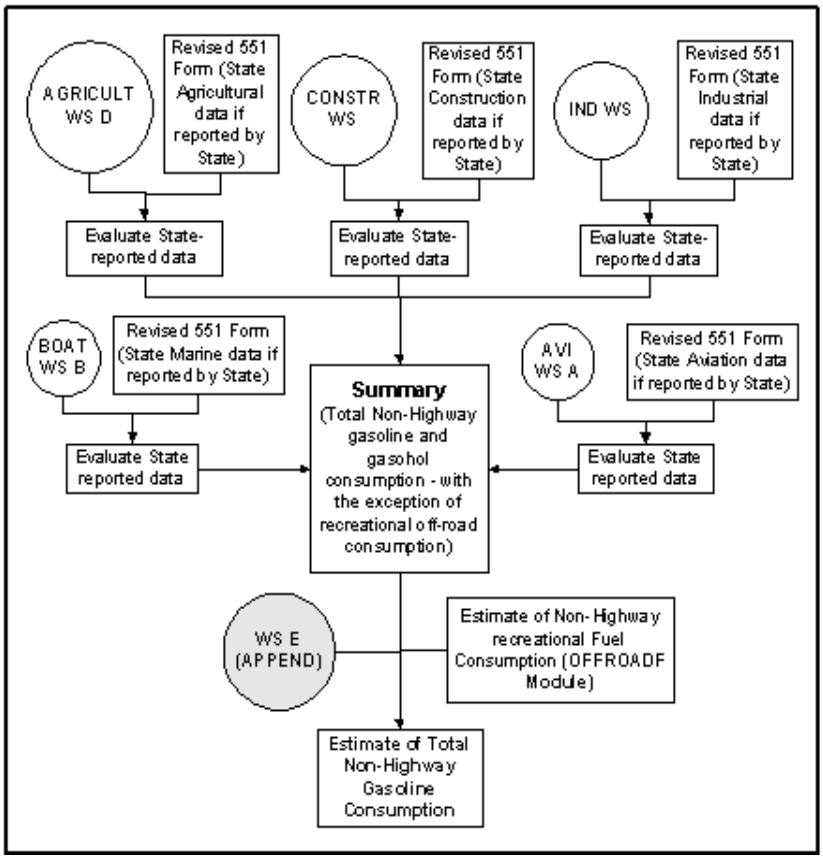


Figure 2-21. Non-Highway Gasoline Consumption ("SUMMARY")

2.5.2 Public Sector Consumption Model

A second model necessary to the fuel attribution determination is the Public Use Model. Using *Highway Statistics* table MV-7 (publicly owned vehicles), the GSA's Federal Motor Fleet Report, percentages of fuel consumption, and population and land area data, the Public Sector Consumption model estimates gasoline consumption by the public sector, which includes Federal, state, county, and municipal governments. At the Federal level, only civilian use of motor fuel is considered (military use is exempted from tax liability). This model creates consistent data for each state that would otherwise be inconsistent due to differing taxation policies. The final estimation of public sector fuel consumption is then used in the Use/User Analysis.

As shown in Figure 2-22, the Public Sector Consumption Model is divided into two main parts, the estimation of Federal employees' on-highway motor fuel consumption and state, county, and municipal (SCM) fuel consumption by fuel type and by state. These two components are described in more detail in the following two sections.

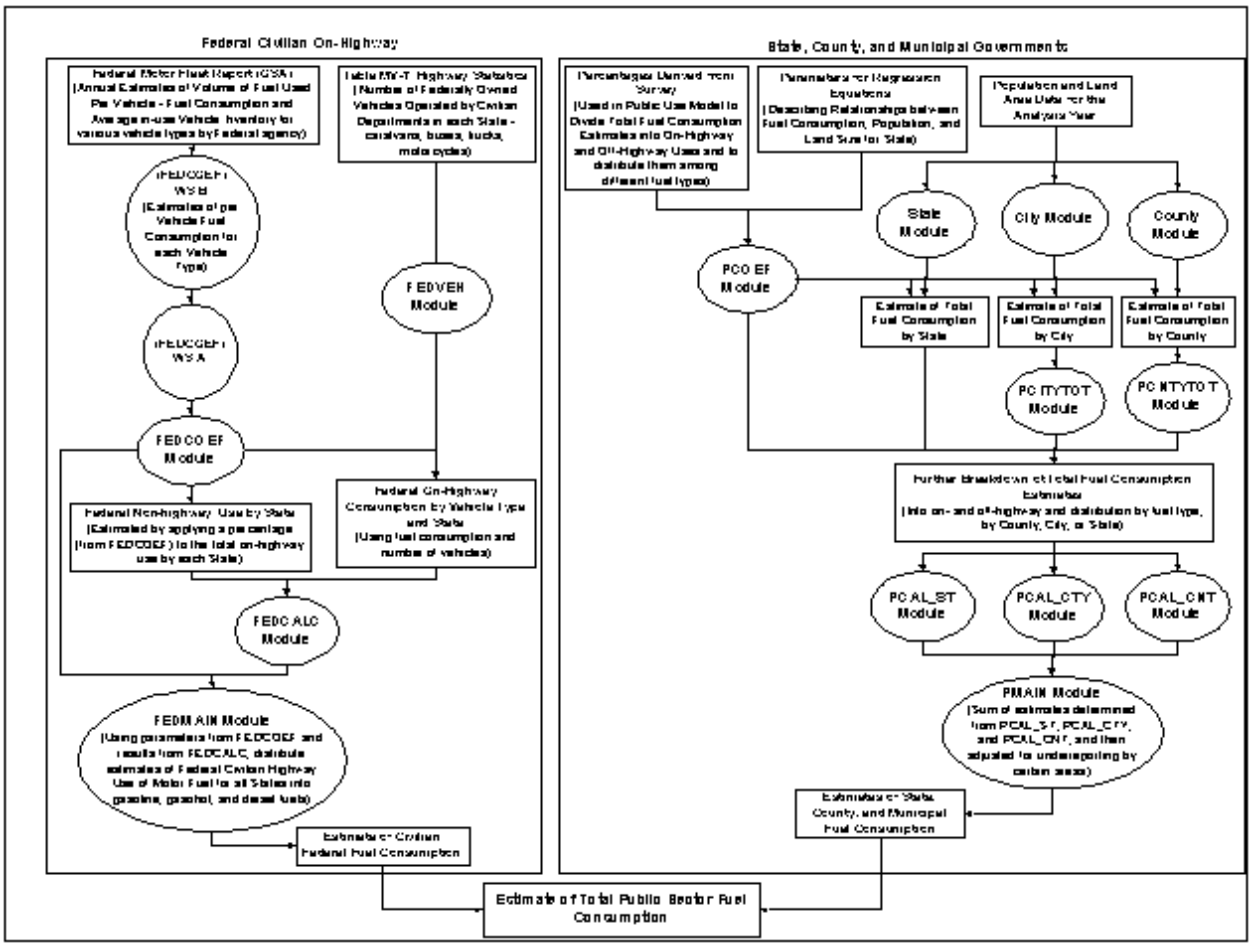


Figure 2-22. Public Sector Consumption

2.5.2.1 Process for Estimating Highway Fuel Use by Federal Civilians

Data Sources

Data used in this part of the public-use model are compiled from various sources, including publications produced by Federal and private organizations. For example, the number of Federally-owned vehicles that are operated by civilian departments and used in each state is obtained from Table MV-7 of *Highway Statistics*. It should be noted that there is a one-year lag for this publication. Data used in the analysis year will therefore be one year behind. Data on the annual estimates of gallons used per vehicle are obtained from the *Federal Motor Fleet Report*, published by the U.S. General Services Administration (GSA) [9].

As in the non-highway model, the procedure used for estimating Federal civilian fuel use has been implemented into a Windows-based spreadsheet computer system. These spreadsheet files are designed in such a way that annual updates and analyses can be

easily done by FHWA. A user's guide was developed by ORNL, which provides detailed information on the operations of this model [10].

Estimation Method

The methodology used in estimating Federal civilians highway use of motor fuel for all states was developed by ORNL in 1992 [8]. This methodology is based on the simple concept of multiplying the number of vehicles by the average gallons consumed per vehicle to derive the total amount of fuel used. This part of the public-use model consists of four modules. The relationships among these modules are presented in Figure 2-22.

Unlike the non-highway fuel use model, the estimation process of the Federal-use model is straightforward. It begins with extracting data from Table MV-7 of the latest publication of *Highway Statistics* to update the worksheet contained in the FEDVEH module. The data of interest is the number of Federally-owned cars/vans, buses, trucks, and motorcycles that are operated by civilian departments and used in each state.

The next module is FEDCOEF, which contains two worksheets. Information taken from the latest GSA report [9] is stored in Worksheet-B of this module. It includes data on fuel consumption and average in-use vehicle inventory for various vehicle types (including automobiles, station wagons, ambulances, various truck types, and buses) by Federal agency. Using these GSA data, Worksheet-B derives estimates of per-vehicle fuel consumption (in gallons) for each vehicle type. These estimates are then automatically transferred to Worksheet-A in the same module for further computation needs.

Note that GSA data are not separated by fuel type. Additional processing is therefore required in order to generate the needed level of detail. To accomplish this, several parameters needed for distributing fuel consumption into different fuel types, as well as breaking fuel usage into on- and off-highway uses, are included in Worksheet-A of the module FEDCOEF. These parameters (or "coefficients") are estimates obtained from the State-County-Municipal (SCM) part of the model, which is discussed in the SCM section that follows.

The third module in the Federal-use model is called FEDCALC. As is explicitly indicated in its module name, this is where the main calculations are performed. FEDCALC combines data from FEDVEH and FEDCOEF to calculate Federal on-highway fuel consumption by vehicle type and by state. Non-highway Federal use by state is then estimated by applying a percentage (taken from the FEDCOEF) to the total on-highway use for each given state. Finally, the FEDMAIN module takes results from FEDCALC and uses parameters from FEDCOEF to further distribute these estimates into gasoline, gasohol, and diesel fuels by

state. This ends the process for estimating Federal civilian motor fuel consumption in each state.

2.5.2.2 Process for Estimating Fuel Use by State, County, and Municipal Governments

Data Sources

The method used in estimating motor fuel uses by state, county, and municipal governments for all states was based on results from a study conducted by ORNL for FHWA in 1994 [11]. It uses population and land-area of a region (e.g., state, county, or city) to estimate fuel used in that region. The basic estimation equations were developed using data collected from a statistical sampling survey of SCM governments in the United States , which was conducted as part of the 1994 study.

The SCM part of the public-use model consists of ten modules. Flows between these modules are presented in Figure 2-22. Although the number of modules involved in this model seems large, the methodology is in fact fairly simple and straightforward.

Estimation Method

Three of the modules, STATE, COUNTY, and CITY, are used to hold population and land-area data for each respective type of geographic region for the analysis year. Module PCOEFcontains parameters (or coefficients) for the regression equations that describe relationships between fuel consumption, population, and land-size for each type of region (i.e., state, county, and city). Detailed technical descriptions of these regression equations and how they were developed can be found in Miaou et al. [11]. PCOEFalso contains several percentages derived from the survey data. These percentages are used in the public-use model to divide the total fuel consumption estimates intoon-highway and off-highway uses, as well as to distribute them among different fuel types.

The PCNTYTOT and PCITYTOT modules combine information from PCOEF with populations and land-area data from the COUNTY and CITY modules, respectively, to estimate the total fuel consumption in their respective regions. Results from these modules are then transferred into associated calculation modules, PCAL_CNT and PCAL_CTY, for county and city respectively. With information from PCOEF, PCAL_CNT and PCAL_CTY further break down the total fuel use estimates into on- and off-highway, and then distribute them by fuel type.

On the state side, the PCAL_ST module uses data from STATE and PCOEF to estimate total fuel used by the state government. It also uses information from PCOEF to separate the

total estimates into on- and off-highway uses, and then to divide them by different fuel types for each state.

Finally, the PMAIN module sums the three sets of estimates obtained from PCAL_ST, PCAL_CNT, and PCAL_CTY to produce a set of total SCM estimates. To account for underreporting in certain areas under the SCM sample survey (e.g., school systems), a final adjustment is made to the estimates in PMAIN.

2.5.2.3 Total Public Fuel Use

This completes the process of estimating public-use fuel consumption. Results from FEDMAIN and PMAIN are automatically entered into other FHWA worksheets through spreadsheet links. These estimates are used in the MF-20 analysis, which is where the FHWA determines whether state-submitted or model-generated data should be used.

After all the steps for estimating public and off-highway uses described above have been completed, a final spreadsheet (PUBNONHW) is run, bringing all the relevant data into a summary sheet entitled "Public Use and Private and Commercial Non-Highway Use of Gasoline" for the analysis year. A macro (currently in Lotus and now being converted to Microsoft Excel) then moves this data, state-by-state, to a printed sheet that will be used in the MF-20 analysis.

Prior to continuing with the state-by-state analyses, FHWA runs the gasohol model to obtain estimates of on-highway gasohol consumption by state. This gasohol estimation model is discussed in the following section.

2.5.3 Gasohol Model

The Gasohol Model uses information from the Revised 551M Summary as well as from an IRS Module to provide reliable estimations of gasohol consumption for each state, in terms of three blends defined by the Energy Policy Act of 1992 (EPACT) and recognized by the IRS and FHWA: 10 percent, 7.7 percent, and 5.7 percent ethanol by volume. IRS taxes the three different blends of gasohol at different tax rates. This model serves to provide comparable estimates of each blend for each state since the states have a variety of methods of reporting gasohol consumption amounts. Some states report only one type of ethanol, while others do not report any gasohol consumption at all; Washington State is the only state that defines the three types of gasohol in legislation identical to those defined in Federal legislation. Since highway-funding attribution is based on Federal motor fuel tax revenue, FHWA has to determine gasohol revenues attributed to each state using the Federal definition of the three types of gasohol. Data obtained from this process is used in the Attribution of HTF receipts as well as in *Highway Statistics* Table MF-33E.

2.5.3.1 Data Sources and Revisions to the Model

The model for estimating gasohol consumption was developed by Battelle under a contract with FHWA in 1994. The original model was reviewed and updated by Battelle for FHWA in 1999. The purpose of the review was to validate and verify the data as well as to evaluate the goodness of the regression equation used in this gasohol estimation model; specifically, the review evaluated how this equation performed in determining gasohol usage for the states.

As a result of this work, the gasohol estimation model was revised. The updated model accurately reflects new data identified during the 1999 study. The screen design of the model (i.e., user-interface) was also updated to improve the ease of transition between data tables maintained by FHWA. The assessment of state data on gasohol, the analysis of the regression equation, and the conclusions drawn from this effort were documented in the 1999 Battelle report, *Gasohol Estimation Model Review* [12].

Major data sources used in the gasohol estimation model are FHWA Form-551M and IRS quarterly tax revenue data. This model also uses information collected from contacting states through a questionnaire survey conducted as a part of the 1999 model review activity. State responses to this survey are documented and provided in *Gasohol Estimation Model Review, State Responses to Questionnaire* by Battelle [13]. A general overview of this gasohol estimation model is presented in Figure 2-7. These procedures are discussed below.

2.5.3.2 Methodology

On a greater level of detail, one can see in Figure 2-23 that the estimation of highway gasohol consumption is divided into two main parts, the ESTNEW module and the IRS module. The main analysis module for the gasohol model, the ESTNEW module, contains the regression model, which enhances the state-reported data quality. The IRS module produces control data for the estimation. "XX" denotes the analysis year (i.e., files used for analysis year 2000 are named ESTNEW00 and IRS00).

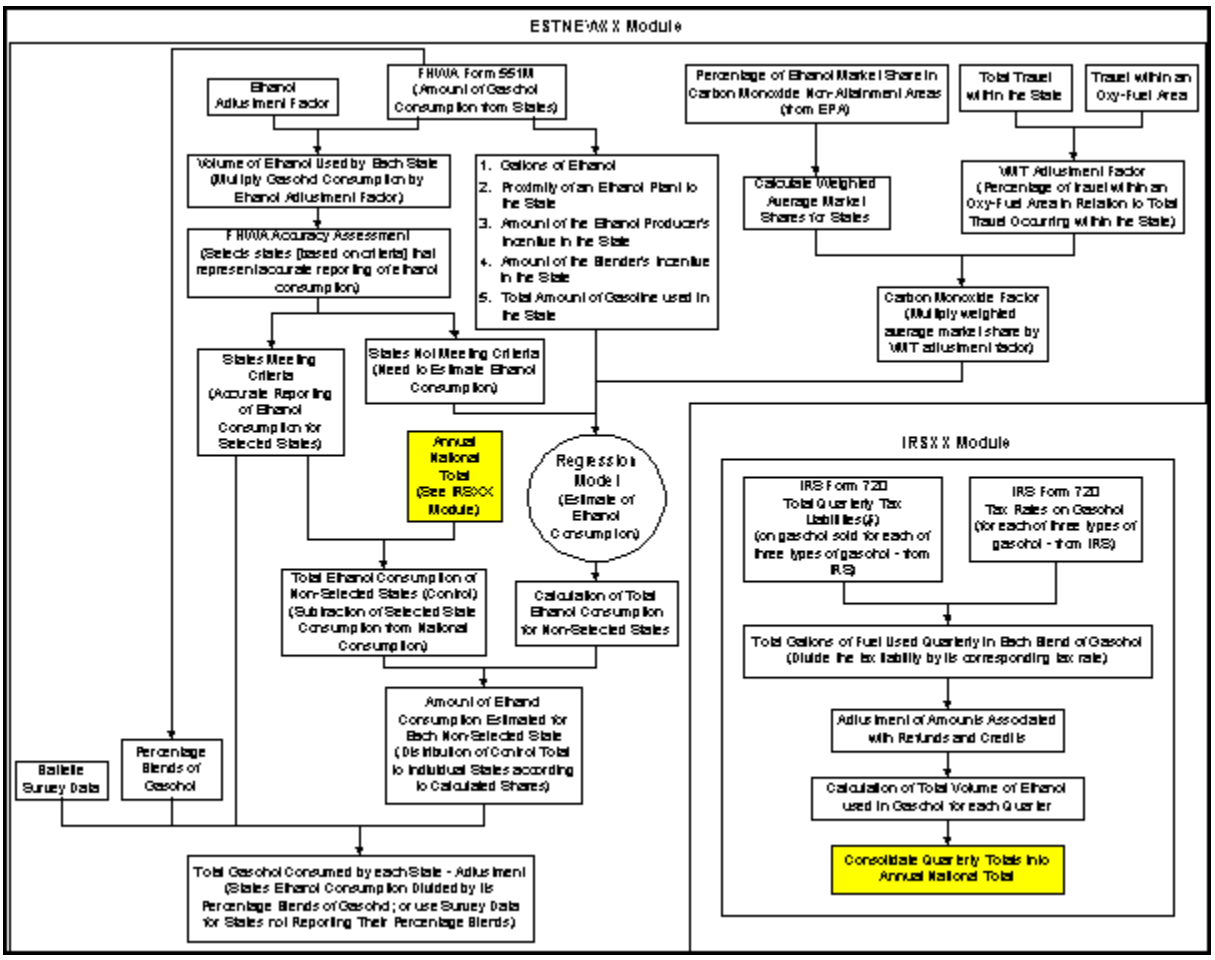


Figure 2-23. Highway Gasohol Consumption

2.5.3.3 Computing the Control Totals

IRS00 contains revenue data collected from IRS-Form 720 (*Quarterly Federal Excise Tax Return*) for the four quarters in tax-year 2000. As mentioned before, IRS data are available only at the national level. Total quarterly tax liabilities ($) and tax rates on gas-for-gasohol and gasohol-sold, for each of the three types of gasohol, are obtained from IRS and entered into the worksheets in IRS00. This module then computes the total gallons of fuel used quarterly in each blend of gasohol by dividing the tax liability with its corresponding tax rate. Refunds and credits on gasohol are handled in a similar manner. IRS data do not separate refunds and credits by the three blends of gasohol. The shares of refunded or credited tax liability among these three types of gasohol, therefore, are assumed to be the same as the shares calculated from those quarterly reported total tax liabilities.

After adjusting amounts associated with refunds and credits, total gallons of ethanol used in gasohol are calculated for each quarter. These quarterly totals are consolidated into an

annual national total in the IRS00 module. The gasohol estimation model then applies this number to calibrate the state estimates obtained from the ESTNEW00 module.

2.5.3.4 Use of State-Provided Data

FHWA receives the amount of gasohol consumption (in gallons) from states as reported on the FHWA-Form 551M. These data are entered into a worksheet in the ESTNEW00 module as an input to the estimation model. These state-reported gasohol consumption estimates are multiplied by an ethanol adjustment factor to calculate the gallons of ethanol that are used by each state. In general, the ethanol adjustment factor used for most states is 10 percent (i.e., a 10 percent blend). Different adjustments were made to acknowledge under-reporting in some states found by interviews conducted under the 1999 model review effort. Adjustments are also made for states that use more than one blending for gasohol. Finally, this factor is set to 0 for states that are not using gasohol.

FHWA then assesses the accuracy of state-reported consumption to select those states that represent accurate reporting of the ethanol used. About 30 states meet the FHWA selection criteria (including states that do not use gasohol). For these selected states, FHWA accepts the state-provided and FHWA-adjusted ethanol gallons as current and accurate.

2.5.3.5 Estimating Ethanol Gallons for Non-selected States

The ethanol consumption for states that are not selected by FHWA (i.e., those values that were in question) are estimated using a regression equation. This regression equation was developed by Battelle and revised in 1999. It has been integrated into the current ESTNEW00 module. A brief description of the regression equation is included later in this section.

Since ethanol consumption for the nation (from IRS00) and the selected states is known, the total ethanol consumption from those non-selected states can be calculated by simple subtraction. The resulting difference is then used as a control total to adjust the ethanol consumption estimates produced from the regression equation for those non-selected states. More specifically, state-level ethanol consumption estimates produced by the regression equation are added to form a total for these non-selected states. Regression-estimated consumption for each non-selected state is then divided by this total (i.e., sum of all regression-based estimates) to produce a "share" (i.e., percentage of the total) for the state. The control total (i.e., the difference obtained from above) is then distributed to individual states according to these calculated shares. The values from this process are the amount of ethanol consumption estimated for each of the non-selected states. All these computations are done inside the ESTNEW00 module.

2.5.3.6 Estimates of Gasohol Gallons

The annual ethanol consumption by state, either from state-provided data or by regression-estimation, is adjusted one more time to determine the total gasohol consumed by each state. This adjustment is done by taking a state's ethanol consumption and dividing it by the state's percentage blends of gasohol (i.e., at 5.7, 7.7, or 10 percent). The percentage blend for each state is provided on FHWA-Form 551M. Many states do not report their percentage blend, however. Data collected from the 1999 Battelle survey is therefore used in the ESTNEW00 module for these states.

2.5.3.7 Steps to Run Model

The following provides the steps for managing and running the model:

Step 1: FHWA receives the values of gasohol from each state as reported on the FHWA Form 551M.

Steps 2 and 3: The gasohol value received from the state is multiplied by an ethanol adjustment factor to calculate the number of gallons of ethanol that are used by the state. For states that collect ethanol gallons data directly and derive total gasohol gallons assuming a 10 percent blend, the adjustment factor is 10. In aggregate, the default value for most states is 10. However, based on results of the interviews, adjustments were made for acknowledged under-reporting (+ .1 for a small amount, + .5 for a large amount). Adjustments also were made for states that use more than one blending.

Step 4: FHWA selects state-provided ethanol gallons values (found in Step 2) that represent accurate reporting of the ethanol used (about 30 states meet this criteria). These ethanol gallons are summed together.

Step 5: The values found in Step 4 are subtracted from the Internal Revenue Service (IRS) control total, the known Federal gasohol revenue as reported by IRS.

Step 6: The values from the states that are in question (i.e., those states not used in Step 4, and which are known to have some gasohol use) are estimated from the regression equation.

This regression equation is currently used to estimate the gallons of ethanol consumed.

"Number of ethanol gallons consumed" is the dependent variable, with the following independent variables:

- The proximity of an ethanol plant to the subject state
- The amount, if any, of the state's ethanol producers' incentive

- A calculated variable, a.k.a. carbon monoxide factor, based on the market share ethanol has in relation to other alternative fuels, multiplied by the percentage of vehicle miles traveled within the ethanol fuel area
- The amount of the state's blenders' incentive
- The total amount of gasoline used (regular [non-blended] gasoline and gasohol blends as reported by the state).

Step 7: Step 6 values are summed, showing the total gallons of ethanol estimated by the regression equation.

Step 8: Each individual estimate (from Step 6) is divided by the total calculated in Step 7 to create a percentage of the total.

Step 9: The percentage found in Step 8 is multiplied by the IRS difference found in Step 5. The value from this is the gallons of ethanol used by state.

Step 10: The ethanol gallon values from Step 9 and Step 3 are divided by the percentage blends to determine a value for gasohol gallons.

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[1] Farm equipment that operates on diesel fuel is not in-scope here because non-highway-use diesel is dyed and therefore is non-taxable. Moreover, this assumption was made due to data limitations encountered during the model development in 1994. Review of currently used modeling approaches as well as further investigation on new data sources will be conducted in a separate follow-up task.

3.1 Introduction

The primary objective of the evaluation effort is to examine the impacts of the changes implemented by FHWA as part of the continuous improvement of the model on the fuel tax attribution process. These changes are intended to improve efficiency and quality of the fuel tax attribution process. As part of the evaluation effort, detailed documentation of the fuel tax attribution process is developed and presented in Chapter 2 of this report. Also, the instructions or guidelines to the states regarding reporting fuel tax data was reviewed and a report presented in a separate document. Two major changes that are the focus of this evaluation effort are the following:

1. The use of Motor Fuel Smart Input Tool by states to submit fuel tax data
2. Oversight at state level to certify that states submit complete and accurate fuel tax data.

This chapter focuses on the impacts of these changes on the fuel tax attribution process. The specific evaluation goals and measures are discussed in the following sections. This chapter also discusses potential actions items directed at further improving the quality of fuel tax data reported by states and efficiency of the attribution process as a whole.

3.2 Evaluation Framework

A detailed review of the fuel tax attribution methodology was conducted using the framework outlined below. The evaluation framework consisted of three major steps involving collecting and analyzing information necessary to provide a comprehensive assessment of the methodology. First, the goals or expectations from the motor fuel tax attribution system were identified. Second, measures for evaluating the various goals were established. Third, the hypotheses to be used to evaluate the fuel tax attribution system were developed. The evaluation goals are system performance, data process quality, risk management, and institutional issues as they relate to the fuel tax attribution process. These evaluation goals are discussed below.

3.2.1 Legacy System Performance

The legacy system performance goal area evaluates the ability, efficiency, and reliability of the system to perform its intended functions of accepting, analyzing data, and delivering accurate and consistent state fuel tax attributions. Evaluating this goal area involves a detailed review of data processing methodology including the assumptions and business rules. It also involves assessing the quality of the input data attribution results. Quality is measured in terms of accuracy, completeness, timeliness, and reliability. Accuracy of

attributions is defined in terms of correlation between state-reported fuel consumption data and HTF attributions. Reliability was defined in terms of the consistency of the HTF attributions as a function of data provided by the states. System efficiency is defined in terms of the throughput in the fuel tax processing system.

3.2.2 Data Processing Quality

The data processing quality goal area evaluates the quality of data analysis procedures applied in processing of motor fuel tax data from the states. This goal area includes the business rules (rules-of-thumb, assumptions, and formulas used in the estimation models) and how these affect the results of the attribution process. This goal assesses the validity of the business rules and the consistency with which they are applied.

3.2.3 Risk Management

Risk management is defined as the systematic application of policies, practices, and resources to the assessment and control of risk. With specific reference to the fuel tax attribution process, risk management relates to the policies, resources, and practices to ensure high quality data from the states, and efficient data acquisition processes and reliable and consistent data analysis tools and processes. It also includes consistent application of policies and procedures regarding data collection, analysis, and reporting HTF attributions. These practices are intended to minimize the risks associated with using incomplete and/or inaccurate data (intentionally or unintentionally), double counting, unreliable analytical procedures, and inconsistent application of business rules. The risks include unfairness, inequity, and inconsistency in the attribution of HTF to the states. The standard approach to risk management involves three major steps:

(i) identify the potential risk, the cause, and consequence; (ii) identify control and mitigation options; and (iii) monitor and evaluate the control and mitigation measures. This goal area evaluates the reliability and consistency of the fuel tax data processing methodology, and the impacts of the quality of state reported data on the attribution process and HTF attributed to the states.

3.2.4 Institutional Issues

This goal area identifies any institutional issues related to data acquisition and handling as well as attribution of fuel tax revenues. This includes institutional arrangements that affect the fuel tax data processing directly or indirectly.

In order to improve the focus of the evaluation, a set of measures has been identified for each of the goals. The hypotheses are selected to reflect the overall objectives of the review. Table 3-1 shows the evaluation framework and summarizes the goal areas,

measures, and hypotheses. The measures were used to test the hypotheses. The evaluation approach adopted is outlined in the following section.

Table 3-1. Evaluation Goals, Hypotheses, and Measures

Goal	Measures	Hypotheses
System Performance	• Consistency of business / decision rules • System reliability	• Assumptions and algorithms adequate • Business rules are consistently applied • System is reliable • Reasonable estimates of highway fund attribution to states
Data Process Quality	• Data inconsistencies • Business /decision rule inconsistencies	• States provide good quality data • Business / decisions rules are logical and applied consistently • Outputs of data processing are consistent and reliable
Risk Management	• Process inconsistencies • Deviations from standard practices	• Procedures consistent with standard practices • Procedures are reliable • State attributions are accurate
Institutional Issues	• Interagency issues • State data issues	• Improved interagency interaction • Easy to acquire state motor fuel data

3.3 Evaluation Approach

Evaluation of the goal areas involves five main analyses or studies directed at assessing the impacts of the changes implemented as part of the FHWA's continuous improvement model. Table 3-2 maps the evaluation goals to the analyses conducted. There is considerable overlap among the studies or analyses in terms of the goal areas that they address. For example, the risk management goal area is addressed by almost all analyses. The following sections describe the analyses conducted.

3.3.1 Process Review

The process review involves detailed review and documentation of the fuel tax data analysis procedures. Description of data processing methodology includes detailed documentation of the attribution process, description spreadsheets, assumptions, business rules, and estimation models. This process review primarily addresses the evaluation goals of system performance, data processing quality, and risk management. The evaluation measures include system reliability, consistency in the application of business rules, consistency of outputs from the attribution process, and inconsistencies in the fuel tax data analysis process.

The review identified and documented data flow sequences, inputs, and outputs generated by each step in the data analysis process. As part of the review, the business rules and assumptions underlying the data analysis processes were identified and documented. Chapter 2 of this report presents the process review. A secondary objective of the process review was to document the fuel tax attribution process to a sufficient level of detail that readers can understand the seemingly complex process. Providing such level of detail offers transparency that is considered part of the risk management associated with fuel tax attribution process because it allows potential causes and consequences to be easily traced and addressed.

Table 3-2. Evaluation Approaches Addressing Goal Areas

Evaluation Approach	Goal Areas	Measures Evaluated
Process Review	• Data process quality • System performance • Risk management	• System reliability • Business rules are consistently applied

		• Consistent outputs • Process inconsistency
Statistical Analysis	• Data process quality • System performance • Risk management	• System reliability • Business rules are consistently applied • Consistent outputs • Process inconsistency
Smart Input Tool	• System performance (efficiency) • Data process quality • Risk management	• Process inconsistency • Data errors
Oversight Review	• System performance (efficiency) • Data process quality	• Data inconsistency • Data error • System reliability
Interviews	• Institutional Issues	• Interagency issues • State data issues

3.3.2 Statistical Data Analysis

Statistical analyses were conducted to evaluate the system reliability and efficiency as well as data process quality goal areas. Indirectly, the results of the statistical analyses were used to evaluate the risk management goal area of the fuel tax attribution process. The statistical analysis was used to evaluate the four measures - system reliability, consistency of business rule application, consistency of attribution outputs, and data analysis process inconsistency. The primary objective of the statistical analysis, therefore, was to examine the consistency and reliability of the fuel data analysis process used by FHWA. To achieve this objective, the relationships between the number of gallons of fuel reported and the HTF attributions to the states were examined. Simple regression analysis was used to explore the relationships. The results of this analysis also establish the validity of the assumptions and business rules applied. Fuel tax attribution data published in the *Highway*

Statistics over the past five years (1997-2001) on number of gallons reported and amounts attributed to the states were in the statistical analysis.

3.3.3 Smart Input Tool

This analysis is a detailed review of the smart data entry tool that addresses the goals of system efficiency (or performance), data process quality, and risk management as noted earlier. The Smart Input Tool is one of the improvements implemented by FHWA as part of the continuous improvement model. The tool is intended to help improve the quality of data submitted by the states by reducing errors and the need to enter data twice, improve efficiency of the data acquisition and analysis process, and above all reduce the risks associated with incomplete and inaccurate data. The measures considered in evaluating the input tool are data errors and inconsistencies in the data analysis process.

The main sources of error in the legacy system were identified to include: (i) data entry (i.e., key punching); (ii) inconsistencies between number of gallons reported on Form 551M and the dollar amounts on Form 556; (iii) misapplication of business rules; and (iv) misapplication of the EVAL analysis. Some of the errors are difficult to identify and correct. Prior to January 2002, a "quick fix" adopted by FHWA to the problem of key punching errors was to enter state reported data submitted on paper twice. The premise was that any errors made in the first round would be caught and corrected during the second entry. However, the chances that errors are made in the second entry still remain. The Smart Input Tool is intended to address the problems of errors associated with data entry. The Smart Input Tool was critically evaluated by comparing it with the legacy system and testing the self-error checking feature of the tool. Input errors were intentionally introduced to test how the tool reacts.

3.3.4 Oversight Review

The oversight review process addresses the goal areas of data process quality and risk management. The introduction of oversight at the state level is also part of FHWA's continuous improvement model to improve the quality of fuel tax data reported by the states and improve the efficiency of the fuel tax attribution process. This review assesses the impacts of the oversight on the quality of state data submissions, and how this data quality affects the efficiency of the entire fuel attribution process. FHWA did not identify data duplication and data completeness as major problems. Whenever incomplete data or errors are detected, FHWA works with the states to resolve it. However, the time and effort required to resolve discrepancies and reconcile state and FHWA data can be saved. The oversight review was implemented to ensure that complete and accurate data are submitted to FHWA. Anecdotal information based on the results of preliminary oversight

reviews conducted in 27 states in the Fall of 2002 were used for the evaluation. The oversights have not been fully implemented at the time of the evaluation effort.

3.3.5 Institutional Issues

This study identifies any institutional issues that impact the fuel attribution process. Limited interviews were conducted with FHWA staff to gain insights into possible institutional issues that directly or indirectly impact the fuel tax attribution process.

The following sections discuss in detail each of these studies or analysis.

3.4 Discussion of Results

This section presents the results of the evaluation effort. The results of the analyses described in the previous section are discussed.

3.4.1 Process Review

A description of the fuel tax attribution process review can be found in Chapter 2 of this report. Process review is one of the critical elements of the evaluation effort. One essential aspect of the process is that FHWA provides clear instructions to the states regarding data requirements. In this regard, the instructions on reporting fuel tax data as contained in Chapter 2 of "Guide to Reporting Highway Statistics" were thoroughly reviewed and reported to FHWA.

One of the analytical processes of particular interest is the EVALUATION analysis ("EVAL"). As described in Chapter 2, the EVAL is a critical step in the fuel tax attribution process because it establishes the validity of the data from the states. This analysis verifies that current changes in state tax rates are considered by the states. The challenge in EVAL is to reconcile the amounts reported on Form 556 with the values derived from the gallons reported on Form 551M. As a business rule, reconciliation is considered complete when the difference is within 5 percent. This requires interacting with the state agencies responsible for submitting the fuel tax data to ensure that the values are reconciled. The implementation of state oversight reviews may help in ensuring that the values reported on the Form 551M agree with the amounts reported on Form 556. This will eliminate the need for adjustments made by FHWA so that the 5 percent difference threshold is achieved.

This project did not specifically evaluate any of the estimation models used in the fuel attribution process in detail. For example, the gasohol model was reviewed to a limited extent. It was observed that, in its present form, the gasohol model uses proximity to the production plant as one of the input variables. The inclusion of this variable was based on

the premise that gasohol cannot be shipped over long distances and therefore proximity to the plant is an important variable that determines consumption. There is one school of thought that believes that with changes in the emission standards and increased usage of gasohol, proximity to production variable is becoming less relevant to determining consumption.

The potential risks of underestimating or overestimating gasohol consumption based on estimates derived from the gasohol model are acknowledged. However, these risks or effects of extrapolating to other states could not be assessed as part of this evaluation effort due to lack of data.

The following are summaries of review comments on the other estimation models used in the fuel tax attribution process. The comments highlight the limitations or weaknesses of the estimation models in terms of irrelevant or outdated data used in the models as well as data elements not considered in the models.

Non-Highway Model

All modules of the non-highway model use information from VIUS. This survey is only conducted once every five years.

Agriculture Module - This module has not been updated with the latest 1997 Census of Agriculture data. The current module uses information on gasoline expenses reported in the 1991 Farm Production Expenditure Report (information at this level of detail is not available after 1992).

Data on non-highway equipment including, specialty agricultural equipment, power and light generators, and stationary power equipment are not included in the model.

Aviation Module - Information used in the latest version of the spreadsheet program was based on 1996 data. This needs to be updated with more recent data. Data on gasoline use by ground support aviation equipment at airports are not included in the module.

Construction Module - Fuel consumption data on non-vehicle gasoline engine equipment, such as mixers, loaders, cranes, power, and light generators are not captured in the module due to lack of data.

Industrial/Commercial Module - This module does not include fuel consumption data for non-vehicle, gasoline engine equipment, such as scrubbers, sweepers, material handling equipment.

Marine Module - It was observed that "Effective Median Household Income" reported in the proprietary periodical Sales and Marketing Management may not be as indicative of the

growth rate as the Disposable Income per Capita published by the U.S. Bureau of Economic Analysis.

The 1991 National Recreational Boating Survey provides a significant amount of data used in this module. Since 1991, the United States Coast Guard has not released an updated survey of this type. The information is outdated and needs to be updated.

It was also noted that the module does not take fueling practices (fuel station vs. pier/dock) into consideration.

Public Use Model

GSA now reports fuel consumption by fuel type instead of by vehicle class. Therefore, fuel consumption data requires modification before it can be used in the estimation model.

It was also noted that GSA report has a two-year time lag. Information on publicly owned vehicles in Table MV-7 (*Highway Statistics)* was calculated based on the numbers of Federal vehicle stocks provided by the GSA in the 1980's. Population land area data have not been updated with the latest Census information. The current SCM government practices are not reflected by data, since it was collected over a decade ago. Therefore, there is the need to update information on publicly owned vehicles.

Much of school bus data are not available since most of these services have been contracted to the private sector. SCM calculation does not include alternative fuel use (1992 EPACT mandates the use of alternative fuel on public sector fleets and fuel providers' fleets). It is important to consider these data improvements in enhancing the estimation modules.

Based on this review, it is recommended that the estimation models need to be reviewed, updated, and enhanced, where necessary.

3.4.2 Statistical Analysis

Two main analyses were performed. The first analysis investigated the relationship between the amount of motor fuel reported by each state (including non-highway use) and the attribution funds they received. The second compared the amount of gasoline (used for highway-use only and including gasohol) reported by each state and the attribution funds they received. These relationships were examined using simple linear regression analysis. The analysis is based on the premise that the amount of funds attributed to each state should be directly proportional to fuel consumption. It is assumed that effects of other variables on the amount attributed are negligible. The amount of motor fuel and the amount of gasoline reported by each state were obtained from *Highway Statistics* Table

MF-21. The corresponding receipts of funds were obtained from *Highway Statistics* Table FE-9. Data for a five-year period between 1997 and 2001 inclusive were used.

3.4.2.1 Discussion of Results of Statistical Analysis

The results of the statistical analysis of historical data are shown in Figures 3-1 and 3-2. These figures show the relationships between total gallons of fuel and gasoline and the respective attributions to the states. The coefficients of correlation of the linear regression lines for the five years are 0.99. These values imply that the amounts attributed to each state are highly correlated with the number of gallons reported. These results also suggest the following:

- The business rules and assumptions appear to be consistently applied in the analytical process
- The analytical process generates fairly consistent outputs
- Data submitted by the states are of reasonable quality, the data adjustment procedures are reasonable and consistently applied, and the models, in general, yield reasonable estimates.

Furthermore, these results suggest that simple linear regression analysis can be used to assess the validity of the future HTF attributions. It is recognized that a single regression model will not be applicable to all years and therefore inadequate for assessing future attributions. However, given the consistently high correlation between the amount of fuel consumed and the amounts attributed, it is possible to set some boundaries to assess the consistency of future attributions. It is suggested that an envelope of regression lines and a minimum coefficient of correlation be used to judge the acceptability of future attributions. As such, it is suggested that a regression analysis should be carried out after each year's attribution and the coefficient of correlation compared with a threshold value of 0.99 and that the regression line should fall within the envelope shown in Figure 3-3. Any outliers should then be identified and reviewed to identify the possible cause(s) of inconsistency.

Reliability and consistency of the attributions also can be investigated by examining the stability of the ratios of attributions to fuel consumption. The regression analysis revealed that the HTF attributions are highly correlated with the amounts of fuel consumed. This suggests that the ratio of HTF attributions to gallons consumed should be stable i.e., lying within a narrow range. Thus, reliability of the analytical process can be assessed using statistical measures such as the range of variation. The range of variation is defined as the mean plus or minus one or two standard deviations. According to standard statistical theory, using one standard deviation as the range of variation about the mean implies that approximately 68 percent of the values lie within this range. On the other hand, the mean

plus or minus two standard deviations implies that 95 percent of the values lie within this range. This statistical measure assumes that the ratios are normally distributed. Figure 3-4 shows the relationship between the statistical ranges and the probabilities.

Scatter plots of the HTF-to-fuel consumed ratios and the range of variation (mean plus or minus one standard deviations) superimposed revealed that the range changes from year to year. It is noted that the scatter plots also provide clear indications of possible outliers that merit further investigation. It is suggested that the range of variation be used to determine reliability and consistency of the attributions and identify outliers for further investigation. It is recommended that the mean plus or minus one standard deviation used be in constructing the threshold range of variation. Given the yearly variations, it is also recommended that a five-year moving average be used in establishing the range of variation. Figure 3-5 illustrates the band of variation for 1997 through 2001.

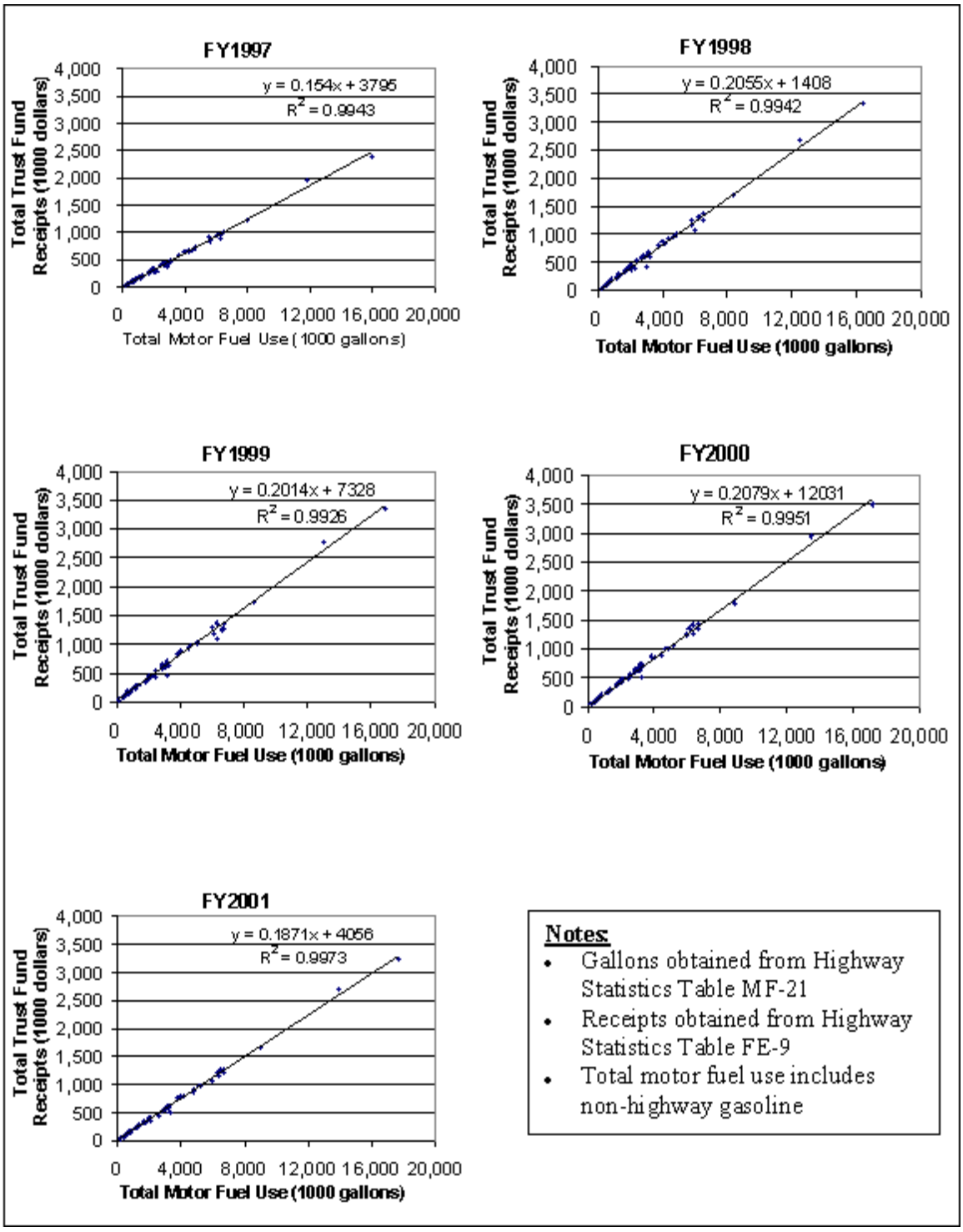

Figure 3-1. Relationship Between Motor Fuel Use and Highway Trust Fund Receipts

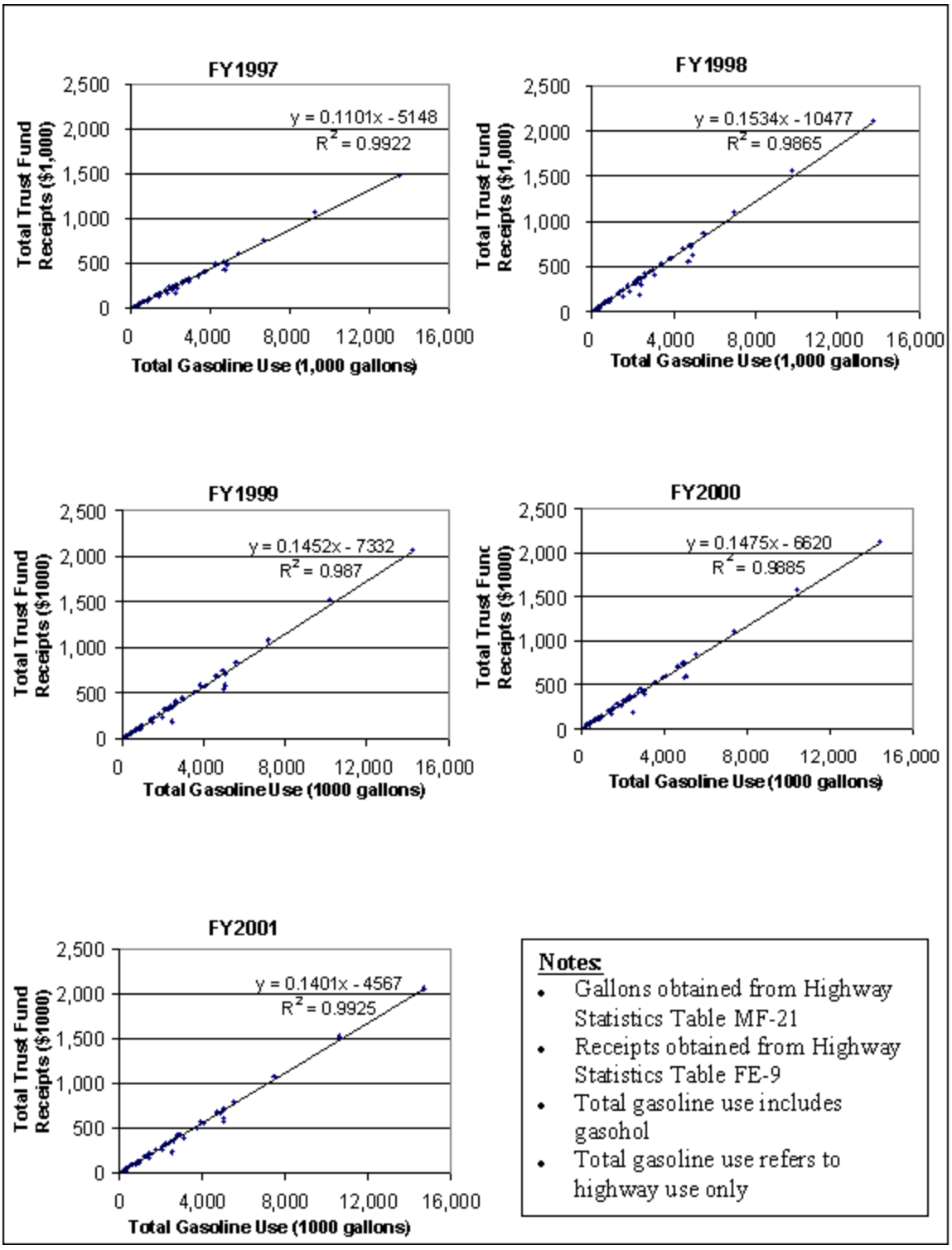

Figure 3-2. Relationship Between Highway Gasoline Use and Highway Trust Fund Receipts

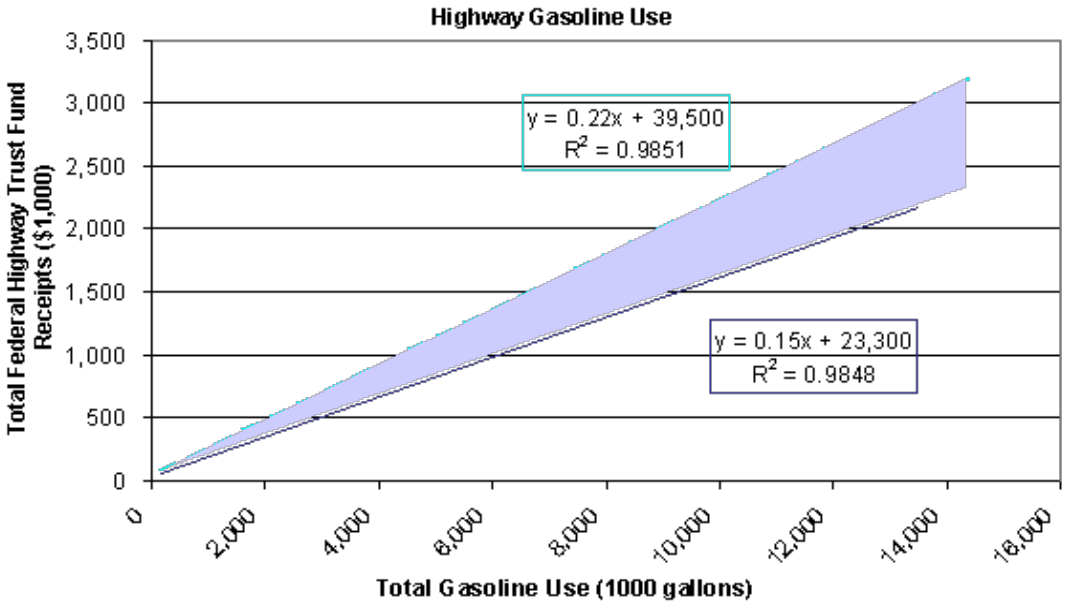

Figure 3-3. Regression Analysis for HTF Attribution Acceptability

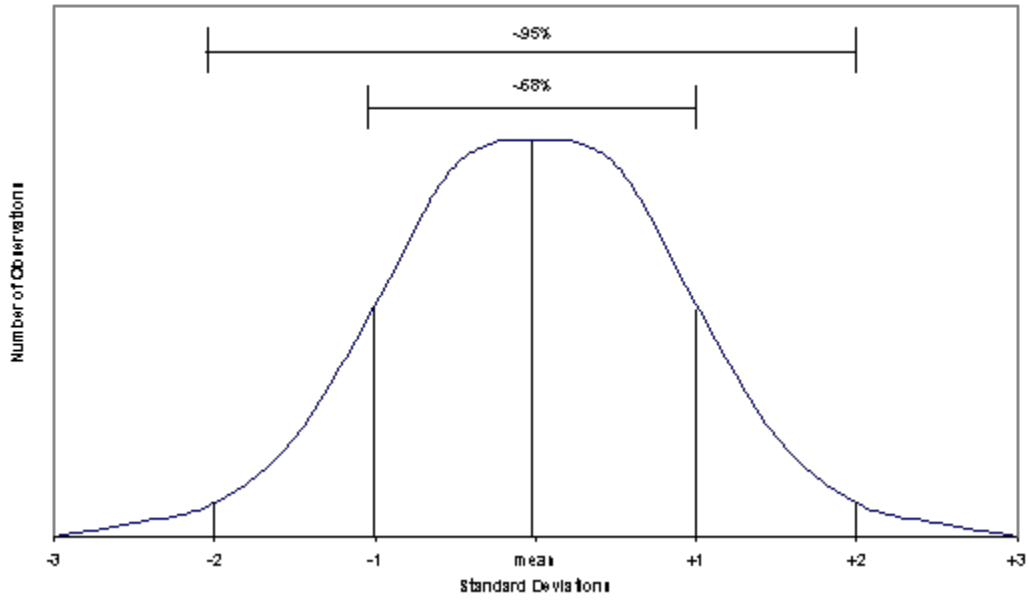

Figure 3-4. Relationship between Statistical Ranges and Probabilities

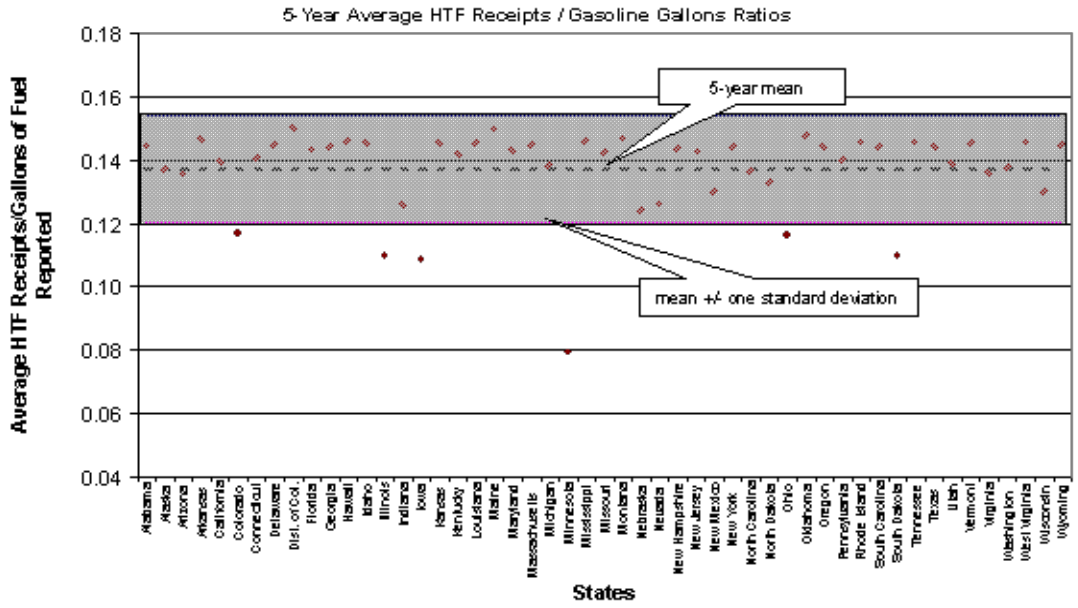

Figure 3-5. Statistical Range of Variation - 1997- 2001

3.4.3 Smart Input Tool

As noted earlier, the primary purpose of the Smart Input Tool is to improve data quality and reduce the risk of erroneous and incomplete data reported by the states, as well as to improve efficiency of the fuel tax data processing. The tool is also intended to simplify and standardize the process in which states report fuel tax data to the FHWA. The Smart Input Tool was implemented in spring 2002 and was made available to all the state departments responsible for reporting fuel to the FHWA. It is based on an MS Windows format and is compatible with the MS Excel application. It allows for seamless data entry and submission of the 551M Form. This software application also allows multiple users to access the state's forms electronically.

Fuel tax data can be entered in three different ways: (i) manually entered into each cell by viewing the form in a spreadsheet format, (ii) manually entered using the "wizard" view (in which the application takes the user through each entry), or (iii) automatically uploaded into the application by linking the form in the application to an existing Excel spreadsheet that already contains the state's fuel data.

The Smart Input Tool was evaluated in three different ways: (1) by comparing the new Smart Input Tool to the legacy system of state data submittal, (2) within the Smart Input Tool, by comparing manual data entry into the tool to entering data through the use of a template, and (3) evaluating the error checking feature within the tool. These assessments are described below.

3.4.3.1 Discussion of Smart Input Tool Evaluation

Smart Input Tool vs. Legacy System

The content (i.e., actual fields) in the Smart Input Tool were compared to the paper 551M Form used by the legacy system (revised 3-00, provided in Chapter 2 of the FHWA's "A Guide to Reporting Highway Statistics," which gives instructions to the states on how to fill out Form 551M). Care was taken to note any discrepancies between the two methods especially any missing data fields. It also avoids the need to manually transfer data reported by the states to the FHWA system for analysis. This transfer might introduce data entry errors. This is avoided with the use of the Smart Input Tool. The use of the Smart Input Tool more efficient than the legacy paper form of data capture for the fuel tax attribution process in the following ways:

- Reduces data entry errors because of the self-error checking feature. Furthermore, data are proofed prior to submission.
- Saves time and labor cost in data acquisition (i.e., inputting data on paper 551M Form), checking and reconciliation. The use of the toll also avoids the need to key in the data twice (once into the state's database and once into the 551M Form).
- Reduces paperwork.
- Data are electronically stored by state and FHWA thus facilitating revisions and updates if necessary.
- Electronic submission is in itself fast and efficient.

Manual Data Entry vs. Template Data Entry

The Smart Input Tool allows two methods of entering the state data: manually entering the data and using a template. Manually entering the data involves simply keying in the necessary information for each field. This can be done in the spreadsheet format or by using the "wizard." The template method involves setting up a spreadsheet - the "template" - with links (cell references) between the 551M Form and the state's own database spreadsheets. Once this template has been set up properly, it allows the data to be directly transferred from the state's database files into the 551M Form, eliminating the need to enter the data twice (i.e., once into the state's files and then once into the Smart Input Tool 551M Form). This template maps the data from the spreadsheet onto the Smart Input Tool 551M Form.

In order to evaluate the manual data entry process, sample data for Indiana , January 2000 was used. The manual data entry method used both the spreadsheet view and the wizard

view of Form 551M in the Smart Input Tool application. For the template data entry process, a template was setup to reference data from an Excel file that was created solely for this test, containing sample data for Indiana , January 2000.

The template option of data entry is the more effective method since it eliminates the need to enter the data twice. Though it may take some time initially to set up the cell references in the template file, it certainly saves time and effort. Overall, the process of creating the template file is fairly simple and straightforward. The program is user friendly. Moreover the feedback mechanism provided through the Community Exchange website enables users to see guidance whenever in doubt.

Error Checking

Perhaps the most beneficial feature of the application is its error-checking ability. A certain amount of simple and logical errors can be flagged by the software application before the form is electronically submitted to the FHWA. This saves time and effort by both the state and FHWA. This aspect was tested in both the manual method and template method of data entry into the Smart Input Tool by intentionally introducing errors. For example, illogical entries were intentionally introduced in the spreadsheet cells and incorrect links were set up in the template. Some fields (or links) were left blank, while other cell references were linked twice (i.e., multiple cells in the sample state spreadsheet were referred to the same Smart Input Tool 551M Form cell for their values). Errors such as these (that could commonly be made when manually entering data or creating cell references) were introduced in order to test how the program handles these mistakes.

There were several error-checking features observed during the testing of the Smart Input Tool. It should be noted that, depending on the method of data entry used (direct manual or use of a template), different types of errors are caught by the tool. For example, it was noted that when manually entering data into the Form 551M file, data could not be entered into those cells that calculate sums and differences. This reduces the risk of human error in these calculations. When using the template method of data entry, there are two steps that must be completed, (1) initially setting up the template file and (2) actually importing the data. Some of the automatic error-checking features associated with each of these steps are detailed below.

When creating references ("links") in the template file, the following error-checking features help to improve data quality:

- The Smart Input Tool program does not allow the user create a link to the shaded cells in the spreadsheet (e.g., those containing totals), which helps reduce calculation errors.

- The program does not allow any references to be entered other than those fitting the specified guidelines. This prevents errors such as referencing a cell as 28G instead of G28, entering the actual value instead of the link, and other errors of this nature.
- The program prevents the same link from being used in multiple cells in the same section of the template. The program alerts the user with an error message when this is attempted.
- Once a link has been assigned to a cell, the cell is highlighted yellow in the template file spreadsheet. This allows for an assessment of any missing links with a quick glance at the screen. It should be noted that this does not check for the correctness of the references made, only the completeness of the cell mapping.

When importing data from an Excel file into the Smart Input Tool Form 551 using a previously created template, the following program features reduce error:

- The program does not allow text to be entered for cells requiring numerical values. "ERROR" automatically appears in the actual cells in the 551 Form when this is done using the template references.
- When importing data, a window appears allowing the user to edit fields in the data files before they are imported. This allows for earlier error detection and resolution.
- State, month, and year of data cannot be linked to the Excel file, but must rather be picked from pull-down menus when prompted. This eliminates the error of incorrectly mapping the cell containing this information in the Excel file, but does not prevent the user from incorrectly selecting the data from these pull down menus, or from forgetting to hit the "Save changes" button before continuing on with the importing process.

Additionally, the program checks for errors after the data has been entered (either manually or imported using a template) into the Smart Input Tool Form 551. These are presented in a validations report, which can be viewed and printed, showing all of the cells that should be either modified or verified before submitting the file to the FHWA. Brief descriptions of what is incorrect about each cell follow the listing of each "problem" cell. This validation offers the opportunity to verify and confirm input data before submission.

3.4.3.2 Conclusions - Smart Input Tool

As noted earlier, the template method of data entry offered by the Smart Input Tool saves time and cost compared to the direct manual data entry. The error-checking feature also improves efficiency and reduces costs. Non-labor cost savings associated with the use of the tool stems from the fact that the data are submitted via the Internet, eliminating

communication charges (e.g., postal and fax). In terms of improvement in efficiency, the turnaround time for the data is improved with the implementation of the Smart Input Tool.

The self-error checking feature of the Smart Input Tool (i) reduces data entry errors, (ii) improves efficiency by eliminating double data entry; (iii) reduces the risk of incomplete and inaccurate input data; and (iv) reduces the time and effort required by both FHWA and the states to reconcile data.

The Smart Input Tool is a definite improvement over the legacy paper system of fuel tax data submittal. It is a major step toward the goal of improvements and standardization within the fuel attribution data reporting process, even though exceptions still will have to be made for states with varying and unusual circumstances, such as unique reporting time periods.

The Smart Input Tool's dependence on technology and the Internet also should be noted when considering the vulnerability of the system. Security measures and backup systems should be valued as necessary supplements to this new system (more so than was necessary in the old paper system). Finally, effective communication (or feedback) between the state agencies and the FHWA in an effort to continually improve upon this new system is essential in making (and keeping) this system a success. The Smart Input Tool community website ("Highway Community Exchange") is a step in the right direction.

3.4.3.3 Recommendations for Improvement - Smart Input Tool

While the input tool improves the efficiency of the data input process in comparison to the legacy system, the following are some improvements that would further enhance the efficiency of the tool:

- Shade those cells in the section "3. Gross Volume Taxed" that are not allowed to be mapped so that the user realizes that they are not supposed to be mapped. "Invalid Cell" and "Valid Cell" messages at the bottom of the "manage template" window do help to distinguish between these two types of cells. However, if the user chooses to enter the data manually, this window does not appear to aid in this distinction.
- Impose restrictions on the text that can be entered in the "Units" fields. This should be controlled so that only an "X" can be entered in *one* of the fields to select the appropriate unit of measure, or by some other method. The user currently can put an "X" in both the box for the gallons as the unit of measure and in the box for liters as the unit of measure. Errors are also possible when using the import feature, such as a mistake in the link assignment resulting in the text "liters" being entered into the "gallons" field, or vice versa. Any of these errors would cause it to be unclear as to whether the fuel data entered in the form were in liters or gallons.

- Allow the user to map a range of cells from its worksheet to the comments field template.
- Allow the user to be able to view the applicable comment when right clicking on the cell so that edits can be made to the comment in the text box that appears.
- Eliminate the following "bugs" encountered when using the "pick list" feature: (1) "Cancel" must be clicked twice in order to exit this option, and (2) the date cannot be deleted from the spreadsheet view - it is inconvenient (nor obvious to the novice user) to have to go to the wizard view in order to be able to delete the date.
- Consider extending the Smart Input Tool to include the 556 Form as well so that this part of the process's efficiency can be improved simultaneously.

3.4.4 Oversight Review

The primary objective of setting up oversights is to ensure that data reported by the states have been checked, verified, and certified prior to submission to FHWA. This reduces the time and effort required to reconcile the data where necessary and ensures that the data are of acceptable quality (accurate, complete, and timely). In evaluating the impact of the oversights, inferences were drawn from results of preliminary oversight reviews in 27 states. The oversights have not been fully implemented and functional in all states at the time of the evaluation. Therefore, the inferences presented below are indications based on limited information. It is likely that the real impacts might be different when the oversights are fully implemented in the future.

A primary role of the oversight is to ensure data are accurate and complete. In particular, changes in the state tax legislations must be taken into account and properly reported. Also, submitting completed data avoids the use of models to estimate missing data. The oversight is also intended to help reduce the time and effort required to reconcile data requirements from FHWA with what the states are able to provide.

In setting up the oversight review program, the states were initially given a limited amount of guidance on how to conduct the reviews. The guidelines were intentionally kept limited in order to get a better understanding of how each state would approach the task and also to facilitate more participation of the states in the actual review process. In other words, the states were involved in establishing how the reviews should be carried out. The guidelines were intended to help individual states develop and carry out detailed reviews of their own processes and participate in beneficial exchanges of ideas between the Division Office representatives and other involved state departments.

3.4.4.1 Observations from Preliminary Reviews

FHWA conducted a two-day workshop in December 2002 to evaluate the results of the preliminary oversight reviews, which were performed by seven Division Office representatives. In all, 27 state reviews were submitted to the FHWA in FY 2002. At the workshop, the reviews were compared and general suggestions on ways to improve the review process were discussed. These suggested improvements were used to develop a plan for improving the review process in the future.

It was found that every state that participated in the oversight review effort conducted their review differently. Some states just used the draft guidelines provided by the FHWA. Others went further and documented their data gathering process. Some states took the initiative to contact their state revenue departments in an effort to verify and confirm fuel revenue data as part of the data review effort. A few other states teamed so that they could assist each other in the review process. Thus, the level of detail and involvement as well as the methods of carrying out the reviews varied widely among the states.

3.4.4.2 Recommendations for Improvement - Oversight Reviews

The workshop participants generated recommendations for improving the review process. These recommendations are grouped into two categories. The first category relates to suggestions on how to improve the reviews performed at the state level. The second category relates to ways of improving the review of state-submitted data at the Federal level.

State-Level Reviews

- Consider setting up division teaming (peer exchange or review) resource centers to aid states unsure of how to effectively go about the review process, similar to the teaming of North Dakota and South Dakota when performing the review
- Address issues such as Native American tribal accounting in the review process
- Provide a paragraph for each cell in the 551M and 556M Forms regarding its derivation, as Massachusetts did in the preliminary oversight review
- Include a check of 551M against 556M Forms
- Investigate the last time the state tax department's motor fuel account was audited
- Include all involved state agencies in the review process

- Involve in the review process teams that are "cross-functional" or "multi-disciplinary"; i.e., both planning- and accounting-minded people and both Division Office representatives and state department representatives
- In addition to the documentation of the state data collection/reduction processes, include documentation of Smart Input Tool use (e.g., how the state's data was entered into the application)
- Include a self-evaluation of data quality, review effort, and recommendations for oversight process
- Identify Division Office representatives who could serve as mentors to other state Division Officers who are not as adept at the review process
- Consider using previous months' state data as reference when deriving the process documentation/mapping.

Federal-Level Reviews

- Establish top management support so that more Division Officers participate in the review process
- Highlight those state review processes that are seen as effective
- Reinforce getting the documentation/mapping of the state procedure (also known as the "benchmark") of data collection/reduction from each state
- Determine appropriate metrics to be used in state-to-state comparisons
- Use numerical ratings in a table of state reviews by state (instead of "checks") so that a state's year-to-year progress toward effective reviewing can be measured
- Improve the community of practice website for feedback
- Create a clearinghouse of all reviews so that one can determine the status of annual reviews submitted to the FHWA. This could be posted online and include a searchable database. States could check the status of their reviews as well as those of other states.
- Compile a CD or website showing a few examples of good reviews for other states to learn from
- Encourage review team to identify deficiencies, set improvement goals/time tables and then follow-up to measure success as part of the risk management process

- Send a memo from FHWA headquarters to the Division Office assessing the Division Office's performance in reviewing the state procedures.

It was concluded that the oversight review offer promise in addressing fuel tax data quality issues in the future.

3.5 Summary of Findings

The following are major findings of the evaluation presented by goal area.

3.5.1 System Performance / Efficiency

- The use of the Smart Input Tool greatly enhances the quality of fuel tax data by reducing the chances of input errors, improving efficiency of the attribution process, and saving cost and time associated with data entry at both state and Federal levels. Also, by improving the quality of data submitted by the states, the time and effort required to reconcile data discrepancies is reduced. The savings in turn improve efficiency of the fuel tax attribution process.
- As noted from the results of the statistical analysis, the analytical processes, particularly the assumptions, business rules, and estimation models, appear to be consistently applied and yield consistent HTF attributions. These findings suggest that the system is reliable in generating fair and consistent attributions based on the number of gallons reported by the states. A statistical measure for assessing reliability of the fuel tax attribution system was developed. The statistical measure reflects the quality and consistency of the state report data and the amounts attributed to the states.
- The value of the oversight reviews at the state level is determined by the improved quality of data submitted by states as well as savings in time and effort required to reconcile state-reported data with FHWA. While there was insufficient information to draw any definitive conclusions, available information indicates that the oversight review will potentially improve the quality of data (in terms of accuracy, completeness, and timeliness) submitted to FHWA and enhance efficiency of the fuel tax attribution system as a whole. The review process will potentially save the time and effort to reconcile state and FHWA data and reduce reliance on estimation models for imputing missing data.

3.5.2 Data Process Quality

- The process review documented the entire fuel tax data analysis process. The document clearly identified the assumptions and business rules applied in adjusting state reported data as well as the estimation models. The documentation, including the flow charts and figures, allows one to understand the sequences of calculations and flow of data elements and outputs. Such detailed level of documentation also offers transparency to facilitate identification of loopholes and implementation of improvements to various elements of the analytical process.
- The process review also offered suggestions to improve clarity in the instructions to states in reporting fuel tax data in Chapter 2 of *"Guidelines to Reporting Highway Statistics."*
- The statistical analysis showed that the analytical procedures generally generate consistent results of fund attribution that are highly dependent on the fuel consumption information reported. The results also support the hypotheses that the business rules and estimation models are consistently applied from year to year and that the data provided by the states are of acceptable quality.
- A statistical measure for assessing reliability of the fuel tax attribution system was developed. This measure allows outliers to be identified and investigated if necessary.
- Some variables used in the estimation models are outdated and/or no longer relevant. These models need to be reviewed and updated with more current data.

3.5.3 Risk Management

- The Smart Input Tool is structured so that states can provide feedback to FHWA, seek clarifications and guidance, offer suggestions for improvements, and offer comments. This is achieved through channels such as the "Highway Community Exchange" on the Smart Input Tool community web. This feature is consistent with standard practices of risk management. Moreover, implementation of the Smart Input Tool is a major improvement directed at reducing the risks associated with submitting incomplete and inaccurate fuel tax data. The use of the Smart Input Tool itself helps reduce the risk and the self-error checking feature helps control the risk to a large extent.
- The results of the statistical analysis show that analytical procedures appear to be reliable and consistently applied and that the amount of fuel consumption is highly correlated with the amount of funds attributed to the states. This implies that the

fund attributions are reasonably fair and consistent. Departures from the expected results can be easily identified and investigated in conformity with standard risk management procedures.

- Recommendations or suggestions for implementing oversight review include feedback mechanisms and interaction between the states and FHWA. This is consistent with standard risk management approaches that would help identify and correct problems efficiently.

3.5.4 Institutional Issues

No major institutional issues have been identified that could significantly impact the fuel tax attribution process. It was noted that the FHWA is implementing a number of changes, some of which are institutional in nature, to help improve the fuel tax attribution process. The possible institutional issues would be the role and relationships of the oversight reviewers and state fuel tax reporting agencies and the FHWA. Some institutional arrangements may be necessary to facilitate the operations of the oversight reviews. Also, with the introduction of the Smart Input Tool and the oversight, interaction between the state reporting agency and FHWA will be modified. These institutional changes are expected to promote efficiency in the fuel tax attribution process rather than impede the process.

Although not directly evaluated (due to lack of data) oversight reviews are expected to enhance interagency interaction at the state level so that data discrepancies and inconsistencies can be quickly resolved. It is anticipated that when oversights are fully implemented, communication among state agencies will improve and data acquisition and reconciliation will be expedited.

3.6 Action Items for Improving Fuel Tax Attribution Process

3.6.1 Introduction

The FHWA has initiated a series of actions as part of the continuous improvement model to address shortcomings of the fuel tax attribution process as well as actions directed specifically at improving and enhancing the process. The objectives of this project include identifying ways that would help FHWA to further improve the efficiency of the fuel tax attribution process. This section outlines potential actions that would further improve data quality and the attribution process.

It is acknowledged that the quality of fuel tax data reported by the states is a major controlling factor of the efficiency and efficacy of the fuel tax attribution process. In the

past, FHWA was responsible for cleaning up state reported fuel tax data and ensuring that the data used in the attribution process is of acceptable quality. Given that the state DOTs are the data providers, it seems logical that the state DOTs should take responsibility for the quality of fuel tax data submitted to the FHWA. Moreover, since the volume of fuel usage reported determines the HTF attributed, it is in the states' best interest to ensure that the quality of data submitted meets the acceptable standards. The current instructions for reporting fuel tax data stresses the need for providing accurate and timely information. However, the instructions do not include information on the risks associated with or the consequences and impacts of low quality fuel tax data on HTF attributions. Furthermore, the instructions do not suggest methods that states can use to assess the quality of the data they submit.

The term data quality is generally defined as the fitness of data for all purposes that require it. Data quality can be measured by several variables as defined below (Turner, 2003).

- **Accuracy** - The measure or degree of agreement between a data value or set of values and a source assumed to be correct. It is also defined as a qualitative assessment of freedom from error, with a high assessment corresponding to a small error.
- **Completeness** (also referred to as availability) - The degree to which data values are present in the attributes (e.g., number of gallons by fuel type) that require them.
- **Validity** - The degree to which data values satisfy acceptance requirements of the validation criteria or fall within the respective domain of acceptable values.
- **Timeliness** - The degree to which data values or a set of values are provided at the time required or specified.
- **Coverage** - The degree to which data values in a sample accurately represent the whole of that which is to be measured.
- **Usability** (also referred to as accessibility) - The relative ease with which data can be retrieved and manipulated by data consumers to meet their needs.

All these quality measures are applicable to fuel tax data. Improving the efficiency and efficacy of the fuel tax attribution process can be approached from two angles. First, identify and implement measures to ensure that high quality fuel tax data are reported by the states. This is addressed in Sections 3.6.2, 3.6.3, 3.6.4, and 3.6.5 below. Second, review and enhance the analytical procedures used in the fuel tax attribution process. This is addressed in Sections 3.6.5, 3.6.7, and 3.6.8 below. These two sets of actions are interrelated. With this background, the following sections describe potential actions that

can be implemented to improve the quality of state reported fuel tax data and the efficiency of the attribution process.

3.6.2 Structured Instructions Manual

Currently, the instructions to states on reporting fuel tax data are presented in Chapter 2 of *"Guide to Reporting Highway Statistics."* This document contains other fuel tax related information. A review of the instructions reveals that the instructions are, in general, clear, but less explicit in a few instances. Given the importance of these instructions in gathering high quality fuel tax data and also noting the differences in state tax structures and specific circumstances, the following measures are proposed:

The instructions should be developed as a stand-alone *Instructions Manual*. The instructions and steps in the manual should be explicit and void of ambiguities.

The instruction manual should be divided into four main sections as follows.

1. The first section of the manual should emphasize the importance of reporting accurate and complete data in a timely fashion. The impacts of poor quality data on the attribution process and how it reflects on the HTF attributed to the states should be stressed. This section should also explain the need for and the effects of data adjustments by FHWA as well as the business rules employed in the attribution process.
2. The second section, the main focus of the manual, should provide detailed instructions and steps for reporting the general fuel tax data items that apply to all states regardless of differences in state the tax structures and exemptions.
3. The third section should provide instructions and steps customized for individual states or groups of states with similar circumstances. For example, states that fully refund Native American diesel gallons should be in the same group with a set of instructions on how to report such data. Customizing the instructions is expected to reduce uncertainties and guesswork on the part of the state officials. Customizing the instructions this way will also improve consistency and uniformity in data reporting.
4. The fourth section should provide guidelines on use of tools and resources available for reporting and evaluating fuel tax data. These include data assessment tools, mentoring program, Information Exchange website as well as FHWA contact numbers.

It is believed that an instructional manual in a structured format as outlined above should address the shortcomings of the current Chapter 2 of *"Guide to Reporting Highway Statistics"* and consequently improve the quality of fuel tax data reporting.

3.6.3 Data Assessment at State Level

It is proposed that, by having the states perform data quality checks on their own data prior to submittal, would expedite the data analysis process by FHWA. The first step in implementing this proposal is to develop an assessment tool that the states can use to compare the state's current year's data with the average of the previous five years for that state. It is envisaged that such an assessment tool should be a statistical model similar to that described in Section 3.4.2 of this report. With this tool, states will be responsible for evaluating their own data, addressing any unexpected results, and either correcting any mistakes that have caused these unexpected results or determining a cause for the change in the data from previous years. Guidelines for using the assessment tool should be included in Section 4 of the *Instructions Manual* outlined above. In addition, the results of the assessment should be submitted with the data to FHWA as proof that states perform these assessments.

3.6.4 Information Exchange Website/Clearinghouse

It is proposed that the FHWA use the existing Highway Community Exchange or similar website to provide guidance, address questions, and post "good examples" of accurate and complete fuel tax data submittals from states. This would serve as a "help" site for states having difficulty using the Smart Input Tool and other tools and resources for data assessment and reporting. Such a website should also serve as a forum for expressing suggestions to improve the data reporting and fuel tax attribution process.

Furthermore, it is important that states are made aware of the value of good quality fuel tax data. Therefore, knowledge of the potential effects of poor quality data on HTF attributions could be a motivating factor for the states to report the highest quality data to FHWA. It is recognized that FHWA currently performs sensitivity analyses a means of quality control. It is recommended that FHWA continues to conduct these periodic sensitive analyses and to publish the results on the Information Exchange website. The published results should be anonymous (i.e., states whose data are used in the analyses should not be identified). The primary purpose of publishing the results is to serve as examples to illustrate the effects of poor quality data and to assist states that have consistent data quality problems.

This website would also provide the channel for feedback from the states that should guide continuous improvement of the Smart Input Tool, oversight program, and other tools designed to improve the fuel tax attribution process.

3.6.5 Mentoring Program

States that consistently provide good quality data could serve as mentors to other states that have difficulty submitting good quality data. Differences in state tax structures and other legislative requirements are recognized. Nonetheless, it is believed that sharing experiences through a mentoring program should help address some of the major issues associated with fuel tax data quality. The mentoring program complements the Information Exchange website by offering a more direct and interactive assistance to states needing help. FHWA should, through use of the oversight program, establish and monitor the mentoring program.

3.6.6 Updates and Enhancements to Estimation Models

The estimation models are critical to the attribution process. Preliminary review of the models indicated that the input variables for some of the models and modules are dated and/or their underlying assumptions are no longer valid. For example, Table 3-3 shows some estimation modules and remarks regarding the currency of data used in developing them as well as their limitations.

Table 3-3. Summary of Limitations of Some Estimation Models Evaluation Approaches Addressing Goal Areas

Model	Remarks
Non-Highway model	
• Agriculture module	• Developed in 1994 with limited data • Assumes no gasohol use for farm equipment • Uses information from *Farm Production Expenditure* summary last updated 1991 • Gasoline consumption not included for: specialty equipment; power and light generators; stationary power equipment
• Aviation Module	• Gasoline consumption not included for: ground support aviation equipment

• Construction Module	• Gasoline consumption not included for: mixers; cranes; power and light generators
• Industrial/Commercial Module	• Gasoline consumption not included for: scrubbers, sweepers, material handling equipment - lack of data
• Marine Module (Boat)	• Assumes no gasohol use • Uses 1991 National Recreational Boat Survey data • Fuel practices (fuel station vs. pier/dock)
• Recreational Module	• Fuel consumption not included for: lawn mowers, snow blowers, chain saws - lack of data • Misleading vehicle registration data
• Public Use model	• Model based on fuel use by vehicle class but data is now reported by fuel type • Federal civilians fuel use estimation method based on 1992 study • State, county, and municipal government fuel use estimated as a function of land area and based on 1994 data

It is important to conduct in depth reviews of these models to determine areas requiring updates and enhancements. Improving the models should in turn improve the reliability of the estimations and outputs from the attribution process. In addition, FHWA should periodically evaluate the models as part of the continuous improvement model. This periodic evaluation allows for specific weaknesses in the models (and modules) to be quickly identified and corrected.

3.6.7 Enhancement of Analytical Framework

Good quality data has little value if the analytical procedures have shortcomings. Elements of the analytical procedures of particular interest include:

- Assumptions and Business Rules

- EVAL Analysis
- GTA Revenue Analysis
- Use/User Analysis.

It is important to review and enhance these procedures where necessary because improved data quality from the states and updated estimation models may impact certain steps in these procedures. Some steps, assumptions, and business rules were necessary to compensate for poor quality data. As data quality improves, some of the analytical steps, assumptions, and business rules may become redundant or obsolete. These rules and assumptions should be revisited to determine their need, validity, and utility in the fuel tax attribution process. For example, as a rule in the EVAL analysis, the process is considered complete if the estimated gallon receipts are within a plus or minus five percent of the reported receipts. The five percent threshold value may be revised as quality of data reported by the states improves. Similarly in the Use/User Analysis, a business rule is used in deciding what value to use if the state reported value differs from FHWA's estimates. Business rules such as this may not be necessary once the quality of state reported data improves to a level that there is increased confidence its use.

3.6.8 Continuous Reviews

FHWA currently employs a continuous improvement model directed at improving the quality of its products and services. In order to evaluate the impacts of changes implemented as part of the continuous improvement model, it is important that FHWA monitors the effectiveness of changes through periodic or continuous reviews of the changes implemented. This monitoring effort will involve data collection and analysis. Some of the data would include the frequency of errors in reported fuel tax data, the number of states using the Smart Input Tool, the number of states reporting poor quality data, and the convergence of state reported data and estimated data from models. To facilitate the evaluation process and ensure that improvements actions are systematically implemented and monitored, it is important FHWA sets up a system or framework for the data collection and analysis required for the reviews. Such a framework would also serve as a reference guide that allows FHWA to monitor its continuous improvement efforts and also ensure that improvements are consistently implemented.

Results of these reviews would be useful in revising guidelines and rules as well as implementing new changes. It is also suggested that FHWA shares the results of the evaluation with the states on a periodic basis.

4.1 Conclusions

The improvements being implemented by FHWA as part of the continuous improvement model have significant positive impacts on the fuel tax attribution process. These impacts include standardizing and streamlining the data reporting by the states to reduce risk associated with poor quality data. For example, the use of the Smart Input Tool for collecting fuel tax data from the states improves the quality of data (fewer errors, more complete, and timely), saves time and costs, and reduces the risks associated with inaccurate and incomplete data. These improvements greatly enhance the quality and reliability of the entire fuel tax attribution process. A procedure for assessing reliability and consistency of the analytical process was developed based on the stability of the ratios of the attributions to fuel consumption. The use of simple regression analysis and statistical ranges to assess consistency and reliability of the attribution process is suggested.

It can be concluded from the evaluation results that the analytical procedures are fairly reliable in generating consistent HTF attributions to the states.

4.2 Recommendations

The following are recommendations to help improve the fuel tax data attribution process:

- Conduct periodic evaluations. This evaluation was conducted at a time when the full effects of some of the changes being implemented have not been felt (e.g., Smart Input Tool). In addition, some improvements have not been fully implemented (e.g., oversight). Thus, the initial indications of the impacts may not be the same in the long term. It is, therefore, recommended that as part of the continuous improvement model, periodic evaluations be conducted to assess the success of the improvements, identify shortcomings, and design corrective measures. It is only when the problems have been identified that policies and practices can be implemented and/or modified to address them. This approach is consistent with standard risk management procedures.
- Convert the spreadsheets into a simple model. The analysis procedures are currently in a number of spreadsheets that are linked. While the use of spreadsheets provides transparency in the analytical procedure, it can sometimes be cumbersome to execute.
- Action items for further improvements: It is recommended that several actions identified to further improve the fuel tax attribution process be reviewed and implemented. These include:

- Development of a structured stand-alone *Instructions Manual* devoted to providing specific guidance on reporting fuel tax data.
- Introduction of data assessment process tool that enables states to assess the quality of their own prior to submission to FHWA.
- Use Information Exchange website to address issues related to fuel tax data and also serve as a feedback mechanism.
- Establishment of mentoring program to assist states that experience consistent data quality problems.
- Review, enhance, and update of estimation models. Data and assumptions used in developing some of the original models need to be reviewed to determine their validity.
- Enhancement of analytical framework including EVAL, GTA, MF-20 analyses to adapt to improvements in quality of fuel tax data and estimation models.
- Development of a framework for systematic monitoring and evaluation of FHWA's continuous improvement programs.

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Attribution Paper

ATTRIBUTION PAPER

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CAVEAT: One of the primary purposes of this paper is to assist the FHWA staff who manage the attribution process to understand all the issues under the topic. Several of the issues addressed are outside the box of traditional attribution practices. An understanding of what those issues are, and why they have been handled as they have, is essential knowledge for those who deal with attribution in great depth. This document does not stand as a description of the current attribution process, and is not advocating any changes to the current procedures.

Introduction

Since FY 1984, motor fuel data has been used in the apportionment of Federal-aid highway funds. State-reported highway use of motor fuel is used to attribute Highway Trust Fund tax payments to highway users and commercial vehicle contributions to highway users in each state.

Think of a pie as a simple analogy to illustrate the attribution procedure. Highway Trust Fund tax payments, as reported by the Department of Treasury, determine the size of the pie of each motor fuel type (gasoline, gasohol, special fuels -- meaning diesel and special fuels), and the gallons on-highway use of each motor fuel type consumed in a state determine that state's slice of the appropriate pie. As special cases, the Federal tire tax, truck tractor and trailer retail excise tax, and the heavy vehicle use tax revenues are also reported by Treasury, which determines the size of those pies, and each state's slice of those pies is based on gallons of special fuels.

Internal Revenue Service (IRS) data provides the tax payment amounts, but IRS does not track where or how the fuel is consumed. The Federal tax collection is too high up the distribution chain to identify ultimate place or type of use. Therefore, the attribution process uses state reported motor fuel tax revenue data to determine highway use of motor fuels. FHWA also uses statistical methods to estimate missing or not-reported state data.

Under the Transportation Equity Act for the 21st Century (Public Law 105-178) (TEA-21), motor fuel data are used in the apportionment of Federal Surface Transportation Program (STP) funds, National Highway System (NHS) funds, Interstate Maintenance (IM) funds, and the Minimum Guarantee. The following shows the use of these factors in FY 1999.

- Highway Trust Fund payments to the Highway Account are used as a 35 percent factor for distributing about $4.9 billion in FY 1999 STP funds.
- Diesel fuel used on highways is used as a 30 percent factor for distributing about $4.6 billion in FY 1999 NHS funds. Unlike the other bullets listed here, this factor uses gallons, not dollars, as the measurement unit.
- Commercial vehicle contributions to the Highway Account are used as a 33.3 percent factor for distributing about $3.6 billion in FY 1999 IM funds.
- The Minimum Guarantee, under which each state is guaranteed that its share of apportionments and highway priority projects will be at least 90.5 percent of its share of attributed contributions to the Highway Account of the Highway Trust Fund, and is estimated to be about $5.7 billion in FY 1999.

Since the Surface Transportation Assistance Act of 1982 (STAA), Congress has expressed desires to manage the cross-subsidy between states (the donor-donee problem). With certain states (called donee states) receiving more in highway Federal-aid than they contributed in payments to the Highway Trust Fund (HTF), pressure from the states who contribute more than they receive (donor states) has culminated in congressional mandates to limit the Federal cross subsidy. Some of the programs to implement this policy include:

- Minimum Allocation (STAA of 1982);
- 90 Percent of Payments (ISTEA);
- Donor State Bonus (ISTEA); and
- Minimum Guarantee (TEA-21).

Objective

Recognizing the increasing importance of accurate, timely reporting of motor fuel and related attribution data in determining state-funding shares, FHWA is reviewing the motor fuel data reporting system used to collect this information. As part of the review process, FHWA is evaluating the attribution process to determine the continued quality of its attribution methodology and to identify areas where improvements can be made.

While FHWA believes it is identifying and appropriately dealing with the vast majority of attribution issues, the primary purpose of this paper is to identify those issues that need to be better addressed, and possibly streamline the attribution process by eliminating issues that have been addressed, but do not warrant the continued effort involved in collecting and analyzing the data for attribution purposes.

Background

It is a surprise to many that the state-by-state contributions to the HTF are not available from the IRS. The Federal fuel taxes, which make up more than 80 percent of the HTF's receipts, are imposed when the fuel is first removed from bulk storage and the tax is paid by the seller. Thus, the typical Federal fuel taxpayer is an oil company. While paid initially by a company, the costs of these taxes become part of the purchase price of the products and are ultimately paid by the highway user. The heavy vehicle-use tax is the only Federal highway-user tax paid directly to the IRS by the vehicle owner, and even then, the return captures only the business address of the owner, not the state or states where the vehicle is operated. Using oil company tax data would only cause problems in attribution because the state in which the motor fuel tax is paid does not reflect where it will be shipped, stored, or - of particular interest in the attribution process - used.

As Federal tax records do not yield the desired information, FHWA estimates the HTF contributions from highway users by looking at tax revenue data in each state. The method for attributing Trust Fund receipts to each state has changed over time, with the last changes made in 1985. A data series, collected from the states by Federal government, on motor fuel use on and off the highway goes all the way back to 1919. FHWA first started making the state HTF payment estimates based on motor fuel data in the early 1970's, in response to general interest in donor-donee issues. With the passage of the Surface Transportation Assistance Act of 1982, the attribution of HTF receipts became a factor in calculating the 85-percent minimum allocation. FHWA solicited comments from the states on its attribution methodology, and modified the methodology to reflect the concerns of the states and the Congress that the attribution employ use-based factors. The resulting methodology, first used to attribute fiscal year 1984 Trust Fund receipts, was published in the *Federal Register* on June 21, 1985 . These procedures have been in use since that time.

The Department of the Treasury reports the tax receipts deposited in the HTF for each tax type. The net receipts, after refunds and transfers, are the contributions to the HTF that are attributed to the highway users in each state. The basic premise is that the Federal motor fuel tax receipts (by fuel type) to the Highway Account are received from each state in proportion to the highway use of that fuel type in each state compared to the total use in all states.

Commercial vehicle contributions -- the diesel fuel tax, truck tire tax, truck and trailer retail sales tax, and the heavy vehicle use tax -- are attributed to the states using highway use of diesel and special fuels (special fuels are very small amounts). This method is considered to be the best available proxy for truck use in each state, and was formalized in the *Federal Register Notice* of June 21, 1985 .

The attribution analysis is basically a process of determining a state's on-highway motor fuel use from state tax data by looking at any given set (in the mathematical sense of set) of motor fuel data, and determining if it is an on-highway use. Typically, state revenue departments have data on motor fuels that are exempted, refunded, or taxed at other rates. From this kind of data, FHWA may be able to identify the use of the fuel and therefore its place in attribution. In many cases, this data does not exist at the state level and FHWA estimates usage from other sources. When FHWA estimates and state's data are both available, a choice must be made about the relative quality of the data, and one or the other is selected.

Historic Attribution Approaches

Historically, there have been two basic methodologies or approaches which have been considered as attribution options. One approach is based on gallons of motor fuel, and the other is based on vehicles miles traveled (VMT). Truck registration data was once used to attribute truck taxes, but was found to inaccurately reflect truck on-highway usage. The June 21, 1985, FHWA *Federal Register Notice* last examined attribution policy, and determined that motor fuel should be the attribution measure. In the time context of the 1985 *Notice*, the emphasis was on attributing the newly imposed and increased truck taxes, and therefore the VMT method received significant consideration. While FHWA continues to pursue improving both motor fuel and VMT reporting, the VMT methodology does not provide the accuracy and veracity that the motor fuel methodology does. It is worthwhile, however, to briefly review both methods.

Advantages and disadvantages of these approaches for attribution purposes

- Accuracy of data:
    - VMT is an estimate and truck VMT is especially subject to uncertainty
    - State motor fuel data are capable of being double-checked thru audits
- Ease/cost of collection
    - Estimated data are cheaper to produce, especially if little data collection is used in the estimation process.
    - States are already collecting motor fuel tax data for their own purposes (though not always in the form FHWA requires).
    - Diesel fuel used in interstate commerce is taxed under International Fuel Tax Agreement (IFTA), which was a procedure not in place in 1985 when attribution policy was last addressed. IFTA is discussed further below.

Interstate motor-carrier fuel use is treated differently from other fuel categories. The intent is to tax major interstate fuel users (typically motor carriers), on the basis of the quantity of fuel used within the state rather than on the basis of fuel purchased in the state. While most of the motor fuel is diesel, gasoline and special fuels are reported. Almost all states and Canadian provinces now use IFTA provisions for taxing motor fuel used by interstate motor carriers in place of Interstate Motor Carrier (IMC) taxation. At least on the interstate level (leaving out intra-state diesel fuel usage, which is captured under normal state reporting,) state use of the IFTA taxation procedure addresses the place of use instead of place of purchase. A problem with IFTA data however, is the reporting lag. IFTA processing takes place on a quarterly basis and a state does not know its IFTA net tax revenue until five to six months after tax liability occurs. Current FHWA guidance asked for state data within sixty days of the end of the reporting month.

FHWA concludes that highway use based on motor fuel data and identified by state tax data or estimated by FHWA continues to be the better approach to attribution. This conclusion is based on three primary facts:

- The current reliance on motor fuel data by the Congress (initiated in the policy guidance of 1985, and confirmed in three subsequent reauthorization bills;
- The general agreement of the states and related organizations (such as the American Association of State Highway and Transportation Officials (AASHTO) that the attribution process an acceptable methodology; and
- The factual basis for motor fuel accounting (versus estimation of VMT).

A Closer Look at Current Legislation

The existing attribution process is not in precise agreement with the language of the TEA-21 legislation. On close inspection, the following discrepancies are revealed:

TEA-21 directs that the Surface Transportation Program (STP) be apportioned with "35 percent of the apportionment in the ratio that the estimated tax payments attributable to highway users in all states paid into the Highway Trust Fund (other than the Mass Transit Account) in the fiscal year for which data are available." Note that it is based on the state's share of tax payments by highway users, which should exclude Federally tax exempt public vehicles using either gas or diesel motor fuels, as these vehicles do not pay a Federal highway tax. Under current motor fuel reporting procedures, gallons of diesel fuel powering public vehicles should not be included, but in reality many states cannot report this use separately. In contrast, gallons of gasoline used to power public vehicle is also not Federally taxed, but it is either reported by the state or is estimated by FHWA models and is

subtracted from total gasoline volume reported, and therefore is treated appropriately in attribution methodology.

TEA-21 directs that 33.3 percent of the Interstate Maintenance Program be apportioned "in the ratio that the of each state's annual contributions to the Highway Trust Fund (other than the Mass Transit Account) attributable to commercial vehicles." Note that commercial vehicles do not include public vehicles. Therefore, in Interstate Maintenance apportionments, gallons of motor fuel used in public vehicles should be excluded from attribution. As above, gallons of diesel fuel may not be reported properly, but gallons of gasoline are either reported or estimated.

TEA-21 directs that the National Highway System component should be apportioned as follows: "30 percent in the ratio that total diesel fuel used on highways in each state bears to the total diesel fuel used on highways in all states." Note that this language does include Federal, state, county and municipal diesel, and that it does not include LPG. Current motor fuel reporting procedures do not ask for public use of diesel (but it is included in some state's data), and attribution procedures therefore do not currently distribute public diesel correctly. Attribution procedures also currently include LPG fuels. Furthermore, notice that the apportionment depends on each state's share of gallons of diesel fuel directly, not Federal tax dollars as apportioned by each state's share of diesel motor fuel. This last point is taken into account in the current attribution process.

Internal FHWA discussion only: how important is it that FHWA follow the letter of the law in this situation, or how important is it that FHWA not change attribution procedures to maintain a continuous data series, or to avoid criticism from states hurt by the changes. Is there any reason that the information provided is more accurate under existing procedures than by procedures that could be developed to meet Congressional language.

Discussion of the Ideal Attribution

Ideally, the FHWA should be asking the following questions in connection with determining attribution of motor fuel:

- Is the unit of fuel in question consumed in the process of propelling a vehicle on a public highway system in the United States ?
- What type of fuel was taxed (based on Federal definitions of the fuel in question).
- If no Federal tax was paid on the unit of fuel used to propel a vehicle on a highway, for what purpose was the motor fuel consumed?
- In what geographical location (state) was the highway on which the unit of fuel was consumed.

The astute reader will immediately begin to ask questions. What about electric vehicles and motor fuels not measured in gallon units? What about motor fuels which are not currently paying any highway tax? How come some highway uses of motor fuel are not included for attribution? And what about the problem of fuel purchased tax-paid in one state, and then consumed on highways in another state? The purpose of this paper is to raise these issues, recognizing that some of them have not been answered in any definitive way.

Where Existing Attribution Procedures Do Not Meet the Ideal

The proceeding sections have discussed attribution methodologies. In the actual world, a perfect attribution procedure cannot and will not be achieved. However, serious effort can be made to identify the significant attribution shortcomings and to analyze the potential to achieve second-best solutions, or some form of satisfactory solution. Several principals should be considered:

- Equity among states, and (as a corollary issue) does data inaccuracy create biases between certain states. (Equity can be defined as treating entities with certain characteristics or parameters alike.)
- Accuracy of reported data.
- Accuracy of estimated data (either by states using unrelated, individual estimation methodologies, or by consistent, single-source estimation procedures run by each state or run by FHWA for all states)
- Size of the inaccuracy. Small inaccuracies may not be worth the cost to resolve. Careful analysis of the costs and benefits of the additional data collection is needed.
- Other

The above points should be considered when analyzing and discussing the following individual issues. The following discussion is grouped into two categories:

- Institutional - management or intergovernmental issues
- Methodological - data collection and analysis issues

Some of the reasons the ideal is un-achievable include:

Institutional

- Because of the need to combat tax evasion, Federal and state legislation is pushing tax payment up the motor fuel distribution chain to the wholesaler or distributor

with the objective of having fewer taxpayers to track. And this is good tax policy. But for attribution purposes, direct highway user taxation at the retail, or use, level would provide the best data for attribution.

- What was meant precisely when Congress passed the legislative language on attribution, and how has this translated into actual practice? Section 157 of the STAA of 1982 defines the Minimum Allocation as: ". . . . shall not be less than 85 per centum of the percentage of estimated tax payments attributable to highway users in that state paid into the Highway Trust Fund, other than the Mass Transit Account, in the latest fiscal year in which data are available." The *Federal Register* Notice of 1985 describes attribution with gallons of highway motor fuel use as the attribution weighting factor: " . . . . . Federal motor fuel receipts to the Highway Account of the Highway Trust Fund are received from each state in proportion to the use of gallons of motor fuel in each state compared to the total highway use of gallons of motor fuel in all states." FHWA documents leading up to the *Federal Register* Notice describe how the decision was made to attribute based on highway use, and how this was coordinated with Congressional staff.
- Federal government definition issues: for example, the Interstate Maintenance Program is 33 percent based on commercial vehicle contributions to the highway account, while the National Highway System Program is 30 percent based on highway use of diesel. FHWA guidance asks states to provide private and commercial use of diesel fuel - this should not include motor fuel consumed by government diesel highway vehicles (which should be included in highway use of diesel.) However, many states cannot split out government uses from private and commercial diesel. The final result of all this is FHWA cannot accurately attribute either commercial vehicle use, or highway use of diesel.
- Cross border transfer of fuel in the tank connected to the vehicle's propulsion motor. This issue is largely a gasoline matter as diesel fuel taxes are more directed at place of use. States don't pursue cross-border taxation due to the way the Interstate Commerce Clause of the U.S. Constitution has been interpreted by the courts. Several states have legislative language that also directs them to ignore propulsion-tank transport of motor fuel.

Methodological

- Federal/state tax legislation asymmetry. As discussed earlier, the way motor fuel is taxed in each state is different from every other state and from the Federal motor fuel tax. A good example of this is gasohol: the Federal government defines three

gasohol types (5.7 to 7.7 percent gasohol, 7.7 to less than 10 percent gasohol, and 10 percent or greater gasohol). None of the states report these three levels, only one state recognizes three types, and only a few recognize two types of gasohol. For this and other reasons, FHWA estimates gasohol for use in attribution. In general, for accurate attribution, each state's data must be analyzed and gallons of motor fuel adjusted to meet FHWA's criteria of on-highway motor fuel use. Adjusting state data to meet standard criteria creates equity among the states in the use of motor fuel data in attribution.

- The inability of state motor fuel tax reporting to capture data required to meet Federal needs. For example, state and local motor fuel is Federally tax exempt, but most states do not capture data that identifies these gallons. In these cases, it has been FHWA's policy to include these gallons for attribution since they were consumed on the highway, even though they did not pay the Federal tax.
- Attributing Federal non-gallon based taxes (the truck and trailer excise, tire excise, and heavy vehicle use taxes) using special fuels gallon data as a proxy.
- Refunds non-highway consumers are entitled to but do not apply for (or exemptions not taken) which will be (but shouldn't be) included as highway use.
- Reporting of the value of assessments (without penalty amounts added in) converted to gallons of motor fuel, captures motor fuel used in a state in the past, not the current reporting period.
- Several states collect fees from the sale of decals in lieu of per unit taxes for highway use of fuels not normally considered as highway fuels (alternative fuel decals are a prime example). While these fees are very poor measures of highway use of these types of fuels, the states that utilize non-distance based decals currently do not get any credit for these highway uses which do pay the Federal motor fuel tax.
- Using the measure of gallons of motor fuel for attribution creates a potential problem as several alternative fuels are not unitized in gallons. Most of these fuels can be treated uniformly by using mandated or scientifically known conversion rates, and therefore they must be adjusted before use in attribution. Furthermore, it may be impossible to separate these fuels for use in attribution at this time, since it is typical that both revenue and unit data are combined with the diesel fuel to create a special fuels category. Furthermore, the use of these fuels is so small that it may not be cost effective to pursue corrections unless the uses of these fuels becomes a larger portion of total highway uses.

How to Deal with Insufficient Data

Assuming FHWA chooses attribution on the basis of where the tax is paid and using motor fuel gallon data, then the question is how to deal with data not available or not of sufficient quality to use for attribution. The options include:

- FHWA estimation of the data using a single methodology;
- FHWA acceptance of state estimation of the data using one standard methodology;
- FHWA acceptance of state estimation by one of several pre-approved methodologies (sometimes called best practices);
- FHWA acceptance of as state's proposed estimation procedures;
- FHWA acceptance of a recommendation from a peer group of states that a state's estimation procedures are acceptable; or
- make a determination to not take any action, and therefore not to use in attribution.

The data on state's ability to track any of the following information came primarily from the Re-assessment survey completed May 1999. Other sources occasionally provided additional data.

Currently FHWA estimates:

- three grades of gasohol (about 32 states have good data on 10 percent gasohol);
- public uses of gasoline (Federal--which 18 states can track, state--which 10 can track, local--which seven can track, and public school--which five can track);
- off-highway uses of gasoline (generally, states do track these) including:
    - aviation;
    - marine;
    - agriculture;
    - construction;
    - industrial and commercial;
- off highway recreational use of gasoline (most states don't track this).

Currently we do not estimate (which means they are assumed to be zero unless a state reports data in accordance with FHWA's *Guide to Reporting Highway Statistics*):

- public uses of non-IFTA diesel (Federal--which 11 states can track, state--which nine can track, local--which seven can track, and public school--which six can track);
- neat (85 percent) alcohols: M85, E85 (three states can track these);
- other alternative fuels, in some unit other than gallons: liquefied petroleum gas (LPG)--18 states can track, liquefied natural gas (LNG)--eight states can track, compressed natural gas (CNG)--13 states can track, kerosene-five states can track;
- electric vehicles;
- travel by decal-registered alternative fuel vehicles (20 states have this form of tax).

Currently FHWA makes some determinations (recognizing our determination are sometimes arbitrary, and largely based on attempting to be consistent across all states):

- gasoline loss allowances -- percentage losses to be capped at 1 percent. The reason for capping this number at one percent is FHWA's belief that the fuel is not actually lost, but is consumed on the highways. States typically use this mechanism for reimbursing taxpayers for administrative costs of paying the tax, and the fuel is not lost. Actual losses, however, are considered to be real losses and are treated as non-highway gallons in attribution. (30 states have no allowances, 10 have a specific percent amount, and four report actual losses.)
- deletes from state-reported diesel data: refunds, exemptions, and other identifiable non-highway and public diesel uses. (Six states can identify private uses, seven can identify commercial uses, six can identify Federal uses, five can identify state uses, five can identify local uses, and three can identify school uses of diesel.)

Issues Under Non-estimation

Not estimating a number means that zero is the estimate. In fact, a bias is most likely introduced in these cases. How big a problem is this?

Conclusions

Initial thoughts on conclusions:

FHWA will probably continue to use gallons of motor fuel reported by states as the proxy for on-highway use, developing estimates where needed and including highway uses where states cannot separate out uses (like state and local gasoline and diesel, and public use of diesel.)

Under the re-assessment process FHWA has been conducting, the following general findings summarizes FHWA position at this point. (January, 2000)

FHWA believes the current attribution is sound:

- the principals on which attribution are based are sound;
- the procedures and processes are sound; and
- decisions need to be made on the need to meet Congressional language on the inclusion or exclusion of public vehicles by program, and the distinction between diesel and special fuels.

Improvements in data are needed:

- improved uniformity
- improved accuracy
- improved consistency

Improvements in documentation are needed:

- revised *Guide*
- attribution description
- IFTA reporting description
- FHWA models and analyses documentation.

Reporting Problem Areas

The two biggest barriers to better reporting for almost all states are:

- Public use of diesel, which is inadequate, in the sense that most states cannot identify public uses separately, and inconsistent, in that those state that can separate it are disadvantaged.
- IFTA, which needs better procedures for report timing, in that most states collect the data quarterly, and that it takes longer for states to administrate the IFTA procedures than the procedures IFTA replaced, and accuracy, while we are not sure why, many states data reveals falling revenues when economic indicators would support opposite conclusions.

Barriers to More Equitable Attribution - Gasoline/gasohol

- Treatment of gasoline flat % loss allowances

- State/Federal mismatch of gasohol definitions
- General improvement/refinement of the gasohol model
- Native American unreported gasoline

Barriers to More Equitable Attribution - Special Fuels

- Inability to report public use of diesel separately/Inclusion of public diesel in gross volume reported
- Native American unreported diesel
- Special fuels not adequately reported
- Unit conversions for special fuels (energy equivalents and non-gallons units)
- Method of taxation (decals fees in lieu of per unit taxes)
- Significance (many special fuels are currently insignificant compared to total motor fuel volume)

Proposed Improvements

- Develop model to estimate public use of diesel
- IFTA reporting

Allow additional time before initial report

Permit alternative reporting procedures

- Eliminate one percent loss allowance cap
- Investigate separation of diesel/special fuels for attribution purposes
- Native American reporting

Tribal negotiation

State-developed estimates

FHWA-developed estimates

Improvements are also needed in the following areas:

- Revise FHWA Form 551M to four columns entitled gasoline, diesel, gasohol and other (other to be defined by the state.)

- Develop a standard to allow inclusion of highway use of alternative fueled vehicles that states currently tax via registration fees rather than per gallon taxes.
- Determine where states include data that they cannot separate and let those states that can separate add the gallons in. It is unfair to penalize states that are going by the *Guide to Reporting Highway Statistics* (*Guide*) when most cannot.
- Revise FHWA's guidance to cover these issues and to add a glossary.
- Continue to communicate the methods used in attribution to improve stakeholder understanding.
- Document the attribution process.
- Produce a Federal register notice to re-issue attribution policy, and to revise *Guide* as discussed above.

LIST OF DATA SOURCES

Table B.1. Model for Estimating Non-Highway Use of Gasoline

Data Source	Data Provider	Frequency	Estimating Fuel Use By	Most Recent Update	Data Items or Other Remarks
Census of Agriculture	USDA	5 year	Agricultural equipment	1997	Gasoline & gasohol expenses for farm production by State and total fuel consumption in U.S. Data collected by the Census prior to 1997.
Farm Production Expenditures	USDA	annual	Agricultural equipment	2000	Farm product expenditure on fuels by region. Also, gasoline & gasohol expense by bulk/station, by region (1991 only).
Petroleum Marketing Annual	EIA	annual	Agricultural equip. Aviation	2000	Gasoline price by state; aviation gasoline sales by state
Highway Taxes and Fees	FHWA	1 - 3 year	Agriculture	2001	Fuel tax rate by state (MF-121T)

Data Source	Data Provider	Frequency	Estimating Fuel Use By	Most Recent Update	Data Items or Other Remarks
Vehicle Inventory & Use Survey	Census	5 year	All trucks used for off-road purposes	1997	State level data on VMT, MPG, annual mileage, and percentage of off-road driving
Motor Vehicle Facts & Figures	Ward's Communication	annual	All trucks used for off-road purposes	2000	Total trucks in operation (U.S. total) based on R. L. Polk. Data previously collected by MVMA
Highway Statistics	FHWA	annual	All but boating and aviation	2000	Specifically, tables VM-1, MF-33GA, and MF-33GLA (no longer published)
Sales & Marketing Management	Bill Communication	periodical	Recreational boating	2001	Effective median household buying income
Boating Statistics	USCG	annual	Recreational boating	2000	Number of registered boats by state
Statistical Abstract of the United States	Census	annual	Construction Recreational boating	2001	Total values of non-residential construction contracts by state. Heating-degree

Data Source	Data Provider	Frequency	Estimating Fuel Use By	Most Recent Update	Data Items or Other Remarks
					days, land area, and CPI by state.
National Recreational Boating Survey	USFWS & USCG	N/A	Recreational boating	1991	Number of powered boats; fuel consumption; gasoline/diesel split by state
U.S. Boating Registration Statistics	NMMA	annual	Recreational boating	2001	State level data on miles of coastal shorelines; square miles of inland water; effective median household buying income
General Aviation And Air Taxi Activity Survey	FAA	annual	Aviation	1999	Total hours flown by state & US total aviation gasoline consumption (total fuel consumption was provided from 1998 on). Renamed from "General Aviation Activity Survey" in 1993.

Data Source	Data Provider	Frequency	Estimating Fuel Use By	Most Recent Update	Data Items or Other Remarks
Vehicle Inventory & Use Survey	Census	5 year	Recreational light trucks	1997	Annual miles driven; MPG; percent miles used off-road; percent personal use; truck weight; body type and configuration
Highway Statistics	FHWA	annual	Recreational light trucks	2000	Truck registrations by state from Table MV-9
Motorcycle Statistical Annual	Motorcycle Industry Council	annual	Recreational motorcycles ATV		Number of motorcycles and ATV used off-road by state
Snowmobile Registration Data	International Snowmobile Manufacturing Association	annual	Recreational snowmobiles		Number of registered and unregistered snowmobiles by state
National Atlas of the USA	National Climactic Data Center		Recreational snowmobiles		Mean annual amount of snowfall and normal winter temperature by state

Table B.2. Model for Estimating Government Use (i.e., Public-use) of Gasoline

Data Source	Data Provider	Frequency	Estimating Fuel Use By	Most Recent Update	Data Items or Other Remarks
Highway Statistics	FHWA	annual	Federal government	2000	Table MV-7 on publicly owned vehicles
Federal Motor Vehicle Fleet Report	GSA	annual	Federal government	?	Fuel consumption & number of vehicles for cars/vans, buses, & trucks
Population projection and land area	Census	annual	SCM government	2001	Population and land size by state, county, and city
Responses from 1992 "Government Use of Motor Fuel Questionnaire"	FHWA	N/A	Federal and SCM governments	1992	Percent of on/off-highway use; percent of gasoline/diesel use

Table B.3. Model for Estimating On-Highway Use of Gasohol

Data Source	Data Provider	Frequency	Most Recent Update	Data Items or Other Remarks
Ethanol Clean Air, Clean Water, Clean Fuel, Industry Outlook	Renewable Fuels Association	annual	2001	U.S. ethanol production capacity by company; ethanol incentives by state
FHWA Form 551M	FHWA	annual	2001	State reported gasohol data

IRS tax revenue data	IRS	annual	2001	Total gasohol and ethanol tax revenue for U.S. (IRS Form 720)
The Clean Fuels Report	J.E. Sinor consultants Inc.			Ethanol incentives by state
Highway Statistics	FHWA	annual	2000	VMT
"Gasohol Estimation Model Review, State Responses to Questionnaire Survey"	Battelle	N/A	1999	Variance in state-reporting of gasohol blend revenue (such as underreporting) and other data used in the ESTNEWXX Module