

Technical Guidance on the Use of MOVES2010 for Emission Inventory Preparation in State Implementation Plans and Transportation Conformity



United States
Environmental Protection
Agency

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Transportation and Regional Programs Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

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Section 1: Introduction

1.1 Background

MOVES (MOtor Vehicle Emissions Simulator) is a computer program designed by the US Environmental Protection Agency (EPA) to estimate air pollution emissions from mobile sources. MOVES2010 (hereafter referred to as MOVES) replaces EPA's previous emissions model for on-road mobile sources, MOBILE6.2. MOVES can be used to estimate exhaust and evaporative emissions as well as brake and tire wear emissions from all types of on-road vehicles.

Compared to MOBILE6.2, MOVES incorporates substantial new emissions test data and accounts for changes in vehicle technology and regulations as well as improved understanding of in-use emission levels and the factors that influence them. Also, MOVES has a completely new software framework that includes many new features and provides much more flexibility for input and output options than MOBILE6.2. New input options in MOVES and changes in the way MOVES handles existing information may appear to create significant new information burdens for states preparing submissions for SIP and conformity related purposes. However, in most cases, existing MOBILE6.2 inputs can be modified to be used with MOVES. Software tools to convert MOBILE6.2 inputs for MOVES are described in this guidance. Moreover, some MOVES features will ultimately make it easier for users to develop local data for MOVES. For example, MOVES uses a vehicle classification system based on the way vehicles are classified in the Federal Highway Administration's Highway Performance Monitoring System (HPMS) rather than on the way they are classified in EPA emissions regulations. This change should make it easier to use highway activity information as inputs to MOVES.

1.2 Purpose of This Guidance

MOVES is designed to allow users to analyze motor vehicle emissions at multiple scales, from national to county level to project level, using different levels of input data. This document provides guidance on the use of MOVES for inventory development in State Implementation Plans (SIPs) and for regional emissions analysis for transportation conformity determinations. The process for generating on-road motor vehicle emissions estimates for conformity purposes is commonly referred to as a "regional emissions analysis" in conformity documents. However this term could be confused with the process of creating an inventory for a SIP. To avoid that confusion, we will refer to a "regional emissions analysis" for transportation conformity as a "regional conformity analysis" in this document.

A separate guidance document, "Policy Guidance on the Use of MOVES2010 for State Implementation Plan Development, Transportation Conformity, and Other Purposes," addresses general policy issues for MOVES such as timing of the use of MOVES in SIPs and conformity analyses, available at www.epa.gov/otaq/stateresources/transconf/policy.htm. Transportation conformity guidance on the use of MOVES for project level, quantitative hot-spot analysis in PM2.5 and PM10 nonattainment and maintenance areas is described in a separate guidance document which will be available at www.epa.gov/otaq/stateresources/transconf/policy.htm.

This guidance focuses on determining what the appropriate inputs are and how MOVES should be run to develop emissions estimates for on-road vehicles for SIPs and regional conformity

analyses. This document presumes that users already have a basic understanding of how to run MOVES through attending MOVES training and reviewing the MOVES User Guide available on the Help menu of MOVES and on the MOVES website (www.epa.gov/otag/models/moves/index.htm). It also presumes a basic understanding of SIP and conformity regulatory requirements and policy.

MOVES includes a default database of meteorology, vehicle fleet, vehicle activity, fuel, and emission control program data for the entire United States. The data included in this database come from a variety of sources and are not necessarily the most accurate or up-to-date information available at the local level for a particular analysis. This guidance describes when the use of that default database is appropriate for SIPs and regional conformity analyses.

One important new feature of MOVES is the option to calculate emissions either as:

- inventory estimates (total emissions in units of mass) or,
- emission rates (emissions per unit of distance for running emissions or per vehicle for starts, extended idle and resting evaporative emissions) in a look-up table format.

Use of the inventory option may simplify the post-processing of MOVES output compared to MOBILE6.2, but it does require vehicle miles traveled (VMT) and vehicle population data as an input to MOVES (when using the emission rates option, VMT and vehicle population are applied during post-processing external to MOVES). Users are free to use either approach to develop emissions estimates for SIPs and regional conformity analyses. Differences in guidance for inputs when producing the emission factor output and inventory output are noted in the guidance text.

This document covers the input options in MOVES that are most important for SIPs and regional conformity analyses. Use of MOVES to analyze certain specific control programs, such as diesel retrofit programs and programs to reduce extended idle emissions from diesel vehicles, will be addressed separately in updates to guidance documents for those programs.¹ MOVES users should always check with their EPA Regional Office if there is any question about the applicability of guidance to any specific situation.

This document has three major sections and is generally organized according to the order in which a user would make selections in each panel of the MOVES Graphical User Interface (GUI):

- Section 1 is a general introduction to this guidance.
- Section 2 focuses on the individual parameters used to create a MOVES Run Specification (RunSpec) file. In general, these parameters are used to define what type of MOVES run it is, what time period, location, vehicle types, road types, and pollutants are included in the run, and how detailed MOVES output will be.
- Section 3 goes through the input options in the County Data Manager (CDM). The CDM is where users enter most local data such as local meteorology, fleet and activity data, fuel specifications, and Inspection and Maintenance (I/M) program information if applicable.

¹ MOVES users should check www.epa.gov/otag/stateresources/transconf/policy.htm for updates to EPA guidance documents for estimating reductions from various control programs.

While using this document, users should refer to the applicable sections of the MOVES User Guide for details of the operation of MOVES. EPA plans to offer upgrades of MOVES features on a regular basis, and will provide supplementary guidance as those upgrades occur. MOVES users are urged to check the MOVES website regularly and subscribe to EPA's mobile source emissions model listserver (subscription information on the MOVES website) to find any updates to MOVES or this guidance. General questions about this guidance should be sent to mobile@EPA.gov. Questions about the application of this guidance to specific SIPs or regional conformity analyses should be addressed to the EPA Regional Office SIP or transportation conformity contact.

1.3 On-Road Emission Inventories for SIPs and Regional Conformity Analyses

State and local air quality and transportation agencies estimate on-road vehicle emissions for a variety of different purposes. Inventories are required for reasonable further progress, attainment, and maintenance SIPs. These inventories also serve as the basis for the motor vehicle emissions budget. Emission estimates are also created specifically for air quality modeling for attainment demonstrations. On-road emissions are also calculated as part of the regional emissions analysis for transportation plan and TIP conformity determinations. Users may also create emission inventories for submission for the National Emissions Inventory and for more general planning purposes, such as comparison of different emission scenarios prior to development of a SIP. EPA recommends using as much local information as possible when preparing inventories for SIPs and emissions analyses for conformity purposes. However, EPA recognizes that these different inventory uses require different levels of detail and that state and local agencies have sometimes used different methods in creating inventories.

In order to provide the necessary inputs for air quality modeling, emission inventories created for attainment demonstrations may need to be based on meteorology and activity inputs for a specific nonattainment episode or for a large number of specific daily inputs covering all or part of a season or year that is going to be modeled in the attainment demonstration. For the development of the motor vehicle emissions budgets and regional conformity analyses, an emission inventory based on typical seasonal day conditions (e.g., typical summer day for ozone precursors) or on aggregated seasonal or monthly emissions for pollutants with annual standards (e.g., annual PM_{2.5} standard) generally is sufficient. Users should consult with their EPA Regional Office if they have questions about this.

Section 2: Creating a Run Specification File

2.1 Creating a Run Specification (RunSpec) File

The Navigation Panel in MOVES is used to select a series of panels which specify the parameters used for creation of the Run Specification (RunSpec) file. The following subsections describe the individual parameters that are important for SIPs and regional conformity analyses.

2.2 Selecting Scale and Calculation Type

Selecting Scale on the Navigation panel in MOVES brings up the Domain/Scale and Calculation Type panel. MOVES provides users with the ability to conduct analyses at three scales: National, County, and Project. Use of the County scale is required for SIPs and for regional conformity analyses. MOVES also provides two options for calculation type: Inventory or Emission Rates. Users are free to use either the Inventory or Emission Rates option depending on their preference. This guidance will provide additional detail where necessary to emphasize differences that may arise if the Inventory or Emission Rate option is selected.

2.2.1 Domain/Scale

Each scale option in MOVES has its own intended purpose and the amount of data that the user must supply varies depending on the selection:

- The National scale can be used to estimate emissions for the entire country, for a state, for a group of counties, or for individual counties. At the National scale, MOVES uses a default national database that allocates emissions to the county level based on a mix of national data, allocation factors, and some pre-loaded local data. In general, EPA cannot certify that the default data in the national database is the most current or best available information for any specific county. Because of this, **users must not use the National scale option when developing emission estimates for SIPs or transportation plan and transportation improvement program (TIP) conformity determinations.**
- The County scale requires the user to enter data to characterize local meteorology, fleet, and activity information through the County Data Manager. The County Data Manager facilitates the input of local data and also allows the user to review county data included in the default national database. **The County scale is the only scale appropriate for developing emission estimates for SIPs or transportation plan and transportation improvement program (TIP) conformity determinations.** Detailed guidance on specific inputs in the County Data Manager, including the use of default inputs, is given in Section 3 of this guidance.
- The Project scale allows the user to perform micro-scale analysis of emissions on individual roadway links or locations where emissions from vehicles starts or extended idle activity occur. The project scale is not intended for use in SIPs or regional conformity analyses. Guidance on the use of the project scale in MOVES for quantitative hot-spot analysis in PM_{2.5} and PM₁₀ nonattainment and maintenance areas is described in a separate guidance document which will be available at www.epa.gov/otaq/stateresources/transconf/policy.htm.

Further description of the Domain/Scale panel is given in section 2.2.2 of the MOVES User Guide.

2.2.2 Calculation Type

The Scale panel also requires that the user select a calculation type of either Inventory or Emission Rates. If Inventory is selected, MOVES provides emissions estimates as mass, using VMT and vehicle population entered by the user. If Emission Rates is selected, MOVES provides emission rates as mass per unit of activity. The Emission Rates option produces a look-up table of emission rates that must be post-processed to produce an inventory. The selection of calculation type is required early in the RunSpec construction process because this choice affects the available options in later panels.

Users are free to use either the Inventory or Emission Rates option depending on their preference. Each approach has advantages and limitations and users will need to decide which approach is more appropriate to the type of analysis they are doing. When modeling a single time and place (or small number of times and places), the Inventory option in MOVES requires significantly less computer run time and memory than the Emission Rate option, and potentially requires less post-processing time. However, for large scale analysis involving multiple counties and many times (e.g., a multi-day analysis of a large number of counties), a user may want to use the Emission Rate option to create a lookup table of rates that--through a post-processor--can be applied to many times and places, thereby reducing total MOVES run time. Successful application of this approach requires a clear understanding of the rates calculations in MOVES and careful planning. Details on the use of the Emission Rate option are provided in Appendix A of the MOVES User Guide. In addition, EPA is developing tools to automate the use of this feature to create inputs for EPA's Sparse Matrix Operator Kernel Emissions (SMOKE) model for SIP development purposes. These tools will simplify the process of post-processing MOVES output for air quality modeling in SIPs.

When the Emission Rate option is chosen, MOVES may ignore some of the inputs in the County Data Manager, depending on what output options are chosen. In those cases, detailed information is applied while post-processing results outside of MOVES, and placeholder information can be used as inputs in the CDM. The inputs that can potentially serve as placeholders are described in section 2.10.4, Output Emission Detail, and in each applicable subsection of section 3, County Data Manager of this document.

2.3 Time Spans

The Time Spans panel includes five sections – one to select the Time Aggregation Level, and four more to select specific Years, Months, Days, and Hours. Guidance for each of these inputs is described separately in this section. For further details on the Time Spans panel, see section 2.2.3 of the MOVES User Guide.

2.3.1 Time Aggregation Level

The Time Aggregation Level has 4 options: Year, Month, Day, and Hour, and determines the amount of pre-aggregation of input data. A longer time span will aggregate or average input data to create a single value for the time aggregation level chosen. For example, if the user chooses

Hour, MOVES will calculate emissions for each hour of a day based on the specific inputs for that hour (e.g., temperature, speed distribution, etc.). If the user chooses Day, MOVES calculates emissions for a day based on the average of the hourly inputs for the day, e.g., a single average temperature is applied to the whole day. Likewise, if the user chooses Month or Year, MOVES will calculate emissions based on single monthly or yearly average inputs, e.g., a single average temperature will be applied to a full month or year.

For SIP and regional conformity analysis, hour should be selected for Time Aggregation Level. Because emissions of criteria pollutants are dependent on ambient temperature, diurnal, daily, and monthly variations in temperature can have large impacts on emission results. Thus using any time aggregation level other than Hour can result in a significant loss of resolution of emissions data and usually a bias toward underestimating emissions. The Day, Month, and Year options are provided in MOVES to reduce model runtime when loss of precision is acceptable, for example in sketch planning analysis, but not for SIPs or regional conformity analyses.

2.3.2 Calendar Year of Evaluation

MOVES can model calendar years 1990 and 1999-2050, inclusive. Note that the County scale in MOVES allows only a single calendar year in a RunSpec. Users who want to model multiple calendar years will need to create multiple RunSpecs, with local data specific to each calendar year, and run MOVES multiple times. Users can refer to Appendix C of the MOVES User Guide to learn about batch mode operation to automate the process of doing multiple MOVES runs.

2.3.3 Month of Evaluation

MOVES allows users to calculate emissions for any month of the year. Emissions for multiple months may be produced by a single RunSpec. Users should choose the appropriate months for the pollutant being analyzed, i.e., the summer ozone season for NO_x and hydrocarbons, or the winter CO season. To develop an annual inventory, select all months.²

In cases where the user intends to model multiple months, the user must be aware of how MOVES treats the input data. Fuel Supply and Meteorology can vary by month in a single RunSpec because the month is defined in the data tables used for these inputs. However, the other data fields in the County Data Manager (or CDM, described in section 3 of this document) can only be input as a single set applied to all months selected. Therefore, if the user has, for example, Average Speed Distribution data that vary by month, the user would have to execute multiple RunSpecs to use each data set with the corresponding month.

If the user has selected the Emission Rates option, the Month can be used to input groups of temperatures. Appendix A of the MOVES User Guide provides more details.

² EPA will be updating the guidance document “Guidance for Creating Annual On-Road Mobile Source Emission Inventories for PM_{2.5} Nonattainment Areas for Use in SIPs and Conformity” to address the use of MOVES for creating annual inventories. The updated guidance will be posted at: www.epa.gov/otaq/stateresources/transconf/policy.htm.

2.3.4 Type of Day of Evaluation

Weekdays and weekend days can be modeled separately in MOVES. MOVES provides the option of supplying different speed and VMT information for weekdays and weekend days to allow the calculation of separate emissions estimates by type of day. Average Speed Distribution, Day VMT Fraction and Hour VMT Fraction are the only inputs in the CDM that differentiate between weekdays and weekend days. For most emissions analyses for SIP or transportation conformity purposes, the use of weekday data and the selection of Weekday in the Time Span panel are recommended. Weekday data should be used for any inventory that represents a typical summer or winter day.

Weekend day data could be used:

- if the user needs to prepare an inventory for a multi-day period that includes weekend days, and
- weekend day data with different speed distributions, daily VMT fractions, and/or hourly VMT fractions are available.

In that case, both weekdays and weekend days should be selected and the different speed and VMT data can be input accordingly.

Options for developing inventories for multi-day periods when speed distributions are available for only one type of day are described below. Both types of days should be selected if the user intends to use the Year, Month, or possibly Portion of Week temporal post-aggregation options described in “Output Emission Detail,” section 2.10.4 of this document.

If the user needs to develop a multiday, monthly, or yearly inventory, and does not have separate weekday and weekend day data, the user can either:

1. select and input the same data for both types of days; or
2. select one type of day (weekdays are recommended) and input the speed distribution for only that day. Each of these options has benefits and drawbacks.

Option 1 allows users to use the built-in post aggregation tools (covered in “Output Emission Detail,” Section 2.10.4 of this document), but the RunSpec will take longer to execute because two days must be calculated rather than just one. Option 2 will execute slightly faster, but output will be available only for the single day and users must externally post-process the output to generate a month’s or year’s worth of emissions. If the user chooses Option 2, and tries to internally aggregate results to the month or year level by selecting Month or Year in this panel, MOVES will provide an incorrect result, as the Month or Year will be the total emissions from only weekdays in that month or year (because weekend-days were not modeled).

For the Day VMT Fraction, users can generate the appropriate mix of VMT on each type of day with the EPA-provided Daily VMT Calculator (described in Section 3.5 of this document). If only one type of day is selected, then the day VMT fraction for that type of day can be set to one and the other type of day can be set to zero.

The Hour VMT Fraction can also differ by type of day and users can supply this information if available; however, if information is only available for a single type of day, either the default value or the user-supplied value for the single day can be used for the other type of day.

2.3.5 Hour of Evaluation

To properly estimate emissions for a day, month or year, the user must select all 24 hours. Also, selection of all 24 hours is required to evaluate evaporative hydrocarbon emissions because they depend on the daily temperature variance.

2.4 Geographic Bounds

Once the County scale is selected (as required for SIPs and regional conformity analyses), the Region section of the Geographic Bounds panel is limited to County or Custom Domain. Either option can be used for SIP and regional conformity analyses and the user should choose the one that is best suited for the data they have available. Each option is explained in greater detail below.

The Geographic Bounds panel is described in section 2.2.4 of the MOVES User Guide.

2.4.1 County

Users should choose County if:

- they are analyzing only one county, or
- they have unique data (different meteorology, age distribution, average speed distribution, road type distribution, ramp fraction, fuel formulation or supply, or I/M program) for each county being modeled, or
- they are using the Inventory calculation type and need output segregated by county.

Users also specify which county they are modeling in the Geographic Bounds panel. The County scale only allows one county and one calendar year to be analyzed at a time. As a result, users will need to do multiple runs of MOVES, using multiple RunSpec files, to develop emission estimates for multiple counties. Users can refer to Appendix C of the MOVES User Guide to learn about batch mode operation to automate the process of doing multiple MOVES runs.

Use of the County option has two advantages. The county option allows the user to more easily make use of some of the MOVES database default inputs for that county if appropriate, as described in section 3 of this document. The county option also provides individual output for each county.

2.4.2 Custom Domain

A custom domain is a geographic area that may consist of multiple counties, parts of counties, or combinations of counties and partial counties that can be described using a single set of inputs in the CDM. A custom domain uses the same meteorology, age distribution, average speed distribution, road type distribution, ramp fraction, fuel formulation and supply, and I/M program to describe the entire area. The custom domain area is described by a single RunSpec file. Using the Custom Domain option can reduce the number of MOVES runs required, but it can only be used if the entire area can be represented by a single set of inputs.

While the Custom Domain option allows users to more easily model multiple counties where input data are identical, MOVES treats the custom domain as a single county. This is a special limitation when using the Inventory calculation option. In that case, source type population and

VMT used to calculate the inventory is the total of the source type population and VMT for the entire area. Because of this, MOVES cannot disaggregate inventory results to provide information about the original counties that the custom domain represents. Users must be aware of this limitation before choosing the Custom Domain approach.

However, when using the Emission Rates calculation option, MOVES produces a lookup table of emission rates. These emission rates can then be post-processed externally to MOVES to produce separate emissions estimates for each county by multiplying the emission rates by the appropriate source type population and VMT for each county. This combination of Custom Domain and Emission Rates can be a very effective way to develop emissions estimates for a large number of areas with similar characteristics, while preserving the ability to specify the emissions within each area.

By selecting Custom Domain, users will create a generic county for which there are no data available in the default database. Therefore, users must supply data for all the tabs in the County Data Manager (see section 3 of this document) and essentially re-create entries in the County and CountyYear tables of the default database by providing information about the area on the Geographic Bounds panel. Users can refer to these tables to find data for the counties that comprise the custom domain being created. Users must provide the following information to create new entries for the County and CountyYear tables for the custom domain:

- CountyID,
- Description (e.g., the name of the county),
- Geographic Phase-in Area (GPA) Fraction,
- Barometric Pressure (in inches of mercury), and
- Refueling Vapor and Spill Adjustment Factors.

The GPA is an area around the Rocky Mountains where the Federal Tier 2 sulfur control program was implemented on a delayed schedule. Users should enter 1 if the custom domain falls within the GPA and 0 if it is outside the GPA; in the unlikely event the custom domain is split, users should enter the fraction of VMT that occurs inside the GPA. The refueling Vapor and Spill Adjustment Factor terms are factors that describe the extent and effectiveness of a Stage II refueling program in the area. Users can refer to the CountyYear table in the MOVES default database to see the default factors for the counties in the Custom Domain or Appendix I of the MOVES User Guide and section 3.11 of this document for additional discussion of Stage II refueling programs.

2.4.3 Domain Input Database

In this section of the Geographic Bounds panel, the user can open the County Data Manager (CDM) by clicking on the “Enter/Edit Data” button (the CDM can also be accessed from the Pre-Processing Menu). It is important to note that the user should complete the rest of the RunSpec panels before importing data in the CDM. Users can reference section 3 in this document, for guidance on developing inputs and User Guide section 2.3.3.4 for how to import the data files.

Once a database has been completely populated, users should select the database in the Database section of this panel. Users may have to hit the Refresh button to make sure the database they create appears on the drop down list.

2.5 Vehicles/Equipment: On-Road Vehicle Equipment

The Vehicles/Equipment menu item and panel is used to specify the vehicle types that are included in the MOVES run. MOVES allows the user to select from among 13 “source use types” (the terminology that MOVES uses to describe vehicle types), and four different fuel types (gasoline, diesel, compressed natural gas (CNG), and electricity). Some fuel/source type combinations are not included in the MOVES database (e.g., diesel motorcycles). For SIP and regional conformity analyses, users must select the appropriate fuel and vehicle type combinations in the On Road Vehicle Equipment panel to reflect the full range of vehicles that will operate in the county. In general, users should simply select all valid diesel, gasoline, and CNG (only transit buses) vehicle and fuel combinations, unless data are available showing that some vehicles or fuels are not used in the area of analysis. For more information on the relationship between source types and HPMS vehicle types, see Sections 3.3 and 3.5 of this document as well as Tables A.1 and A.2 in the Appendix of this document.

The fuel and vehicle combinations selected on this panel will be affected by the Alternate Vehicle Fuel and Technology (AVFT) panel and Fuel Supply tab of the CDM. If no changes are made on the AVFT panel, default gasoline, diesel, and CNG fractions will be used. If the user has data detailing the fleet and activity of alternative fuel/vehicle combinations, then those combinations should be selected in this panel and corresponding changes must be made to the AVFT. In the Fuel Supply tab of the CDM, the user must provide valid fuel formulations that correspond to all vehicle-fuel combinations selected in the On-Road Vehicle Equipment panel. See section 3.9.3 of this document for more information about the requirements for this tab.

Detailed information describing the local vehicle fleet and its activity can be entered in the CDM using the Source Type Population, Age Distribution, Vehicle Type VMT, Average Speed Distribution, and Road Type Distribution tabs. See Section 3 of this document for more information on these input options and the use of default vs. local information.

The Vehicles/Equipment panel is described in more detail in section 2.2.5 of the MOVES User Guide.

2.6 Road Type

The Road Type Panel is used to define the types of roads that are included in the run. MOVES defines five different Road Types:

- Off-Network (roadtype 1) – all locations where the predominant activity is vehicle starts, parking and idling (parking lots, truck stops, rest areas, freight or bus terminals)
- Rural Restricted Access (2) – rural highways that can only be accessed by an on-ramp
- Rural Unrestricted Access (3) – all other rural roads (arterials, connectors, and local streets)
- Urban Restricted Access (4) – urban highways that can only be accessed by an on-ramp
- Urban Unrestricted Access (5) – all other urban roads (arterials, connectors, and local streets)

Users should select the road types present in the area being analyzed. The determination of rural or urban road types should be based on the HPMS classification of the roads in the county being analyzed.

All SIP and regional conformity analyses must include the Off-Network road type in order to account for emissions from vehicle starts, extended idle activity, and evaporative emissions (for hydrocarbons). The Off-Network road type is automatically selected when start or extended idle pollutant processes are chosen and must be selected for all evaporative emissions to be quantified. Off-Network activity in MOVES is primarily determined by the Source Type Population input, which is described in Section 3.3 of this document. Some evaporative emissions are estimated on roadways (i.e., roadtypes 2, 3, 4, and 5) to account for evaporative emissions that occur when vehicles are driving. All roads types are automatically selected when Refueling emission processes are selected.

MOVES uses Road Type to assign default drive cycles to activity on roadtypes 2, 3, 4, and 5. For example, for unrestricted access road types, MOVES uses drive cycles that assume stop and go driving, including multiple accelerations, decelerations, and short periods of idling. For restricted access road types, MOVES uses drive cycles that include a higher fraction of cruise activity with less time spent accelerating or idling, although some ramp activity is also included.

Selection of road types in the Road Type panel also determines the road types that will be included in the MOVES run results. Different characteristics of local activity by road type are entered in the CDM using the Average Speed Distribution and Road Type Distribution importers as described in sections 3.6 and 3.7 below.

The Road Type panel is described in section 2.2.6 of the MOVES User Guide.

2.7 Pollutants and Processes

In MOVES, pollutant refers to particular types of pollutants or precursors of the pollutant, such as CO or NO_x, while process refers to the mechanism by which emissions are created, such as running exhaust or start exhaust. Users must select all processes associated with a particular pollutant in order to account for all emissions of that pollutant. For example, there are 11 separate pollutant processes in MOVES for hydrocarbon emissions; all 11 must be selected when estimating hydrocarbon emissions for SIPs or regional conformity analyses.

For many pollutants, the emissions calculation is based on prior calculation of another pollutant. In such cases, users must select all of the base pollutants that determine a particular dependent pollutant. For example, when selecting volatile organic carbons (VOCs), users must also select non-methane hydrocarbons, total hydrocarbons, and methane. MOVES will display error messages in the box on the Pollutants and Processes screen until all necessary base pollutants are selected.

The Pollutants and Processes panel is discussed in section 2.2.7 of the MOVES User Guide.

2.8 Manage Input Data Sets

This panel allows users to create alternate data tables that are used in place of data from the MOVES default database. In most cases, SIP and conformity users will not use this panel at all because they will not have to input any databases other than the one created with the County Data Manager (the County database is input in the Domain Input Database section of the

Geographic Bounds panel, see section 2.3.3 of this document). However, if the user wishes to enter additional data about the area being analyzed that is not one of the input requirements in the CDM, then the data would be referenced in this panel. Appendix I of the MOVES User Guide describes how the Manage Input Data Sets panel can be used create an alternate data table that includes a Stage II refueling control program (section 3.11 of this document provides guidance on inputs for a Stage II program). Users should consult with EPA before using the Manage Input Data Sets panel to input other additional data.

The Manage Input Data Sets panel is described in section 2.2.8 of the MOVES User Guide.

2.9 Strategies

The Strategies option in the Navigation panel provides access to three additional panels – Alternative Vehicle Fuels and Technologies, On-Road Retrofit, and Rate of Progress. Use of the On-Road Retrofit panel will be addressed separately in an update to EPA’s Retrofit Guidance which will be found at www.epa.gov/otaq/stateresources/transconf/policy.htm.

Applying different control strategy options using these panels is described in section 2.2.9 of the MOVES User Guide.

2.9.1 Alternative Vehicle Fuels and Technologies

The Alternate Vehicle Fuels and Technologies panel (AVFT) allows users to assign source type activity to vehicles with different fuel and/or engine technologies. Users can rely on the defaults provided, but they have the option of modifying the information on this panel if detailed local information is available. For SIPs and regional conformity analyses, users cannot assume future changes in vehicle activity associated with alternate fuel or engine technologies unless those alternate technologies are required by regulation or law.

The AVFT strategies panel is used to adjust the fraction of VMT from gasoline, diesel, and alternative fuel vehicles by MOVES source type and model year. This feature takes the place of the “Diesel Fraction” and “NGV fraction” commands in MOBILE6.2. However, the MOBILE6.2 inputs were in the form of sales fractions, while the MOVES input is in the form of activity fractions. This means the most appropriate input is the fraction of total VMT for each sourcetype and model year that is travelled by vehicles of each fuel/technology type. If a user does not have information to calculate fractions using VMT or energy, fraction of vehicle population may be used.

MOVES will assume the same driving behavior for a source type, regardless of fuel or technology (e.g., the same average speed and road type distributions). If the user has information detailing distinct driving behavior for the different vehicle-fuel combinations, then individual RunSpecs must be conducted for each combination to capture how this will impact emissions. However, the AVFT does give users a tool to account for differences in mileage accumulations by fuel type. For example, if the user has data demonstrating that diesel vehicles, on average, travel more miles per year and thus the VMT fraction from diesel vehicles is greater than the population fraction, then the appropriate input in the AVFT is the fraction of VMT from each type of vehicle.

Users should be aware that the fractions entered in the AVFT have implications for the On-Road Vehicle Equipment panel (see section 2.5) and the Fuel Supply information entered in the CDM (see section 3.9.2). Any vehicle, fuel, or engine technology for which the AVFT fraction entered is greater than 0 must be selected in the On-Road Vehicle Equipment panel, otherwise the fraction of VMT allocated to this portion of the vehicle fleet will not be modeled (i.e., the VMT and associated emissions will be “lost”). With respect to the data input in the Fuel Supply tab of the CDM, a fuel formulation must be supplied for all vehicle-fuel combinations selected in the On-Road Vehicle Equipment and AVFT panels. Please refer to section 3.9.2, Fuel Supply, of this guidance for more detail. Users can also refer to Appendix F of the MOVES User Guide for an example demonstrating how to use the AVFT.

2.9.2 On-Road Retrofits

Use of the On-Road Retrofit panel will be addressed separately in an update to EPA’s retrofit guidance, which will be posted at www.epa.gov/otaq/stateresources/transconf/policy.htm. Users can refer to Appendix D of the MOVES User Guide for an explanation of how to use this panel.

2.9.3 Rate of Progress

This section only applies to SIP analysis in certain ozone nonattainment areas. The Clean Air Act Amendments of 1990 include provisions known as reasonable further progress, or rate of progress requirements that call for regular incremental reductions in hydrocarbon and NO_x emissions over the time period prior to the attainment deadline for moderate and above ozone nonattainment areas. Proper implementation of these provisions requires estimating an adjusted base year emission inventory, which is essentially an estimate of what motor vehicle emissions would have been in the absence of any motor vehicle standards, fuel standards, or state or local motor vehicle programs required by the Clean Air Act Amendments of 1990. Details on the use of this information in the rate of progress calculation will be provided in the applicable ozone NAAQS implementation rule.

The check box in the Rate of Progress panel is used to disable all motor vehicle requirements of the 1990 Clean Air Act Amendments. Details of the motor vehicle requirements affected by this command are given in Section 2.2.9 of the MOVES User’s Guide. States using MOVES to generate rate of progress plans will need to use this command to estimate adjusted base year emissions. More generally, comparing MOVES runs with and without this command can also be used for estimating the total benefits of all control programs required by the Clean Air Act Amendments of 1990.

2.10 Output

The Output option in the Navigation panel provides access to two panels – General Output and Output Emissions Detail. In general, users can generate output in whatever form works best for their specific needs. The following subsections provide some guidelines to consider when specifying output details and format.

The Output panels are described in detail in section 2.2.10 of the MOVES User Guide.

2.10.1 Output Database

Users can create databases and name them according to personal naming conventions, but EPA recommends that users indicate that a database is an output database (such as using “_out” at the end of the output database name). Results from multiple RunSpecs can be stored in a single output database, but generally these RunSpecs should be similar in units and aggregation because, typically, the user wants to compare results (e.g., RunSpecs that are identical except that a different fuel formulation was used) or sum them (e.g., RunSpecs for multiple counties that are part of the same nonattainment area). EPA recommends that users create a new output database for RunSpecs that are considerably different from RunSpecs stored in existing output databases. Users will also want to consider total database size when deciding which RunSpecs to store in the same output database.

2.10.2 Unit Selection

Users are free to choose any of the mass unit selection options, but should generally choose a unit whose magnitude is appropriate for the parameters of the RunSpec so that interpretation and processing of the output is easier. For example, selecting tons in the output for a run aggregated hourly may produce emissions of “zero” if emissions are less than one ton. For most scenarios, grams should be selected to avoid these rounding losses.

2.10.3 Activity Output

MOVES allows the user to select multiple activity output options. These options are distance traveled, population, starts, source hours, source hours idling, source hours operating, and source hours parked. For Inventory calculations, activity output is not required, but can provide a check on whether activity was properly entered in MOVES. For Emission Rate calculations, distance and population are reported automatically, but the values in the output are intermediate steps in the rate calculation and do not represent the true activity. Users can refer to section 2.2.10.1.3 of the MOVES User Guide for instructions on selections that must be made to ensure the Activity Output is produced.

2.10.4 Output Emission Detail

This panel allows the user to select the amount of detail that will be provided in the output. Having MOVES provide more detail is useful as these results can later be aggregated by the user so that the output can be analyzed in a variety of ways. However, too much detail can lead to very large output tables and longer query execution in MySQL, so users should not select the most detail for all RunSpecs. It is up to users to determine exactly what output detail is needed and care should be taken ahead of time to determine where analysis will be focused in post-processing.

Output at the Hour level is recommended for Time unless the user is certain that emission results are not needed by time of day. As described in section 2.3, if the user only selected a single Type of Day because the user had a single Average Speed Distribution, then selecting any time period longer than the Portion of the Week would not be appropriate.

For Location, the County scale only allows one county or custom domain to be modeled at a time, so selection of County is recommended. For the All/Vehicle Equipment Categories section, in most cases Model Year does not have to be selected. Detailing output by Fuel Type

may be helpful if the AVFT was used to input activity by alternate fuel vehicles or if separate output for gasoline and diesel vehicles are needed.

For the On Road section, detail for Source Type and/or Road Type can provide useful information and users will generally want to select at least one of these to be able to differentiate light and heavy duty emissions or restricted and unrestricted roadway emissions.

Another output option is SCC, an abbreviation for Source Classification Code. EPA uses SCCs to classify different types of anthropogenic emission activities. The existing SCCs for on-road vehicles are combinations of vehicle type and road type based on the classifications used in MOBILE6.2. When SCC output is selected, MOVES internally maps emissions by source type and road type to the MOBILE6.2 equivalents and then prepares output by SCC.

2.10.4.1 Output Emission Detail in Emission Rate Calculations

When the Emission Rates option is chosen in MOVES, Road Type is automatically selected in the Output Emission Detail Panel. Users should also select Source Type when using the Emission Rates option. If Source Type is not selected, MOVES will calculate aggregate emission rates for all source types based on the VMT by source type used as an input in the RunSpec (i.e., values entered using the County Data Manager). Thus, the output emissions rates would only be valid for the mix of VMT by source type used to aggregate them. When users select Source Type in Output Emissions Detail and produce a table of emissions rates by road type and source type, these emissions rates can be correctly applied to VMT estimates that may have different amounts of VMT by individual source type.

When Road Type and Source Type detail are selected, MOVES produces lookup tables of emission rates by source type and road type, for each average speed bin. These emission rates are independent of the source type population, vehicle type VMT, road type distribution, and average speed distribution entered in the CDM. For running emissions, users then post-process these lookup tables outside of MOVES to apply local VMT by source type and road type to the gram per mile emission rates for each speed bin (based on local distributions of average speed). For start and evaporative emissions, users would post-process the lookup tables outside of MOVES to apply local source type population information to the gram per vehicle emission rates. Additional detail on the applicability of data entered in the CDM when using the Emission Rates option is provided in the individual subsections of section 3 of this document.

2.11 Advanced Performance Features

The Advanced Performance Features panel is used to invoke features which may be used to improve the run time for long model runs by saving and reusing intermediate results. It is not required for use in SIPs or regional conformity analyses. Use of these features requires knowledge of the detailed software components of the MOVES program, the inputs they require, and the outputs they produce. Users interested in these features should review section 2.2.11 in the MOVES User Guide and the MOVES Software Design and Reference Manual.

Section 3: County Data Manager

3.1 County Data Manager

The County Data Manager (CDM) is a user interface developed to simplify importing specific local data for a single county or a user-defined custom domain without requiring direct interaction with the underlying MySQL database. Use of the CDM is necessary when the scale is set to County and is required for SIPs and regional conformity analyses.

Before a user can input any locality specific data, a database must be created on the Database tab. EPA recommends that this database name end with “_in” to indicate it is a user input database. When the database is created, MOVES keeps track of the selections made in the RunSpec at that moment. Users should be careful of making changes to the RunSpec after the Domain Input Database has been created, because this can create inconsistencies between the Domain Input Database and the rest of the RunSpec. Users should review section 2.3.3.4 of the MOVES User Guide for more information on the RunSpec and the Domain Input Database.

The CDM includes multiple tabs, each one of which opens importers that are used to enter specific local data. These tabs and importers are:

- Meteorology
- Source Type Population
- Age Distribution
- Vehicle Type VMT
- Average Speed Distribution
- Road Type Distribution
- Ramp Fraction
- Fuel Supply
- I/M Program

Each of the importers allows the user to create an import template file with required data field names and with some key fields populated. The user then edits this template to add specific local data with a spreadsheet application or other tool, and imports the data files into MOVES. In some importers, there is also the option to export default data from the MOVES database in order to review it. Once the user determines that the default data are accurate and applicable to the particular project, or determines that the default data need to be changed and makes those changes, the user then imports that data into MOVES. Details of the mechanics of using the data importers are provided in the MOVES User Guide. Guidance for the use of these importers for SIPs and regional conformity analyses is given below.

In order to complete a RunSpec at the County scale, the user must either import local data or review and import default data for each tab in the CDM except for Ramp Fraction. However, when running MOVES using the Emission Rates option, some of the inputs in the CDM may not actually be used, depending on the choices the user makes in the Output Emission Detail panel.

More details on the CDM and the importers it contains are given beginning with section 2.3.3.4 of the MOVES User Guide.

Although there is currently no importer in the CDM to enter local specifications for a Stage II program, this section of the document also includes guidance in section 3.11 on entering local information of Stage II refueling programs in MOVES.

3.2 Meteorology Data

Local temperature and humidity data are required inputs for SIP and regional conformity analyses with MOVES. Ambient temperature is a key factor in estimating emission rates for on-road vehicles with substantial effects on most pollutant processes. Relative humidity is also important for estimating NO_x emissions from motor vehicles. MOVES requires a temperature (in degrees Fahrenheit) and relative humidity (in percent – 0 to 100 scale) for each hour selected in the Run Spec. For example, MOVES requires a 24-hour temperature and humidity profile to model a full day of emissions on an hourly basis. EPA has created a tool (available at www.epa.gov/otaq/models/moves/tools.htm) that takes minimum and maximum daily temperatures and creates an hourly temperature profile that could be used as input to MOVES.

The choice of specific temperature and humidity data may depend on the type of analysis. For air quality modeling of a specific exceedance episode, actual hourly meteorological data for the episode or for a longer period may be required. For more generic modeling of average summer or winter day ozone or CO conditions for SIP or conformity purposes, users should input average daily temperature profiles during the months when ozone or CO exceedances typically occur. For ozone season analysis, users can enter the local average temperature profile (which could be based on average minimum and maximum temperatures) for July, or for the three month period that best represents the area's ozone season (typically June, July and August; or July, August, and September). For CO season analysis, users can enter the local average temperature profile (which could be based on average minimum and maximum temperatures) for January, or for the three month period that best represents the CO season (typically December, January, and February).

Temperature assumptions used for regional conformity analyses must be consistent with those used to establish the emissions budget in the SIP as required in the transportation conformity rule, 40 CFR §93.122(a)(6). Detailed local meteorological data are available from the National Climatic Data Center at www.ncdc.noaa.gov. The MOVES database also includes default average monthly temperature and humidity data for every county in the country. These default temperature and humidity data are based on 30 year averages from the National Climatic Data Center for the period from 1971 to 2000. EPA does not recommend using these default values for SIPs or regional conformity analyses. Sources of temperature data and any methods used to adjust them to fit the requirements of MOVES must be documented in any official SIP submission or conformity documentation.

3.2.1 Meteorology Data in Emission Rate Calculations

If the Emission Rate calculation type is chosen, users can enter a different temperature and humidity for each hour of the day to create an emission rate table that varies by temperature. Emission rates from a lookup table that varies by temperature can be post-processed outside of MOVES to calculate emissions for any mix of temperatures that can occur during a day. This creates the potential to create a lookup table of emission rates by temperature for the range of temperatures that can occur over a longer period of time such as a month or year from a

relatively small number of MOVES runs. Appendix A of the MOVES User Guide provides more detail about how to produce emission rate lookup tables by temperature.

The Meteorology Data Importer in MOVES is described in section 2.3.3.4.4 of the MOVES User Guide.

3.3 Source Type Population

Source type (vehicle type) population is used by MOVES to calculate start and evaporative emissions. In MOBILE6.2, starts and evaporative emissions were calculated as emission factors in grams per mile. As a result, start and evaporative emissions were related to VMT. However, the relationship between VMT and vehicle starts or evaporative emissions is not always consistent. Chained trips may involve multiple starts with relatively low VMT. Evaporative emissions depend more on how long a vehicle is parked than how many miles it is driven. In MOVES, start and resting evaporative emissions are related to the population of vehicles in an area rather than the VMT for those vehicles. Because vehicle population directly determines start and evaporative emission, users must develop local data for this input.

MOVES categorizes vehicles into 13 source types, which are subsets of 6 HPMS vehicle types in MOVES, as shown in Table 3.3. EPA believes that states should be able to develop population data for many of these source type categories from state motor vehicle registration data (e.g., motorcycles, passenger cars, passenger trucks, light commercial trucks) and from local transit agencies, school districts, bus companies, and refuse haulers (intercity, transit, and school buses, and refuse trucks). Estimating population for other source types may be more difficult. If population is not available for a particular source type, users could estimate population for that source type based on the MOVES default split of that source type within the HPMS vehicle class. In the absence of any other source of population data, users could base population estimates on the VMT estimates for a particular source type and the ratio of MOVES default population to VMT by source type. That ratio can be calculated by doing a very simple MOVES run at the national scale for the county in question, and including VMT and population in the output (a running emissions process must be selected to generate VMT). Local VMT times the ratio of default population to default VMT will give an estimate of local population based on local VMT.

Table 3.3 MOVES Source Types and HPMS Vehicle Types			
Source Type ID	Source Types	HPMS Vehicle Type ID	HPMS Vehicle Type
11	Motorcycle	10	Motorcycles
21	Passenger Car	20	Passenger Cars
31	Passenger Truck	30	Other 2 axle-4 tire vehicles
32	Light Commercial Truck	30	Other 2 axle-4 tire vehicles
41	Intercity Bus	40	Buses
42	Transit Bus	40	Buses
43	School Bus	40	Buses
51	Refuse Truck	50	Single Unit Trucks
52	Single Unit Short-haul Truck	50	Single Unit Trucks
53	Single Unit Long-haul Truck	50	Single Unit Trucks
54	Motor Home	50	Single Unit Trucks
61	Combination Short-haul Truck	60	Combination Trucks
62	Combination Long-haul Truck	60	Combination Trucks

Users who have already developed population data for MOBILE6.2 vehicle types can use the table A.1 in the Appendix of this document to assign those populations to the MOVES source types.

The Source Type Population Importer in MOVES is described in section 2.3.3.4.2 of the MOVES User Guide.

3.3.1 Source Type Population in Emissions Rate Calculations

If the Emission Rates option is used, and Source Type is selected in the Output Emission Detail panel, MOVES will produce emission rates for start and non-running evaporative emissions by source type in terms of grams per vehicle. Total start and non-running evaporative emissions would then be calculated outside of MOVES by multiplying the emission rates by the vehicle populations for each source type. In that case, data entered using the Source Type Population Importer just serves as a placeholder during emissions calculations within MOVES. However, the CDM still requires a complete source type population table to work. Users could supply a table with simple dummy values to produce the necessary emission rates. The guidance in this section concerning the use of local vehicle population data still applies whether local source type population is applied within MOVES using the Inventory option or outside of MOVES using the Emission Rate option.

3.4 Age Distribution

The age distribution of vehicle fleets can vary significantly from area to area. Fleets with a higher percentage of older vehicles will have higher emissions for two reasons. Older vehicles have typically been driven more miles and have experienced more deterioration in emission control systems. A higher percentage of older vehicles also means that there are more vehicles

in the fleet that do not meet newer, more stringent emissions standards. Surveys of registration data indicate considerable local variability in vehicle age distributions.

For SIP and conformity purposes, EPA recommends and encourages states to develop local age distributions. This basic guidance is unchanged from past guidance. However, MOVES categorizes the vehicle fleet into different vehicle classes and more model years than MOBILE6.2. To simplify the transition from MOBILE6.2 to MOVES, EPA has created data converters that take registration distribution input files created for MOBILE6.2 or NMIM and convert them to the appropriate age distribution input tables for MOVES. These converters are available at www.epa.gov/otaq/models/moves/tools.htm. As users develop new data in the future, EPA recommends recording those data according to MOVES vehicle classifications and model year breakdown.

A typical vehicle fleet includes a mix of vehicles of different ages. MOVES covers a 31 year range of vehicle ages, with vehicles 30 years and older grouped together. MOVES allows the user to specify the fraction of vehicles in each of 30 vehicle ages for each of the 13 source types in the model.

While the MOVES age distribution input asks for an age distribution by source type, EPA does not expect that detailed local age distribution data will be readily available for all 13 of these source types. If local age distribution information is not available for some source types, states can use the same age distribution for all source types within an HPMS vehicle class. For example, states could use the same age distribution for source types 31 and 32 if separate age distributions for passenger trucks and light commercial trucks are not available.

Local age distributions can be estimated from local vehicle registration data. If users are unable to acquire data to develop a local age distribution or have reason to believe that data about locally registered vehicles is not necessarily representative of that entire portion of the fleet (as may be the case with heavy duty vehicles), then MOVES national default age distributions can be used. A set of these national default age distributions for all source types and all calendar years is available on EPA's website at www.epa.gov/otaq/models/moves/tools.htm.

The default age distributions in MOVES are specific for each calendar year and include assumptions about changes in age distributions over time. If local registration age distributions are used, they normally should not change across calendar years. In particular, EPA will not accept SIP or regional conformity analyses that include modeling assumptions that the vehicle fleet will have a younger average age in the future than is reflected in the latest registration age distribution information currently available. States must fully document the sources of data and methods used to develop local age distributions used in modeling for SIP and conformity purposes.

The Age Distribution Importer in MOVES is described in Section 2.3.3.4.3 of the MOVES User Guide.

3.5 Vehicle Type VMT

EPA expects users to develop local VMT estimates for SIPs and regional conformity analyses. Travel demand forecasting models (TDFMs) are often the source of information used by MPOs and state DOTs to estimate VMT, though reasonable professional practice may also be used in many areas. Transportation modelers for MPOs and state DOTs traditionally adjust estimates of vehicle miles of travel generated through the TDFM process to the Highway Performance Monitoring System (HPMS) estimates of VMT and/or other locally developed actual vehicle counts. These procedures generate consistent VMT estimates from TDFMs for roadway functional classes within HPMS for use in SIP analysis. Section 3, “Developing Locality-Specific Inputs from Travel Demand Models,” of the EPA document, “Volume IV: Chapter 2, Use of Locality-Specific Transportation Data for the Development of Mobile Source Emission Inventories,” (September 1996), discusses how to reconcile traffic demand model results with HPMS VMT estimates. For regional conformity analysis, the transportation conformity regulations allow the interagency consultation process to determine if other information or procedures, such as locally developed count-based programs, may be acceptable (40 CFR 93.122(b)(3)).

As input, MOVES requires *annual* VMT by HPMS vehicle class. EPA has created a tool that allows users to input average annual daily VMT as well as monthly and weekend day adjustment factors to create the annual VMT by HPMS class and appropriate monthly and daily adjustments needed by MOVES.³ EPA has also created a set of software tools that can import VMT tables by MOBILE6.2 vehicle types (either 8, 12, 16, or 28 MOBILE6.2 vehicle types) and facility types, as well as MOBILE6.2 hourly VMT fractions, VMT mix, and ramp fractions and convert these to the equivalent MOVES tables of VMT by HPMS class, VMT fractions by hour, and road type distribution.⁴

Mapping MOBILE6.2 vehicle types to their equivalent MOVES source types is a complex process. Table A.2 in Appendix 2 shows the mapping scheme the converter tools use to convert VMT by MOBILE6.2 vehicle types to their equivalent MOVES source types. This table is provided here for reference. EPA strongly encourages states to use the converter tools to create the appropriate MOVES input tables from MOBILE6.2 data to avoid errors.

The Vehicle Type VMT Importer in MOVES is described in section 2.3.3.4.4 of the MOVES User Guide.

3.5.1 Vehicle Type VMT in Emissions Rate Calculations

If the Emission Rates option is used, and Source Type is selected in the Output Emission Detail panel, MOVES will produce emission rates for running emissions by source type and road type in terms of grams per mile. Total running emissions would then be calculated outside of

³ This spreadsheet-based tool is called “AAD VMT Calculator HPMS” and can be found at www.epa.gov/otaq/models/moves/tools.htm. Instructions for use of the VMT calculator can be found within the spreadsheet.

⁴ EPA’s Tools for MOVES website (www.epa.gov/otaq/models/moves/tools.htm) includes 8 different VMT spreadsheet-based converters to address ways VMT could be broken down by MOBILE6.2 vehicle types and facility types. The website describes the basic differences between the converters, and more detailed instructions on their use can be found within the spreadsheets.

MOVES by multiplying the emission rates by the VMT for each source type and road type. In that case, data entered using the Vehicle Type VMT Importer serves as a placeholder during emissions calculations within MOVES. However, the CDM still requires a complete VMT table to work. Users could supply a table with simple dummy values to produce the necessary emission rates. The guidance in this section concerning the use of local VMT data still applies whether local VMT is applied within MOVES using the Inventory option or outside of MOVES using the Emission Rate option.

3.6 Average Speed Distribution

Vehicle power, speed, and acceleration have a significant effect on vehicle emissions. MOVES models those emission effects by assigning activity to specific drive cycles or operating mode distributions. While direct input of operating modes and drive schedules is possible using Project Level inputs, the model also can use the distribution of vehicle hours traveled (VHT) by average speed to determine an appropriate operating mode distribution. Thus, for SIP development and for regional conformity analyses, where activity is averaged over a wide variety of driving patterns, a local speed distribution by road type and source type is a reasonable surrogate for more detailed local drive cycles or operating mode distributions. In these cases, EPA expects states to develop and use local estimates of average speed. The Average Speed Distribution importer in MOVES calls for a speed distribution in VHT in 16 speed bins, by each road type, source type, and hour of the day included in the analysis. EPA urges users to develop the most detailed local speed information that is reasonable to obtain. However, EPA acknowledges that average speed distribution information may not be available at the level of detail that MOVES allows. The following paragraphs provide additional guidance regarding the development of average speed distribution inputs.

Average speed, as defined for use in MOVES, is the distance traveled (in miles) divided by the time (in hours). This is not the same as the instantaneous velocity of vehicles or the nominal speed limit on the roadway link. The MOVES definition of speed includes all operation of vehicles including intersections and other obstacles to travel which may result in stopping and idling. As a result, average speeds, as used in MOVES, will tend to be less than nominal speed limits for individual roadway links.

Selection of vehicle speeds is a complex process. The recommended approach for estimating average speeds is to post-process the output from a local travel demand network model. In most transportation models, speed is estimated primarily to allocate travel across the roadway network. Speed is used as a measure of impedance to travel rather than as a prediction of accurate travel times. For this reason, speed results from most travel demand models must be adjusted to properly estimate actual average speeds.

To ease the transition from MOBILE6.2 to MOVES, EPA has provided data converters that convert MOBILE6.2 speed distribution inputs to MOVES format (an additional data converter is available to convert NMIM-formatted speed distributions to MOVES format). These converters also handle the conversion of a VMT based speed distribution to a VHT based speed distribution. These data converters are available at www.epa.gov/otaq/models/moves/tools.htm. These converters can assist users in applying current vehicle speed information for MOVES

inventories, if this reflects the latest available information for a given area. Over time, users will generate updated speed information for SIP or conformity analyses through updated travel demand modeling, rather than continuing to use data generated for the previous MOBILE6.2 model.

Speed is entered in MOVES as a distribution rather than a single value. Table 3.6 shows the speed bin structure that MOVES uses for speed distribution input. Section 3.6.4 of this document explains how to create a speed distribution from a single average speed. However, EPA encourages users to use underlying speed distribution data to represent vehicle speed as an input to MOVES, rather than one average value. Use of a distribution will give a more accurate estimate of emissions than use of a single average speed.

Table 3.6 MOVES Speed Bins		
Speed Bin ID	Average Bin Speed	Speed Bin Range
1	2.5	speed < 2.5mph
2	5	2.5mph <= speed < 7.5mph
3	10	7.5mph <= speed < 12.5mph
4	15	12.5mph <= speed < 17.5mph
5	20	17.5mph <= speed < 22.5mph
6	25	22.5mph <= speed < 27.5mph
7	30	27.5mph <= speed < 32.5mph
8	35	32.5mph <= speed < 37.5mph
9	40	37.5mph <= speed < 42.5mph
10	45	42.5mph <= speed < 47.5mph
11	50	47.5mph <= speed < 52.5mph
12	55	52.5mph <= speed < 57.5mph
13	60	57.5mph <= speed < 62.5mph
14	65	62.5mph <= speed < 67.5mph
15	70	67.5mph <= speed < 72.5mph
16	75	72.5mph <= speed

As is the case for other MOVES inputs, EPA does not expect that users will be able to develop distinct local speed distributions for all 13 vehicle source types. If local average speed distribution information is not available for some source types, states can use the same average speed distribution for all source types within an HPMS vehicle class. For example, states could use the same average speed distribution for source types 31 and 32 if separate average speed distributions for passenger trucks and light commercial trucks are not available. States could also use the same speed distributions across multiple HPMS vehicle classes if more detailed information is not available.

Average speed estimates for calendar years other than the calendar year on which the average speed estimates are based must be logically related to the current year methodology and estimates, with no arbitrary or unsupported assumptions of changes in average speeds. Future

average speed estimates should account for the effect of growth in overall fleet VMT on roadway congestion and average speeds.

The Average Speed Distribution Importer in MOVES is described in section 2.3.3.4.5 of the MOVES User Guide.

3.6.1 Additional Guidance for Inventories Used in Attainment Modeling

Results from photochemical models are sensitive to differences in the estimated inventory by time of day. For SIP-related on-road vehicle emission inventory development intended for use in photochemical models, EPA encourages states to develop and use their own specific estimates of VHT by average speed by hour of the day. However, hourly estimates are not required. In the absence of local hourly speed data, users could develop peak and off-peak speed distributions if available, or develop a daily average speed distribution. However, generating a daily average speed distribution for a highway network with a considerable number of highly congested links is not generally recommended as emissions can be significantly underestimated. The VHT fractions by average speed used in inventory modeling for SIPs and regional conformity analyses should be consistent with the most recent information used for transportation planning.

3.6.2 Additional Guidance for Speeds on Local Roadways

MOVES uses four different roadway types that are affected by the average speed distribution input: rural restricted access, rural unrestricted access, urban restricted access, and urban unrestricted access. In MOVES, local roadways are included with arterials and collectors in the urban and rural unrestricted access roads category. In MOBILE6.2, local roadways were a separate category with a fixed speed of 12.9 mph. For MOVES, EPA recommends that the average speed distribution for local roadway activity be included as part of a weighted distribution of average speed across all unrestricted roads along with the distribution of average speeds for arterials and connectors. Users who want to treat local roadways and arterials separately can develop separate average speed distributions and estimate results using two separate MOVES runs, each with appropriate VMT, one using the local roadway average speed distribution for unrestricted access roads and one using the arterial average speed distribution for unrestricted access roads. However, using properly weighted average speed distributions for the combination of all unrestricted access roads should give the same result as using separate average speed distributions for arterials and local roadways.

3.6.3 Average Speed Distributions in Emission Rates Calculations

If the Emission Rates option is used, and Source Type is selected in the Output Emission Detail panel, MOVES will produce a table of emission rates by source type and road type for each speed bin. Total running emissions would then be calculated outside of MOVES by multiplying the emission rates by the VMT for each source type in each speed bin. In that case, data entered using the Average Speed Distribution Importer is ignored by MOVES. However, the CDM still requires a complete speed distribution to work. Users could supply a table with simple dummy values to produce the necessary emission rates. The guidance in this section concerning the use of local speed distribution data still applies whether local average speed distributions are applied within MOVES using the Inventory option or outside of MOVES using the Emission Rate option.

3.6.4 Creating a Distribution from a Single Average Speed

If only a single average speed is available for a particular road type and that average speed is not identical to the average speed in a particular speed bin, users should apply the following formula for creating the appropriate speed distribution among two adjacent speed bins.

The general formula is:

VHT Fraction A in Speed Bin with closest average speed lower than observed average speed +
VHT Fraction B in Speed Bin with closest average speed higher than observed average speed = 1

VHT Fraction A = $1 - [(\text{observed average speed} - \text{average speed of lower speed bin}) / (\text{average speed of higher speed bin} - \text{average speed of lower speed bin})]$

VHT Fraction B = $1 - [(\text{average speed of higher speed bin} - \text{observed average speed}) / (\text{average speed of higher speed bin} - \text{average speed of lower speed bin})]$

Or more simply: VHT Fraction B = $1 - \text{VHT fraction A}$

The following example can be used as a guideline. If the single average speed for a roadway is 28.7 miles per hour, the average speed distribution will be split between the 25 and 30 bins with values of .26 and .74, respectively. These values are found with the following equations:

VHT Fraction A in 25 mph Speed Bin + VHT Fraction B in 30 mph Speed Bin = 1

$A = 1 - (28.7 \text{ mph Avg. Speed} - 25 \text{ mph (Bin Speed)}) / (30 \text{ mph Bin Speed} - 25 \text{ mph Bin Speed}) = 0.26$

$B = 1 - (30 \text{ mph Bin Speed} - 28.7 \text{ mph Avg. Speed}) / (30 \text{ mph Bin Speed} - 25 \text{ mph Bin Speed}) = 0.74,$

Or more simply, $B = 1 - A$

3.6.5 Average Speed Distributions for Ramps

The Average Speed Distribution for ramps should be included within the Average Speed Distribution for highways, but it must be properly weighted according to the VHT. To do this, the VHT and VMT for highways and ramps can be found separately using local data or the formula above if only a single average speed is known. The resulting VHT and VMT for each type of roadway can then be summed to find the combined total VHT and VMT on the roadways. The total VMT can then be divided by the total VHT to find a combined average speed and the equations above can then be used to calculate an average speed distribution.

For example, assume the user has data that 1.00 million miles were driven on urban ramps with an average speed of 34.6 mph (the MOBILE6.2 default value) and 10.0 million miles were driven on urban highways with an average speed of 52.0 mph. The combined speed distribution would be found as follows:

VHT on Ramps: 1.00 million miles / 34.6 mph = 28,900 hours

VHT on Highways: 10.0 million miles / 52.0 mph = 192,000 hours

Combined VHT: 28,900 hours + 192,000 hours = 220,900 hours

Combined VMT: 1.00 million miles + 10.0 million miles = 11.0 million miles

Combined Average Speed: 11.0 million miles / 220,900 hours = 49.8 miles per hour

Using the equations above, the average speed distribution for 49.8 mph is 0.96 in the 50 mph speed bin and 0.04 in the 45 mph speed bin.

This method is preferred for calculating the average speed on highways instead of finding a weighted and normalized distribution of the ramp and highway speeds individually. This is because MOVES associates ramp drive cycles with the overall average speed distribution input by the user, and cannot differentiate which speeds the user intends to correspond to ramps. For example, if the user input a portion of the speed distribution in the 30 mph speed bin, intending this to represent ramp speeds, MOVES would instead use the drive cycles more generally associated with congested highway activity at 30 mph, and not ramps specifically.

3.7 Road Type Distribution

The fraction of vehicle miles traveled (VMT) by road type varies from area to area and can have a significant effect on overall emissions from on-road mobile sources. EPA expects states to develop and use their own specific estimates of VMT by roadtype. The VMT fractions by road type used in inventory modeling for SIPs and regional conformity analyses should be consistent with the most recent information used for transportation planning.

For each source type, the Road Type Distribution table stores the distribution of VMT by road type (e.g., the fraction of passenger car VMT on each of the road types). EPA has created a series of VMT converters (based on different options for describing the MOBILE6.2 vehicle types), that also incorporate a road type distribution converter. These can be found at www.epa.gov/otaq/models/moves/tools.htm.

As is the case for other MOVES inputs, EPA does not expect that users will be able to develop local road type distributions for all 13 vehicle source types. If local road type distribution information is not available for some source types, states can use the same road type distribution for all source types within an HPMS vehicle class. For example, states could use the same road type distribution for source types 31 and 32 if separate average speed distributions for passenger trucks and light commercial trucks are not available. States could also use the same road type distribution across multiple HPMS vehicle classes if more detailed information is not available.

The Road Type Distribution Importer in MOVES is described in section 2.3.3.4.6 of the MOVES User Guide.

3.7.1 Road Type Distributions in Emission Rate Calculations

If the Emission Rates option is used, MOVES will automatically produce a table of emission rates by road type. Running emissions would then be calculated outside of MOVES by multiplying the emission rates by the VMT on each road type for each source type in each speed bin. In that case, data entered using the Road Type Distribution Importer is ignored by MOVES. However, the CDM still requires a complete road type distribution to work. Users could supply a table with simple dummy values to produce the necessary emission rates. The guidance in this section concerning the use of local road type data still applies whether local road type distributions are applied within MOVES using the Inventory option or outside of MOVES using the Emission Rate option.

3.8 Ramp Fraction

The default ramp fraction on both rural restricted roads (road type 2) and urban restricted roads (road type 4) is 8% of VHT. Use of the Ramp Fraction tab is optional (the default value of 8% will be automatically applied if the user does not import local data). Users who have good local data indicating a different fraction for ramp activity should use it.

The Ramp Fraction tab imports a table that duplicates the roadtype table in the MOVES default database. This table is structured so that the fraction of VHT on ramps for either rural restricted (road type 2) or urban restricted (road type 4) roads is entered in the rampFraction field.

In section 3.6 above, the example given demonstrates how the Ramp Fraction can be calculated using Average Speed and VMT on ramps and highways. In that example, the VHT on ramps was 28,900 and the total was 220,900 hours resulting in a ramp fraction of 0.131 or 13.1%.

An alternative approach is for users to separately model highways and ramps in two RunSpecs, if desired. To do this, activity on highways is modeled by setting Ramp Fraction equal to 0 and activity on ramps by setting Ramp Fraction to 1; for each run, the user would only input appropriate VMT in the Vehicle Type VMT tab (i.e., highway VMT for the first run and ramp VMT for the second). This approach allows users to separate emissions from the highway and ramp that cannot be done if the Ramp Fraction is used as fraction of total highway VMT.

Ramp fraction inputs are not applied when the Emission Rate option is selected and will not affect the rates on rural and urban restricted roads (road types 2 and 4, respectively).

The Ramp Fraction Importer in MOVES is described in section 2.3.3.4.7 of the MOVES User Guide.

3.9 Fuel (Formulation and Supply)

In general, users should first review the default fuel formulation and fuel supply data, and then make changes only where local volumetric fuel property information is available. The lone exception to this guidance is in the case of RVP where a user should change the value to reflect the regulatory requirements and differences between ethanol- and non-ethanol blended gasolines.

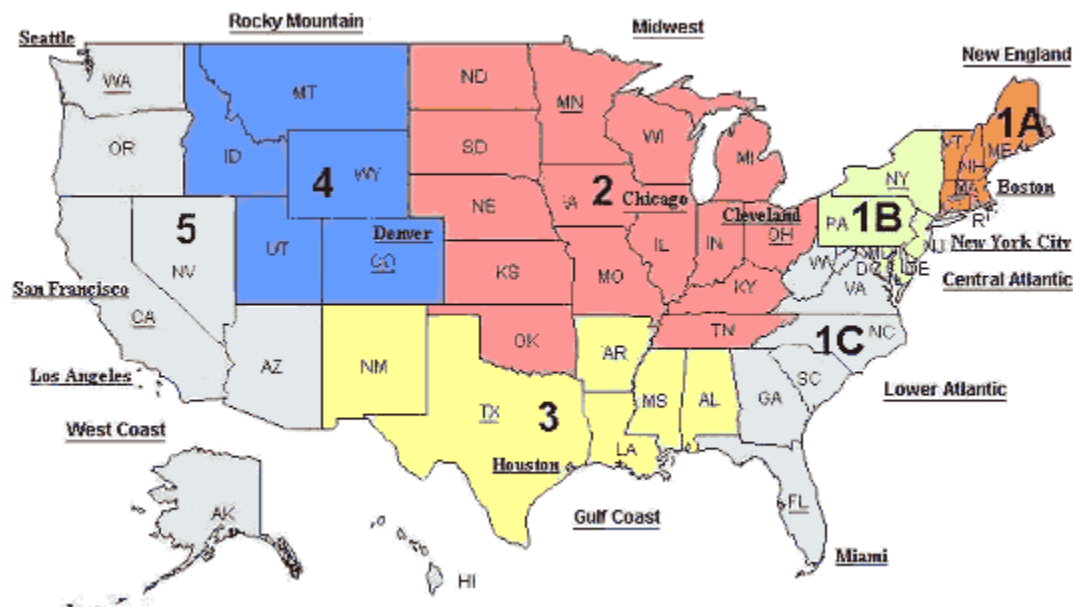
MOVES has two tables – called fuelformulation and fuelsupply – that interact to define the fuels used in the area being modeled. The fuelformulation table defines the attributes (such as RVP,

sulfur level, ethanol volume, etc.) of each fuel; the fuelsupply table identifies the fuel formulations used in an area and each formulation's respective market share. MOVES calculates fuel adjustments based on the attributes defined in the fuelformulation table. MOVES then uses the marketshare field from the fuelsupply table to appropriately weight the fuel adjustment factors. Users should refer to sections 2.3.3.4.8 and 2.3.3.4.9 of the MOVES user guide to ensure information has been properly entered and imported for all vehicle-fuel type combinations selected on the On Road Equipment and AVFT panels.

MOVES has default gasoline and diesel fuel formulation and supply information for every county-year-month combination that can be selected. The default fuels in each county were developed from two sources: 1) the NMIM County Database (NCD), which incorporates data from local, regional (refinery-level), and RFG fuel surveys, for years up to 2005; and 2) the Energy Information Administration's Annual Energy Outlook 2007, which projected fuel usage for 2012 (all later years are identical to 2012). Values for some fuel properties were interpolated in the gap between 2005 and 2012 to generate a consistent trend.

As a result of this interpolation, some fuel properties in the default database may not match actual local data. Users should take care to review the characteristics of the default fuel formulations and compare them with real world data, where available. This is particularly true for areas that use reformulated gasoline (RFG) as fuel property information in these areas is publicly available (see www.epa.gov/otaq/regs/fuels/rfg/proper/rfgperf.htm). Almost all RFG areas began blending gasoline with 10% ethanol (E10) shortly after the Renewable Fuel Standard (RFS) was passed in 2005. However, the default data may simply reflect a linear trend from 0% (or some other small amount) E10 market share in 2005 up to 100% E10 market share in 2012. Sources of publicly available fuel information outside of RFG areas are the National Institute for Petroleum Energy Research (NIPER) or the Alliance of Automobile Manufacturers (AAM) North American Fuel Survey.

If the user plans to enter local fuel property information into MOVES, characteristics of multiple sampled fuels should not simply be averaged to create one generic fuel. The volume of a fuel formulation consumed in an area is an important consideration and MOVES provides users the ability to enter multiple fuel formulations and the market share of each one. Therefore, if volumetric fuel data is not available, users should rely on the default values for most properties (RVP is the exception, see below). If users have volumetric information for some, but not all, of the fuel properties, new fuel formulations can be created that use the available local data and default values can be used for the unknown properties. Users can either rely on the default fuel properties in the county being modeled or from a fuel with the desired properties in the same Petroleum Administration Defense District (PADD) and the same year, if possible.



Petroleum Administration Defense Districts

Source: Energy Information Administration (EIA), a statistical agency of the U.S. Department of Energy.

3.9.1 Fuel Formulation

The following sections detail each field in the fuelformulation table and highlight the characteristics users should be able to provide and where default data can be used:

fuelformulationID: This number identifies the fuel and is entered in the fuelsupply table to define the fuel(s) used in the area being modeled. Users can either modify characteristics for an existing fuelformulationID or create a new fuelformulationID. It is recommended that if a new fuelformulationID is created, it be an unused number within the range for each fuel type: gasoline – 500 to 9999; diesel/biodiesel – 20000 to 21000; new fuel formulations should not be created for compressed natural gas (CNG) or electricity as there is only one form of these fuels.

fuelsubtypeID: This number provides a small level of detail about the type of fuel the formulation is describing. The fuelsubtype table in the default database contains the list of values for fuel sub-types that can be entered for this field. It is important that the fuel sub-type represent the fuel formulation being described, but in some cases there may be more than one fuel sub-type that describes the fuel formulation. The most common situation where this could arise is in the case of reformulated gasoline, where the description for fuelsubtypeID 11 is “Reformulated Gasoline (RFG).” However, many reformulated gasolines are blended with 10% ethanol and therefore have a fuelsubtypeID of 12 for “Gasohol (E10)” (generally speaking, any gasoline blended with ethanol should have one of the gasohol fuel sub-types). Most of the fuels that have fuelsubtypeID=11 are blended with an oxygenate other than ethanol, such as MTBE, ETBE, or TAME.

RVP stands for “Reid Vapor Pressure” and is measured in pounds per square inch (psi). This is a commonly used property to define the volatility of gasoline and users may be able to provide local information for this field where data has been collected; however, regulatory RVP levels should be used for future years as “over-compliance” on the part of fuel suppliers is not an enforceable measure. Areas covered by the federal volatility control program should see 40 CFR 80.27(b) for applicable RVP values and areas with SIP fuel programs should rely the state regulations describing the fuel program when modeling future years. In RFG areas, there is no specific RVP requirement that must be adhered to, only a VOC performance standard; therefore, historical RVP values can be used in future years. When regulatory RVP values are used in future years, users should be sure to properly account for the 1 psi ethanol waiver allowed under 40 CFR 80.27(d). In areas where this waiver applies, users should adjust the RVP of the fuel formulation to account for the 1 psi ethanol waiver in both E10 and non-ethanol blended fuel. This means that gasoline blended with 10% ethanol should have an RVP with an additional 1 psi above the applicable standard in 40 CFR 80.27, and non-ethanol blended gasolines should have their RVP set to the applicable standard in 40 CFR 80.27. For diesel fuel, CNG, and electricity, a value of zero should be entered for RVP.

sulfurLevel: The sulfur level is measured in parts per million (ppm) in terms of weight. Sulfur levels must be entered for all gasoline and diesel fuel. Recent rulemakings (see Tier 2 gasoline sulfur and Ultra-Low Sulfur Diesel (ULSD) rules, 65 FR 6698 and 66 FR 5002, respectively) have resulted in a changing landscape for sulfur levels in both gasoline and diesel fuels. Therefore, users can rely on default information if local data are not available, but additional detail will be given for both types of fuel below. For CNG and Electricity, a sulfur level of zero should be entered.

Gasoline: The Tier 2 gasoline sulfur rule established a national average of 30 ppm sulfur (S) and a cap of 80 ppm S, which was fully implemented in 2006 (except for the Geographic Phase-In Area, see 65 FR 6755, February 10, 2000). This means that some areas will have sulfur levels above 30 ppm S and users creating a new formulation should not assume 30 ppm S gasoline. Areas where the MOVES default gasoline sulfur level is above 30 should use this value unless local data on sulfur content are available. MOVES2010 does not provide additional benefits or reductions for sulfur levels below 30 ppm S.

Diesel: Between 2006 and 2010, the Ultra-Low Sulfur rule requires at least 80% of the highway diesel fuel sold to meet the 15 ppm S standard; the remaining 20% must meet the Low Sulfur Diesel standard of 500 ppm S. In the Regulatory Impact Analysis for the Non-road Diesel rule (RIA: EPA420-R-04-007, Rule: 69 FR 38957, June 29, 2004), a weighted average of the sulfur level in diesel fuel was estimated as 43 ppm S and in many areas, the MOVES default sulfur level value is 43 ppm S for these years because the singular value from the NCD was used to generate the fuel properties in MOVES. The default weighted value is acceptable if users do not have local data in this instance because the diesel sulfur value impacts the fuel adjustment in a linear fashion for all emission calculations. However, users can also enter two diesel fuel formulations, with sulfur level of 11 and 331 and market shares of 0.9 and 0.1, respectively, which would yield an average sulfur level of 43 ppm S and be more representative of actual fuel usage. If users have volumetric data for diesel fuel sulfur levels

in the area being modeled, this information can be entered in the sulfurLevel and marketShare fields of the fuelFormulation and fuelSupply tables, respectively.

ETOHVolume is short-hand for the percent by volume of ethanol the gasoline/ethanol mixture. With the promulgation of the Renewable Fuel Standard (RFS) (see 72 FR 23900, May 1, 2007), use of gasoline blended with 10% ethanol (E10) continues to increase and expand into parts of the country that historically have not used E10. However, there are two potential sources of error for differences between the default fuel and actual fuel usage. First, since the Annual Energy Outlook 2007 report was used to generate the default fuel properties for 2012, the geographic extent of E10 usage does not necessarily match current projections which incorporate the increased ethanol requirements proposed under the Energy Independence and Security Act of 2007. Second, where values for E10 market share were linearly interpolated between 2005 and 2012, they may not match actual market shares. Therefore, users should attempt to acquire information about the amount of ethanol blended fuel used in the modeled area, both for past and future years. For diesel fuel, CNG and Electricity, a value of zero should be entered.

MTBEVolume is short-hand for the percent by volume of the gasoline/MTBE mixture. The volume of MTBE used as part of the nation's fuel supply declined significantly with implementation of the RFS, but had it had been declining prior to that with bans in several states. However, MTBE usage was still fairly common from 1999-2005 and should be accounted for if those years are being modeled. Users can rely on default data for this variable or use local information where available, particularly if the MOVES default includes MTBE for a time when a local ban was in place. For diesel fuel, CNG, and Electricity, a value of zero should be entered.

ETBEVolume is short-hand for the percent by volume of the gasoline/ETBE mixture. ETBE was blended with gasoline in very limited amounts and default data can be used. For diesel fuel, CNG, and Electricity, a value of zero should be entered.

TAMEVolume is short-hand for the percent by volume of the gasoline/TAME mixture. TAME was blended with gasoline in very limited amounts and default data can be used. For diesel fuel, CNG, and Electricity, a value of zero should be entered.

AromaticContent: This field is the percent volume of aromatic hydrocarbon compounds in gasoline. Users can rely on default data. For diesel fuel, CNG, and Electricity, a value of zero should be entered.

OlefinContent: This field is the percent volume of olefinic hydrocarbon compounds in gasoline. Users can rely on default data. For diesel fuel, CNG and Electricity, a value of zero should be entered.

BenzeneContent: This field is the percent volume of benzene in gasoline. The default database accounts for the Mobile Source Air Toxics rule (see 72 FR 8428, February 26, 2007), which establishes a national average benzene content of 0.62 percent by volume. Users can rely on default data. For diesel fuel, CNG, and Electricity, a value of zero should be entered.

E200 is short-hand for the percent of gasoline that evaporates at 200 degrees Fahrenheit. Users can rely on default data. For diesel fuel, CNG, and Electricity, a value of zero should be entered.

E300 is short-hand for the percent of gasoline that evaporates at 300 degrees Fahrenheit. Users can rely on default data. For diesel fuel, CNG, and Electricity, a value of zero should be entered.

VolToWtPercentOxy is short-hand for the volume to weight ratio of the oxygenate blended with gasoline. The values are constant for each oxygenate: 0.3488 for ethanol, 0.1786 for MTBE blends, 0.1533 for ETBE, and 0.1636 for TAME. Users should enter the appropriate value if an oxygenate is present. For gasoline formulations without an oxygenate, and for diesel fuel, CNG, and Electricity, a value of zero should be entered.

BioDieselEsterVolume: This field is the percent volume of biodiesel in diesel fuel. A value of 100 can be entered for pure biodiesel. There are no default fuel formulations that contain any biodiesel and the user must provide information for the fuel parameters. This field should only be used with diesel fuels; a value of zero should be entered for all other fuel types.

CetaneIndex: The cetane index is a number that can be calculated from the diesel fuel's density and distillation range, but is not used in MOVES2010. A value of zero should be entered for all fuel types.

PAHContent: This field is the percent volume of Polycyclic Aromatic Hydrocarbons, but is not used in MOVES2010. A value of zero should be entered for all fuel types.

The Fuel Formulation Importer in MOVES is described in section 2.3.3.4.8 of the MOVES User Guide.

3.9.2 Fuel Supply

After the fuel formulations for the area being modeled have been reviewed and/or modified, the fuel supply table can be populated. There are six fields in this table. The countyID field identifies the area being modeled; this number is a 4- or 5-digits and is a concatenation of the FIPSstateID followed by the FIPScountyID. The fueleyearID is equal to the yearID for years up to 2012; for years after 2012, the fueleyearID should remain 2012. The monthgroupID is the same as the monthID; monthgroupID was built in to allow for the possibility of seasonal fuels, but that option is not currently functional. The fuelformulationID is explained above. The marketshare is described in detail below.

The marketshare is each fuel formulation's fraction of the volume consumed in the area. The marketshare should sum to one within each fuel type, listed below:

fuelTypeID	Description
1	Gasoline
2	Diesel Fuel
3	Compressed Natural Gas (CNG)
5	Placeholder
9	Electricity

In many cases, only gasoline and diesel fuel vehicles will be selected and therefore only these two fuel types have to be imported. Within each fuel type, multiple fuel formulations can be listed as long as the market share sums to one (e.g., three gasoline fuel formulations with market shares of 0.5, 0.4, and 0.1, and two diesel fuel formulations with market shares of 0.6 and 0.4).

If more vehicle-fuel combinations are selected on the On Road Vehicle Equipment panel (and some fraction of VMT assigned to them on the AVFT panel), then each additional fuel type must also be entered. However, it should be noted that only gasoline and diesel fuels exist in the default fuelsupply table; so if other fuel types are selected and the defaults are exported from the County Data Manager, no default alternative fuel formulations will be exported. Therefore, it is the user's responsibility to enter the fuelformulationID for the alternative fuel type in the fuelsupply table before importing.

The Fuel Supply Importer in MOVES is described in section 2.3.3.4.9 of the MOVES User Guide.

3.10 Inspection and Maintenance Programs

Inspection and maintenance programs continue to be important local control programs in many nonattainment areas. MOVES has simplified I/M program inputs compared to MOBILE6.2, but it includes the capability of modeling all the aspects of an I/M program that have a significant impact on vehicle emissions.

EPA recommends that users modeling an existing I/M program in MOVES begin by examining the default I/M program description included in MOVES for the particular county in question. The default I/M data can be reviewed by selecting the Export Default Data button in the I/M tab of the County Data Manager. Users should review the details of the default I/M program and make any necessary changes to match the actual local program. In particular, users should note that any grace periods or exemptions ages in an I/M program need to be included in the beginning and ending model years based on the calendar year of evaluation as discussed in section 3.10.5 of this document. The default I/M files do not incorporate grace periods or exemption ages.

The I/M program description includes the state, county and year IDs as well as pollutant process I/D, source type ID, fuel type ID, I/M program ID, inspection frequency, test standards ID, beginning and ending model years, and a compliance factor. It also includes a column labeled "useIMyn" which allows the user to turn off ("N") or on ("Y") the portion of the I/M program described in that row of the table.

The I/M Importer in MOVES is described in section 2.3.3.4.10 of the MOVES User Guide.

3.10.1 Pollutant process ID

MOVES estimates emission reductions from I/M programs for hydrocarbons, NO_x, and CO. For exhaust emissions, I/M programs can affect both running and start emissions. For evaporative emissions, I/M programs affect hydrocarbon emissions from fuel vapor venting and fuel leaks.

3.10.2 Source Type ID and Fuel Type ID

These entries are used to describe the source (vehicle) types and fuel types included in the I/M program. Users should check to make sure that the vehicle and fuel types match the I/M program parameters for the vehicles included in the local program. MOVES currently calculates I/M program benefits only for gasoline vehicles.

I/M programs have historically applied to vehicles by regulatory weight class; however, MOVES applies I/M benefits by source type. This can lead to discrepancies between the number of vehicles covered in the actual I/M program and the number of vehicles that MOVES assumes is covered. For example, an I/M program that targets trucks less than 8501 lbs. Gross Vehicle Weight Rating (GVWR) (i.e. regulatory classes LDT1, LDT2, LDT3, and LDT4) would include parts of two MOVES source types: passenger trucks (sourcetypeID 31), light commercial trucks (32). However, these sourcetypes also include vehicles with GVWR greater than 8501 lbs. When an I/M program is applied to source types 31 and 32 in MOVES, all of the vehicles in these source types get I/M benefits. EPA is working on a tool to resolve this complexity, but in the meantime, users can adjust the compliance factor to account for the fraction of vehicles within a source type that are actually covered by the I/M program. This process is described in section 3.10.6 of this document.

3.10.3 Inspection Frequency

MOVES allows users to enter either annual or biennial test frequency. MOVES also includes an option for continuous I/M, however, there are currently no emission benefits assigned to this option in MOVES.

3.10.4 Test Standards and I/M Program ID

MOVES allows users to choose between 13 exhaust emissions tests and 7 evaporative emissions tests, as listed in Table 3.10.4.

Table 3.10.4 MOVES I/M Emission Test Types		
Test Standards ID	Test Standards Description	Description
11	Unloaded Idle Test	Test performed while vehicle idles in Park or Neutral
12	Two-mode, 2500 RPM/Idle Test	Test performed while vehicle idles and at 2500 rpm
13	Loaded / Idle Test	Test performed while vehicle operates on a chassis dynamometer at constant load
21	ASM 2525 Phase-in Cutpoints	Test performed on a dynamometer, under load, through a defined “steady state” driving cycle at 25 mph and 25% load, at phase-in cutpoints.
22	ASM 5015 Phase-in Cutpoints	Test performed on a dynamometer, under load, through two defined “steady state” driving cycles at 25 mph and 25% load, and 15 mph and 50% load, at phase-in cutpoints.
23	ASM 2525/5015 Phase-in	Test performed on a dynamometer, under load, through two defined

Table 3.10.4 MOVES I/M Emission Test Types		
Test Standards ID	Test Standards Description	Description
	Cutpoints	“steady state” driving cycles at 25 mph and 25% load, and 15 mph and 50% load, at phase-in cutpoints.
24	ASM 2525 Final Cutpoints	Test performed on a dynamometer, under load, through a defined “steady state” driving cycle at 25 mph and 25% load, at final cutpoints.
25	ASM 5015 Final Cutpoints	Test performed on a dynamometer, under load, through a defined “steady state” driving cycle at 15 mph and 50% load, at final cutpoints.
26	ASM 2525/5015 Final Cutpoints	Test performed on an inertia-weighted dynamometer through two defined “steady state” driving cycles at 25 mph and 25% load, and 15 mph and 50% load, at final cutpoints.
31	IM240 Phase-in Cutpoints	Test performed on a dynamometer, under load, through a pre-defined “transient” driving cycle of up to 240 seconds at phase-in cutpoints.
33	IM240 Final Cutpoints	Test performed on a dynamometer, under load, through a pre-defined “transient” driving cycle of up to 240 seconds.
41	Evaporative Gas Cap Check	A test conducted by pressurizing the gas cap for the purpose of identifying leaks in the gas cap.
42	Evaporative System Pressure Check	A test conducted by pressuring the evaporative system by way of the fuel tank’s fillneck and sometimes referred to as the fillneck pressure (FP) test.
43	Evaporative System OBD Check	Test of the evaporative emission related systems and components performed by visual check of the MIL and scan of the OBD computer system for readiness, MIL status, and stored trouble codes, on 1996 and newer, OBD-equipped vehicles.
44	Evaporative Gas Cap and Pressure Check	A pair of tests to identify leaks in the gas cap (GC) and the rest of the vehicle’s evaporative system. The latter test is conducted by pressuring the evaporative system by way of the fuel tank’s fillneck and is referred to as the fillneck pressure (FP) test.
45	Evaporative Gas Cap and OBD Check	The evap OBD test performed in conjunction with a separate check of the gas cap (GC) for the purpose of identifying leaks in the gas cap not otherwise identified by the evap OBD check. This combination of tests can only be conducted on 1996 and newer, OBD-equipped vehicles.
46	Evaporative Pressure and OBD Check	The evap OBD test performed in conjunction with a separate fillneck pressure test.
47	Evaporative Gas Cap, Pressure and OBD Check	The evap OBD test performed in conjunction with a separate fillneck pressure test and gas cap test.
51	Exhaust OBD Check	Test of exhaust-related systems and components performed by visual check of Malfunction Indicator Light (MIL) and scan of on-board (OBD) computer for system readiness, MIL status and stored trouble codes, on 1996 and newer OBD-equipped vehicles only

In MOVES, I/M programs that have both exhaust and evaporative inspection components, including OBD programs, are modeled as two separate, simultaneous programs identified using different I/M program ID numbers in the I/M program ID column. Users should be careful to include both the exhaust and evaporative components to ensure proper credit for the program. Likewise, an I/M program that applies different tests to different vehicles (e.g., an IM240 program that applies to older model years and an OBD program that applies to newer model years) is also modeled as two separate, simultaneous programs identified using different I/M program ID numbers in the I/M program ID column and using the beginning and ending model year columns to differentiate what model years are covered by each program..

3.10.5 Beginning and Ending Model Years

MOVES uses these two columns to specify the beginning and ending model years affected by a particular part of the I/M program. For I/M programs without a grace period for new vehicles or an exemption period for older vehicles this is simply the first and last model year affected by the program.

For I/M programs with a grace period for new vehicles or an exemption period for older vehicles, this entry should reflect the actual model years covered by the program in the calendar year of evaluation. As a result, the beginning and ending model years for an I/M program may vary depending on the calendar year of analysis. For example, a typical OBD I/M program might apply to all model years beginning with 1996. However, if that program also includes a grace period during which newer vehicles are exempt from the program, the ending model year of the program should reflect the most recent model year included in the program based on the calendar year of analysis. For example, if in calendar year 2005, the most recent model year being tested in a program with a grace period is the 2002 model year, a MOVES run for calendar year 2005 would have an ending model year of 2002. An analysis of the same program for calendar year 2010 would have an ending model year of 2007.

Similar adjustments to the beginning model year should be made to account for exemptions of older model years. In that case, the beginning model year of the program should reflect the earliest model year still being tested. For example, if in 2005, the oldest model year still being tested in a program with exemptions for older vehicles is the 1985 model year, a MOVES run for calendar year 2005 would have a beginning model year of 1985. An analysis of the same program for calendar year 2010 would have a beginning model year of 1990.

Note that because of this treatment of beginning and end years, a unique set of I/M inputs would be needed for each calendar year modeled. This is different than MOBILE6.2, where one set of I/M inputs could be used for any calendar year.

3.10.6 Compliance Factor

MOVES uses the compliance factor input to account for both the compliance and waiver rates of the I/M program. Since both are calculated as multiplicative factors, the total compliance factor entered in MOVES is calculated as:

$$\text{Compliance Factor} = \text{compliance rate} \times [(100 - \text{waiver rate}) / 100]$$

The compliance rate is the percentage of vehicles in the fleet that complete the I/M program and receives either a certificate of compliance or a waiver. Historical compliance should be determined by sticker surveys, license plate surveys, or a comparison of the number of final tests to the number of vehicles subject to the I/M requirement. Planners should not assume a compliance rate of 100%. An area planning to implement an I/M program using a registration denial system that automatically generates compliance documents that uniquely identify the complying vehicle and that are serially numbered and accounted for, and that relies on centralized processing by government clerks with management oversight may assume a 96% rate for modeling purposes prior to program implementation. Once the program begins implementation, however, the compliance rate should be based on operating program data.

The waiver rate is the percentage of vehicles that fail an initial I/M test and do not pass a retest, but do receive a certificate of compliance. Actual historical waiver rates should be used as the basis for estimating future waiver rates. Because the Compliance Factor in MOVES is a measure of the percentage of vehicles operating in the modeling domain that actually receive an I/M benefit, the percentage of vehicles that are not waived (i.e., 100 – waiver rate) is used as one input when calculating the compliance factor.

As discussed in section 3.10.2, the compliance factor can also be used to adjust for the fraction of vehicles covered within a particular source type. This is done by using the information in Table A.1 in the Appendix of this document to determine what fraction of vehicles within a source type are covered by the I/M program. This fraction is then included along with the compliance rate and waiver rate to calculate the overall compliance rate for a particular source type.

Using the example from section 3.10.2, an I/M program that targets trucks less than 8501 lbs. GVWR (regulatory classes LDT1, LDT2, LDT3, and LDT4) would include parts of two MOVES source types: passenger trucks (sourcetypeID 31) and light commercial trucks (32). The user would determine the percentage of those regulatory classes in MOVES source types 31, and 32 using the information in Table A.1 in the Appendix to this document. This percentage would then be included along with the compliance and waiver rates to determine the compliance factor for the source type. If 97% of passenger trucks fell within the regulatory classes covered by the I/M program, and the compliance rate for the program is 96%, and the waiver rate is 8%, the overall compliance factor for passenger trucks will be:

$$\begin{aligned}\text{Compliance factor} &= \text{regulatory class coverage} \times \text{compliance rate} \times (1 - \text{waiver rate}) \\ 0.86 &= 0.97 \times 0.96 \times 0.92\end{aligned}$$

The compliance factor input can also be used to make any other necessary adjustments to the I/M program benefits. For example, if an I/M program does not apply to an entire county (or custom domain) the user could adjust the compliance factor by the fraction of VMT that occurs in the I/M covered area.

3.11 Stage II Refueling Programs

MOVES can model the effects of Stage II vehicle refueling controls. The two types of Stage II emissions included in MOVES are vapor displacement and spills. Stage II control programs can affect both types of losses and MOVES allows the user to specify the impact of controls on each type separately. The impact of controls for refueling losses are affected by a combination of the efficiency of the control technology, the coverage of the program (including the impact of exemptions) and the state of repair of the equipment, which is affected by the frequency of formal inspections.

There is currently no importer for this in the CDM. Appendix I of the MOVES User Guide explains how to review the appropriate data table in MOVES, how to create a new database in MOVES to account for Stage II, and how to input the database in MOVES using the Manage Input Data Sets panel (described in section 2.8 of this document and section 2.2.8 of the MOVES User Guide).

MOVES includes default county-level Stage II control efficiencies. Users should check that the default data is accurate for the local area. MOVES separates the Stage II control efficiency into two factors, a refueling vapor adjustment factor, and a spillage adjustment factor, which are measures of the efficiency of the Stage II program at reducing vapor displacement and spillage. Calculation of Stage II efficiency is addressed in Section 3.3.6.1 of “Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources,” (EPA-450/4-81-026d). This document may be obtained at www.epa.gov/otaq/invntory/r92009.pdf. In the absence of any local information that differentiates the efficiency of the Stage II program for controlling vapor displacement and spillage, the same control efficiencies should be used for both programs.

Appendix

Users who have already developed population data for MOBILE6.2 vehicle types can use the following table to assign those populations to the MOVES source types.

Table A.1 Population Mapping from MOBILE6.2 Vehicle Types to MOVES Source Types				
MOBILE6.2 Vehicle Type		MOVES Source Type		
ID	Name	ID	Name	Fraction
1	LDGV	21	Passenger Car	1.00
2	LDGT1	31	Passenger Truck	0.78
		32	Light Commercial Truck	0.22
3	LDGT2	31	Passenger Truck	0.78
		32	Light Commercial Truck	0.22
4	LDGT3	31	Passenger Truck	0.78
		32	Light Commercial Truck	0.22
5	LDGT4	31	Passenger Truck	0.78
		32	Light Commercial Truck	0.22
6	HDGV2B	31	Passenger Truck	0.63
		32	Light Commercial Truck	0.37
7	HDGV3	31	Passenger Truck	0.63
		32	Light Commercial Truck	0.37
8	HDGV4	31	Passenger Truck	0.06
		32	Light Commercial Truck	0.94
9	HDGV5	31	Passenger Truck	0.06
		32	Light Commercial Truck	0.94
10	HDGV6	43	School Bus	0.04
		52	Single Unit Short-haul Truck	0.69
		53	Single Unit Long-haul Truck	0.03
		54	Motor Home	0.23
		61	Combination Short-haul Truck	0.01
11	HDGV7	43	School Bus	0.04
		52	Single Unit Short-haul Truck	0.69
		53	Single Unit Long-haul Truck	0.03
		54	Motor Home	0.23
		61	Combination Short-haul Truck	0.01
12	HDGV8A	52	Single Unit Short-haul Truck	0.90
		53	Single Unit Long-haul Truck	0.08
		61	Combination Short-haul Truck	0.02
13	HDGV8B	52	Single Unit Short-haul Truck	0.90
		53	Single Unit Long-haul Truck	0.08
		61	Combination Short-haul Truck	0.02
14	LDDV	21	Passenger Car	1.00
15	LDDT12	31	Passenger Truck	0.42
		32	Light Commercial Truck	0.58
16	HDDV2B	31	Passenger Truck	0.43
		32	Light Commercial Truck	0.57

Table A.1 Population Mapping from MOBILE6.2 Vehicle Types to MOVES Source Types				
MOBILE6.2 Vehicle Type		MOVES Source Type		
17	HDDV3	31	Passenger Truck	0.43
		32	Light Commercial Truck	0.57
18	HDDV4	31	Passenger Truck	0.10
		32	Light Commercial Truck	0.90
19	HDDV5	31	Passenger Truck	0.10
		32	Light Commercial Truck	0.90
20	HDDV6	51	Refuse Truck	0.01
		52	Single Unit Short-haul Truck	0.72
		53	Single Unit Long-haul Truck	0.06
		54	Motor Home	0.07
		61	Combination Short-haul Truck	0.11
		62	Combination Long-haul Truck	0.03
21	HDDV7	51	Refuse Truck	0.01
		52	Single Unit Short-haul Truck	0.72
		53	Single Unit Long-haul Truck	0.06
		54	Motor Home	0.07
		61	Combination Short-haul Truck	0.11
		62	Combination Long-haul Truck	0.03
22	HDDV8A	51	Refuse Truck	0.02
		52	Single Unit Short-haul Truck	0.30
		53	Single Unit Long-haul Truck	0.02
		61	Combination Short-haul Truck	0.35
		62	Combination Long-haul Truck	0.31
23	HDDV8B	51	Refuse Truck	0.02
		52	Single Unit Short-haul Truck	0.30
		53	Single Unit Long-haul Truck	0.02
		61	Combination Short-haul Truck	0.35
		62	Combination Long-haul Truck	0.31
24	MC	11	Motorcycle	1.00
25	HDGB	43	School Bus	1.00
26	HDDBT	41	Intercity Bus	0.62
		42	Transit Bus	0.38
27	HDDBS	43	School Bus	1.00
28	LDDT34	31	Passenger Truck	0.42
		32	Light Commercial Truck	0.58

The following table shows the mapping scheme the converter tools use to convert VMT by MOBILE6.2 vehicle types to their equivalent MOVES source types.

Table A.2 Vehicle Miles Traveled Mapping from MOBILE6.2 Vehicle Types to MOVES Source Types				
MOBILE6.2 Vehicle Type		MOVES Source Type		
ID	Name	ID	Name	Fraction
1	LDGV	21	Passenger Car	1.00
2	LDGT1	31	Passenger Truck	0.78
		32	Light Commercial Truck	0.22
3	LDGT2	31	Passenger Truck	0.78
		32	Light Commercial Truck	0.22
4	LDGT3	31	Passenger Truck	0.78
		32	Light Commercial Truck	0.22
5	LDGT4	31	Passenger Truck	0.78
		32	Light Commercial Truck	0.22
6	HDGV2B	31	Passenger Truck	0.63
		32	Light Commercial Truck	0.37
7	HDGV3	31	Passenger Truck	0.63
		32	Light Commercial Truck	0.37
8	HDGV4	31	Passenger Truck	0.05
		32	Light Commercial Truck	0.95
9	HDGV5	31	Passenger Truck	0.05
		32	Light Commercial Truck	0.95
10	HDGV6	43	School Bus	0.03
		52	Single Unit Short-haul Truck	0.80
		53	Single Unit Long-haul Truck	0.06
		54	Motor Home	0.09
		61	Combination Short-haul Truck	0.02
11	HDGV7	43	School Bus	0.03
		52	Single Unit Short-haul Truck	0.80
		53	Single Unit Long-haul Truck	0.06
		54	Motor Home	0.09
		61	Combination Short-haul Truck	0.02
12	HDGV8A	52	Single Unit Short-haul Truck	0.88
		53	Single Unit Long-haul Truck	0.08
		61	Combination Short-haul Truck	0.04
13	HDGV8B	52	Single Unit Short-haul Truck	0.88
		53	Single Unit Long-haul Truck	0.08
		61	Combination Short-haul Truck	0.04
14	LDDV	21	Passenger Car	1.00
15	LDDT12	31	Passenger Truck	0.41
		32	Light Commercial Truck	0.59
16	HDDV2B	31	Passenger Truck	0.42
		32	Light Commercial Truck	0.58
17	HDDV3	31	Passenger Truck	0.42
		32	Light Commercial Truck	0.58
18	HDDV4	31	Passenger Truck	0.08
		32	Light Commercial Truck	0.92

Table A.2 Vehicle Miles Traveled Mapping from MOBILE6.2 Vehicle Types to MOVES Source Types				
MOBILE6.2 Vehicle Type		MOVES Source Type		
19	HDDV5	31	Passenger Truck	0.08
		32	Light Commercial Truck	0.92
20	HDDV6	51	Refuse Truck	0.01
		52	Single Unit Short-haul Truck	0.55
		53	Single Unit Long-haul Truck	0.05
		54	Motor Home	0.01
		61	Combination Short-haul Truck	0.27
		62	Combination Long-haul Truck	0.11
21	HDDV7	51	Refuse Truck	0.01
		52	Single Unit Short-haul Truck	0.55
		53	Single Unit Long-haul Truck	0.05
		54	Motor Home	0.01
		61	Combination Short-haul Truck	0.27
		62	Combination Long-haul Truck	0.11
22	HDDV8A	51	Refuse Truck	0.01
		52	Single Unit Short-haul Truck	0.08
		53	Single Unit Long-haul Truck	0.01
		61	Combination Short-haul Truck	0.42
		62	Combination Long-haul Truck	0.48
23	HDDV8B	51	Refuse Truck	0.01
		52	Single Unit Short-haul Truck	0.08
		53	Single Unit Long-haul Truck	0.01
		61	Combination Short-haul Truck	0.42
		62	Combination Long-haul Truck	0.48
24	MC	11	Motorcycle	1.00
25	HDGB	43	School Bus	1.00
26	HDDBT	41	Intercity Bus	0.73
		42	Transit Bus	0.27
27	HDDBS	43	School Bus	1.00
28	LDDT34	31	Passenger Truck	0.41
		32	Light Commercial Truck	0.59