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# Using MOVES to Prepare Emission Inventories in State Implementation Plans and Transportation Conformity:

Technical Guidance for MOVES2010, 2010a and 2010b

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## Technical Guidance for MOVES2010, 2010a and 2010b

Transportation and Climate 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. EPA created MOVES as a state-of-the-art model for estimating emissions from all on-road vehicles including cars, trucks, motorcycles, and buses. MOVES is based on analysis of millions of emission test results and considerable advances in the Agency's understanding of vehicle emissions. 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 for any part of the country, except California.<sup>1</sup>

In 2010, the MOVES model version called MOVES2010 officially replaced the previous on-road emissions model, MOBILE6.2. Subsequently, EPA has made minor revisions to this version in releases of MOVES2010a and MOVES2010b; hereafter, we use the term "MOVES" to mean any of these three versions.

MOVES incorporates substantial recent 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. MOVES significantly improves estimates of criteria pollutants compared to MOBILE6.2, EPA's earlier model. MOVES also has a new software framework that provides more flexibility for input and output options than MOBILE6.2.<sup>2</sup> 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

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 ("regional conformity analyses") in states other than California. This document supersedes the previous technical guidance. A "regional emissions analysis" for transportation conformity purposes involves estimating on-road motor vehicle emissions at the regional level. However, this term could be confused with the process of creating an inventory for a SIP. To avoid that confusion, an analysis done for transportation conformity is referred to as a "regional conformity analysis" in this document. MOVES can estimate motor vehicle emissions at

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<sup>1</sup> In California, a different on-road emissions model, EMFAC, is used for regulatory purposes instead of MOVES.

<sup>2</sup> New input options in MOVES and changes in the way MOVES handles existing information may appear to require more types of information as compared to MOBILE6.2; however, in most cases, existing MOBILE6.2 inputs can be modified to be used with MOVES.

various scales: National, County, and Project. Use of the County scale is required for SIPs and regional conformity analyses. This guidance covers the use of the County scale only.

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 web site ([www.epa.gov/otaq/models/moves/index.htm](http://www.epa.gov/otaq/models/moves/index.htm)). It also presumes a basic understanding of SIP and conformity regulatory requirements and policy.

MOVES is designed to allow users to analyze motor vehicle emissions at multiple scales, from national to county scale to project scale, using different levels of input data. 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 typically not the most current or best available information for any specific county. This guidance describes when the use of that default database is appropriate for SIPs and regional conformity analyses.

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, are addressed separately in updates to guidance documents for those programs.<sup>3</sup> 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 four major sections. The last two sections are 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 helps with planning an emissions analysis with MOVES.
- Section 3 focuses on the individual parameters used to create a MOVES Run Specification (RunSpec) file. In general, these parameters define the type of MOVES run, the time period, location, vehicle types, road types, and pollutants, and how detailed MOVES output will be.
- Section 4 describes 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.

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<sup>3</sup> MOVES users should check [www.epa.gov/otaq/stateresources/transconf/policy.htm](http://www.epa.gov/otaq/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 [www.epa.gov/otaq/models/moves/index.htm](http://www.epa.gov/otaq/models/moves/index.htm)) to find any updates to MOVES or this guidance.

### **1.3 How do MOVES2010a and MOVES2010b compare to MOVES2010, and which one should I use?**

MOVES2010a and 2010b are minor revisions to the MOVES2010 model. Neither of these revisions are considered to be a new emissions model for SIP and conformity purposes and thus neither minor revision began a new emissions model grace period under 40 CFR 93.111.

EPA released MOVES2010a in September 2010. That minor revision primarily affects greenhouse gases rather than criteria pollutants. MOVES2010a incorporates car and light truck greenhouse gas emission standards affecting model years 2012-and-later (published May 7, 2010) and updates effects of corporate average fuel economy standards affecting model years 2008-2011. MOVES2010a includes reductions in greenhouse gases associated with those standards in future calendar years, and small reductions in refueling and sulfur-related emissions associated with the reductions in vehicle fuel consumption. MOVES2010a also includes a number of other improvements, explained in an EPA factsheet, "EPA Releases MOVES2010a Mobile Source Emissions Model Update: Questions and Answers," found on the web at [www.epa.gov/otaq/models/moves/MOVES2010a/420f10050.pdf](http://www.epa.gov/otaq/models/moves/MOVES2010a/420f10050.pdf).

MOVES2010b was released in April 2012. This minor revision includes the 2010a improvements and some additional changes. For example, MOVES2010b provides more flexibility for varying inputs within a single custom domain, and relocates the interface for entering data about Advanced Vehicle and Fuel Technologies from the main input panel to the County Data Manager. MOVES2010b also includes a number of other improvements, explained in an EPA factsheet, "EPA Releases MOVES2010b Mobile Source Emissions Model Revision: Questions and Answers," found at EPA's MOVES website, [www.epa.gov/otaq/models/moves/index.htm](http://www.epa.gov/otaq/models/moves/index.htm).

EPA finds it acceptable to use MOVES2010, MOVES2010a, or MOVES2010b for SIPs and regional conformity analyses. EPA recognizes that state and local agencies that have already begun a modeling analysis for a SIP with one of these models may wish to continue the analysis with that same model. However, when starting a new SIP or regional conformity analysis, EPA recommends using MOVES2010b to take full advantage of the improvements incorporated in this version. More information on the implementation of these models for SIP and regional conformity analysis is available in the "Policy Guidance on the Use of MOVES2010 for State Implementation Plan Development, Transportation Conformity, and Other Purposes" (see Section 1.4 below.) An input database converter is included with MOVES2010b that allows users to convert input databases created with MOVES2010a into a format compatible with MOVES2010b.

This guidance applies to all three versions of MOVES2010. It has been updated to reflect MOVES2010b, and where MOVES2010 and MOVES2010a differ, it is noted.

### **1.4 What other MOVES guidance is available?**

EPA has released other MOVES guidance and documentation. Listed here are several EPA documents that may be of particular interest:

- “Policy Guidance on the Use of MOVES2010 for State Implementation Plan Development, Transportation Conformity, and Other Purposes,” EPA-420-B-12-010, April 2012, addresses general policy issues for MOVES such as timing of the use of MOVES in SIPs and regional conformity analyses. This latest version of this guidance is available at [www.epa.gov/otaq/stateresources/transconf/policy.htm#models](http://www.epa.gov/otaq/stateresources/transconf/policy.htm#models).
- “Transportation Conformity Guidance for Quantitative Hot-spot Analyses in PM<sub>2.5</sub> and PM<sub>10</sub> Nonattainment and Maintenance Areas,” EPA-420-B-10-040, December 2010, provides guidance on using MOVES for quantitative PM<sub>10</sub> and PM<sub>2.5</sub> hot-spot analysis for transportation projects. This guidance is also available at [www.epa.gov/otaq/stateresources/transconf/policy.htm#project](http://www.epa.gov/otaq/stateresources/transconf/policy.htm#project).
- “Using MOVES in Project-Level Carbon Monoxide Analyses,” EPA-420-B-10-041, December 2010, provides guidance on using MOVES for CO emissions from transportation projects. This guidance is available at [www.epa.gov/otaq/stateresources/transconf/policy.htm#project](http://www.epa.gov/otaq/stateresources/transconf/policy.htm#project).
- “Using MOVES for Estimating State and Local Inventories of On-Road Greenhouse Gas Emissions and Energy Consumption” (EPA-420-D-001, January 2012, draft) describes how to use MOVES to estimate greenhouse gas emissions and/or energy consumption from on-road vehicles in a state or metropolitan area. The latest version of this guidance document is available at [www.epa.gov/otaq/stateresources/ghgtravel.htm](http://www.epa.gov/otaq/stateresources/ghgtravel.htm).

EPA’s MOVES website, [www.epa.gov/otaq/models/moves/index.htm](http://www.epa.gov/otaq/models/moves/index.htm), contains all of EPA’s guidance and documentation about the MOVES model, including user guides for the latest models, instructions for downloading MOVES, notices of upcoming MOVES training, and how to subscribe to EPA’s MOVES email announcements.

Information on the use of MOVES in SIPs and regional conformity analyses may also be found at [www.epa.gov/otaq/stateresources/transconf/policy.htm](http://www.epa.gov/otaq/stateresources/transconf/policy.htm).

### **1.5 Whom do I contact for additional information?**

General questions about this guidance should be sent to [mobile@EPA.gov](mailto: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. Regional contacts for transportation conformity can be found at <http://www.epa.gov/otaq/stateresources/transconf/contacts.htm>.

## Section 2: Planning Your Emissions Analysis

MOVES is a flexible model using an array of input and output options, allowing more than one way to use MOVES to develop emissions estimates. This section covers approaches to developing on-road inventories for SIP and regional conformity analysis purposes using MOVES. These approaches affect the number of runs that will be needed and the degree to which additional data calculations or post-processing of the MOVES output will be necessary after the runs. The interagency consultation process should be used to determine which options will best meet the needs of the region. This section addresses how to make that determination when planning MOVES runs. This section covers the following topics:

- The types of inventories that users may need to create;
- The types of data that will be needed to run MOVES;
- Options for calculating an inventory within or outside of MOVES;
- Options for modeling more than one county; and
- A summary of planning approaches for a SIP or conformity inventory.

### ***2.1 For what purposes are on-road emission inventories created?***

State and local air quality and transportation agencies estimate on-road vehicle emissions for a variety of different regulatory purposes. Inventories are required for reasonable further progress, attainment, and maintenance SIPs. These inventories may serve as the basis for the SIP motor vehicle emissions budget, which are used in regional conformity analyses. Emission estimates are also created specifically for air quality modeling for attainment demonstrations. On-road emissions are calculated as part of the regional conformity analysis for transportation plan and transportation improvement program (TIP) conformity determinations as well as the regional emissions analysis associated with projects in isolated rural areas. Users may create emission inventories for submission to 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 regional conformity analyses. However, EPA recognizes that state and local agencies sometimes use different methods and different levels of detail in creating inventories depending on the intended purpose.

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 for a specific nonattainment episode or for a large number of specific days covering all or part of a season or year to be modeled in the attainment demonstration. For the development of the SIP's motor vehicle emissions budgets and regional conformity analyses, an emission inventory based on typical seasonal day (e.g., typical summer day for ozone precursors) or annual inventory that is based on monthly emissions (e.g., annual PM<sub>2.5</sub> standard) generally is sufficient. Users should consult with their EPA Regional Office if questions arise.

## **2.2 What data are required to run MOVES?**

MOVES needs certain information regarding the time and place being modeled in order to calculate emissions, including information about vehicle miles traveled (VMT) by vehicle type, the number of each type of vehicle in the fleet (that is, the population of vehicles), vehicle age distribution, fuel information, meteorological data, et cetera. Section 3 of this guidance describes the information that is needed and how users can enter it.

For most inputs, users must input local data, but there are some inputs where relying on the default database of information included in MOVES is acceptable as discussed in Section 4. As with any model, the quality of the inputs affects the quality of the model's results. Including specific information about a particular county or set of counties helps to ensure that the emissions estimates from MOVES will be as accurate as possible. The data in the MOVES database are typically not the most current or best available for any specific county. However, there are some instances where default information can be used without affecting the quality of the results. Section 3 discusses the data fields for which it would be acceptable to use default data.

## **2.3 What options do users have for calculating an inventory within or outside of MOVES?**

MOVES offers two options for calculation type:

- With an Inventory approach, users input VMT and vehicle population data into MOVES and the model calculates the inventory. Output is total emissions in units of mass.
- With the Emission Rates approach, users apply VMT and vehicle population to the emission rates that MOVES generates to calculate an inventory (although VMT and vehicle population data are still needed as inputs for an Emission Rates MOVES run). The Emission Rates approach produces a look-up table of emission rates. Output examples include emissions per unit of distance for running emissions, per profile for evaporative processes, or per vehicle for starts and extended idle emissions.

Users may select either the Inventory or Emission Rates approach to develop emissions estimates for SIPs and regional conformity analyses.<sup>4</sup> Differences in input for Inventory versus Emission Rate calculation are noted in the guidance text. Using the Inventory method may be preferable when the user wants to minimize post-processing steps required thus avoiding inadvertent errors during post-processing. The Emission Rates method may be preferable when the user wants to apply emission rates to multiple geographic locations.

## **2.4 What options do users have to model more than one county?**

Users have two options for defining an area when using the County scale: either County or Custom Domain (described in Section 3.4 of this document). The County *scale* must be used for SIP and regional conformity analysis; within the County scale, users have the options of modeling an individual county (the “County” option) or a group of counties (the “Custom

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<sup>4</sup> Section 3.2.2 includes a discussion of the equivalency of the Inventory and Emission Rates options in calculating emissions.

Domain” option). Selecting the County option allows one county to be modeled in the run; the user chooses the particular county from a pull-down menu from the geographic bounds panel. When only one county is being modeled, selecting County as the region within the County scale is the choice to make.

For a multi-county area, though, users have two approaches. One approach is to select the County option and run MOVES multiple times, once for each county. Use of the County option allows the user to access more easily some of the MOVES database default inputs for that county if appropriate. Each run where County is chosen will produce output for the county selected.

The second option is to select Custom Domain as the region within the County Scale, which allows the user to define 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. MOVES2010b provides additional flexibility when using Custom Domain:

- In MOVES2010 or MOVES2010a, one set of inputs is used to describe the entire Custom Domain. Therefore, multiple counties can be modeled with a Custom Domain only if they have the same meteorology, vehicle age distribution, average speed distribution, road type distribution, ramp fraction, fuel formulation and supply, and I/M program. All of the user inputs apply to the entire custom domain, and the output MOVES generates applies to the entire Custom Domain.
- In MOVES2010b, the user can vary vehicle activity by zone within a Custom Domain, and generate output by zone as well. Zones can be the individual counties within the Custom Domain. Vehicle age distribution, fuel formulation and supply, and I/M program must be the same throughout the Custom Domain, but the user can vary meteorology inputs by zone and allocate vehicle activity among the zones. Total activity in terms of VMT and population is provided for the entire area, and MOVES allocates these data to the zones based on factors the user inputs. The advantage is that the user can model a multi-county area and generate output for each county (or zone) with a single run.

When Custom Domain is selected, users do not have direct access to county-specific information in the MOVES database, but modelers can obtain this information with some extra steps. Section 3.4 provides further information on County and Custom Domain, including how activity can be allocated by zone in MOVES2010b.

## ***2.5 What are the options for creating inventories for SIPs and conformity?***

The choices in selection of calculation type and modeling domain imply that there is more than one approach for creating an on-road emission inventory for an area made up of more than one county, such as a metropolitan area. For example:

- Each county could be modeled individually, either with Inventory or with Emission Rates, depending on the user’s preference.

- The user could define the modeling area as one or more Custom Domains. In some cases, one Custom Domain might be appropriate for an entire metropolitan area; in metropolitan areas made up of many counties, more than one Custom Domain may be needed. MOVES2010b allows the user to vary activity by county and generate output by county (or zone).
- Another option a modeler could use would be to model one county as a representative county with Emission Rates to generate emission rates at various temperatures. These emission rates could then be applied to a larger area, as long as fuel used and the I/M program in the larger area is the same as that modeled for the representative county.

Table 1 summarizes the combinations of calculation type and geographic area definition that users can employ for creating emissions inventories using the County scale. Any of the combinations will produce accurate results when executed correctly. The number of counties included in the area to be modeled and whether results for each individual county are needed are key considerations in choosing an approach.

**Table 1: Summary of Modeling Approaches Using the County Scale**

<b>Geographic Area</b>	<b>Approach</b>	<b>Advantages</b>	<b>Considerations</b>
One county, using County option	Use Inventory	<ul style="list-style-type: none"> <li>• Shorter run time and smaller output files</li> </ul>	
	Use Emission Rates	<ul style="list-style-type: none"> <li>• Rates can be applied on a link basis if desired</li> </ul>	<ul style="list-style-type: none"> <li>• Longer run time, larger output files</li> <li>• Users may want to estimate start and evaporative emissions with a separate run, because number of starts and temperatures vary by hour</li> <li>• Running, start, evaporative, and extended idle rates must be post-processed to create an inventory</li> </ul>
Multi-county area using County option	Use Inventory and County to model each county separately	<ul style="list-style-type: none"> <li>• Automatic access to MOVES default database</li> <li>• Produces results for each county</li> </ul>	<ul style="list-style-type: none"> <li>• An individual run is needed for each county, so this strategy is more feasible if the number of counties is small</li> </ul>
	Use Emission Rates and County to model a representative county (or counties), and create inventories from rates with activity data for each county	<ul style="list-style-type: none"> <li>• Only one run per representative county is necessary</li> <li>• Allows user to generate results for each county</li> <li>• Automatic access to MOVES default database</li> <li>• Rates can be applied on a link basis if desired</li> <li>• Better able to model an area when vehicle characterization (age distribution, fuel type, I/M) are uniform in the area, but temperatures vary widely</li> </ul>	<ul style="list-style-type: none"> <li>• Emission rates from the representative county can be used for other counties only if they have the same fuels and I/M program as the representative county (i.e., a separate run is needed for each combination of fuel type and I/M program present in the area). See Section 4.10 (fuels) and Section 4.11 (I/M programs) for more information.</li> <li>• Users may want to estimate start and evaporative emissions with a separate run because number of starts and temperatures vary by hour</li> <li>• Running, start, evaporative, and extended idle rates must be post-processed to create an</li> </ul>

Geographic Area	Approach	Advantages	Considerations
			inventory
Multi-county area using Custom Domain	Use Inventory and Custom Domain to model the entire area	<ul style="list-style-type: none"> <li>• Only one run per Custom Domain is necessary</li> <li>• MOVES2010b: Some vehicle activity can be varied by county within the Custom Domain and output can be generated by county</li> </ul>	<ul style="list-style-type: none"> <li>• No automatic access to MOVES default database</li> <li>• The same fuels and I/M program must apply throughout the area of the custom domain</li> <li>• MOVES2010, MOVES2010a: Results cannot be easily disaggregated by county</li> </ul>
	Use Emission Rates and Custom Domain to model the entire area, and create inventories from rates with activity data for each county  <i>Note: this approach has no advantage over using Emission Rates and a representative county (see below)</i>	<ul style="list-style-type: none"> <li>• Only one run per Custom Domain is necessary</li> <li>• Allows user to generate an inventory for each county, by taking the MOVES output of emission rates and multiplying them by activity data from each county</li> <li>• Rates can be applied on a link basis if desired</li> </ul>	<ul style="list-style-type: none"> <li>• No automatic access to MOVES default database</li> <li>• The same fuels and I/M program must apply throughout the area of the custom domain</li> <li>• Users may want to estimate start and evaporative emissions with a separate run because number of starts and temperatures vary by hour</li> <li>• Running, start, evaporative, and extended idle rates must be post-processed to create an inventory</li> </ul>
Multi-county area, with rates by temperature	Use Emission Rates and County to model a representative county; model each hour as a separate temperature to get emission rates for each temperature; then create inventories from rates at the appropriate temperature with activity data for each county	<ul style="list-style-type: none"> <li>• Allows user to generate results for each county</li> <li>• Automatic access to MOVES default database</li> </ul>	<ul style="list-style-type: none"> <li>• Several representative counties will need to be run to capture the combinations of fuels and I/M programs that exist</li> <li>• Users may want to estimate start and evaporative emissions with a separate run because number of starts and temperatures vary by hour</li> <li>• Running, start, evaporative, and extended idle rates must be post-processed to create an inventory</li> <li>• Users will need to use care to ensure appropriate rates are used for each county</li> </ul>

## Section 3: Creating a Run Specification File

### 3.1 How is a Run Specification (RunSpec) Created?

Users establish a RunSpec file to define the place and time period of the analysis as well as the vehicle types, road types, fuel types, and the emission-producing processes and pollutants that will be included in the analysis. In other words, the MOVES RunSpec defines the question you are asking. The RunSpec is a computer file in XML format that can be edited and executed directly, or that can be accessed, changed, and run through the MOVES graphical user interface (GUI).

The Navigation Panel in the MOVES GUI is used to access a series of other panels and tabs that specify the RunSpec file. The following subsections describe each set of input options needed to create the RunSpec, as defined in the Navigation Panel. When estimating emissions for a SIP or regional conformity analysis, the user would progress through the Navigation Panel and make the appropriate selections or data as follows:

- Description
- Scale and Calculation Type (Inventory or Emissions Rate)
- Time Spans
- Geographic Bounds
- Vehicles/Equipment
- Road Type
- Pollutants and Processes
- Manage Input Data Sets
- Strategies
- Output
- Advanced Performance Features

Each panel is described below and the appropriate references to the MOVES User Guide are indicated. Note that selections made in some panels affect available options in other panels. While MOVES does allow the user to complete these panels in any order, we recommend filling them out in the order they appear in the Navigation panel.

*Tip: The entire RunSpec should always be completed before the user creates an input database in the County Data Manager.*

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#### 3.1.1 Description

(MOVES User Guide Section 2.2.1)

The Description panel allows the user to enter a description of the RunSpec using up to 5,000 characters of text. Entering a complete description of the RunSpec will help users keep track of their MOVES runs. The description may also be helpful in documenting the run for external reviewers of a SIP or conformity analysis.

## 3.2 Scale and Calculation Type

(MOVES User Guide Section 2.2.2)

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. 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 between these two options.

*Tip: Use of the County scale is required for SIPs and for regional conformity analyses.*

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### 3.2.1 Domain/Scale

(Section 2.2.2 of the MOVES User Guide)

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 regional conformity analyses.**
- 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 regional conformity analyses.** Detailed guidance on specific inputs in the County Data Manager, including the use of default inputs, is given in Section 4 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 CO, PM<sub>2.5</sub> and PM<sub>10</sub> nonattainment and maintenance areas is described in a separate guidance document which is available at [www.epa.gov/otaq/stateresources/transconf/policy.htm#project](http://www.epa.gov/otaq/stateresources/transconf/policy.htm#project).

### 3.2.2 Calculation Type

(Section 2.2.2.2 of the MOVES User Guide)

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 approach 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 may choose either the Inventory or Emission Rates approach depending on their preference. As discussed in Section 2 of this document, each approach has advantages and limitations and users will need to decide which approach is more appropriate for the type of analysis they are conducting. Both approaches use the same underlying emission data and will produce the essentially same results if the user calculates an inventory from rates in the same way that MOVES does this internally.

As noted in Section 2.5, the Emission Rates approach is more complex than the Inventory approach. Successful application of this approach requires careful planning and a clear understanding of the rates calculations in MOVES. Using the Emission Rates approach may require multiple model runs to cover all pollutant processes and the pollutant processes do not use the same activity units. Large differences in results between the Inventory and Emission Rates approaches are usually an indication of a mistake in post-processing of the emission rates. The most common mistakes when using Emission Rates approach are not including all pollutant processes or multiplying emission rates by the wrong activity. To correctly compile an emissions inventory using rates, running rates must be multiplied by VMT, while start, extended idle and evaporative rates must be multiplied by the total population of vehicles in the area.

Even when done correctly, minor differences in post-processing methods can create small differences in results. EPA recommends that the same approach be used in any analysis that compares two or more cases (e.g., the base year and attainment year in a SIP analysis or the SIP budget and the regional conformity analysis). The interagency consultation process should be used to agree upon a common approach. If different approaches are used for the SIP budget and the regional conformity analysis for practical reasons, the interagency consultation process should be used to determine how to address (and minimize) any differences in results. The methods, and those methods used to develop inventories should be fully documented in the regulatory submittal and conformity determinations.

In MOVES2010 and MOVES2010a, refueling emissions are not calculated when using Emission Rates approach and have to be calculated separately using the Inventory approach. MOVES2010b includes the option of calculating refueling emission rates.

Details on the use of the Emission Rate approach are provided in Appendix A of the MOVES User Guide. In addition, EPA has developed 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 simplify the process of post-processing MOVES output for

air quality modeling in SIPs and are described at EPA's modeling web site [www.epa.gov/ttn/scram](http://www.epa.gov/ttn/scram).

### **3.3 Time Spans**

(Section 2.2.3 of the MOVES User Guide)

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.

#### **3.3.1 Time Aggregation Level**

The Time Aggregation Level has 4 options: Year, Month, Day, and Hour. This 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). 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, select Hour 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.

#### **3.3.2 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.

#### **3.3.3 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<sub>x</sub> and hydrocarbons, or the winter CO season. To develop an annual inventory, select all months.

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 4 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.

### 3.3.4 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 SIPs and regional conformity analyses, 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 entered accordingly.

However, if you have speed distributions for only one type of day, use the same information for both types of days. Doing so will make using built-in post aggregation tools easier. These tools are covered in Section 3.10.4 of this document, Output Emission Detail.

*Tip: If data are included for only one type of day, and Month or Year is selected in this panel, MOVES will provide an incomplete result. The emissions for the month or year will be the total emissions from only one day type (e.g., weekdays) in that month or year and emissions from the other day type (e.g., weekend-days) will be missing.*

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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 (e.g., weekday), then the day VMT fraction for that type of day can be set to one in the converter spreadsheet and the other type of day can be set to zero. In the actual dayVMTfraction MOVES input table, fractions should be calculated such that each day represents 1/7<sup>th</sup> of the week (e.g., a weekday fraction of 0.715 and a weekend fraction of 0.285).

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.

### **3.3.5 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.

### **3.3.6 Time Span Rates**

(Appendix A of the MOVES User Guide)

When the emission rates option is chosen, users may choose to approach the selection of options in the Time Spans panel differently than when using inventory mode. For example, when modeling running emission rates, instead of entering a diurnal temperature profile for 24 hours, users can enter a range of 24 temperatures in increments that represent the temperatures over a period of time. By selecting more than one month and using a different set of incremental temperatures for each month, users could create a table of running emission rates by all the possible temperatures over an entire season or year.

For start and evaporative emissions, by selecting more than one month and entering a different diurnal temperature range or profile for each month, users can create multiple start and evaporative emission tables that could be used for an entire season or year.

Users should consult Section 4.2.2 for additional guidance on developing rate lookup tables. It is important to note that the selected month will have no impact on the emissions results (assuming identical fuel and temperature inputs). For instance, a temperature of 40 degrees for a particular hour will result in the same emission rate regardless of what month is chosen.

## **3.4 Geographic Bounds**

(Section 2.2.4 of the MOVES User Guide)

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 two options: 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.

### **3.4.1 County Option**

Within the County scale, users should choose the County option if the following is true:

- Only one county is being analyzed, or
- Unique data are available (e.g., different vehicle age distribution, fuel formulation or supply, or I/M program) for each county being modeled,<sup>5</sup> or
- The analysis uses the Inventory calculation type and output is segregated by county.

Users also specify the county to be modeled in the Geographic Bounds panel. The County option allows only one county and one calendar year to be analyzed at a time. As a result, multiple runs of MOVES, using multiple RunSpec files, will be needed to develop emission

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<sup>5</sup> Note, with MOVES2010b, there is more flexibility to model multiple counties with varying data using a Custom Domain as described in Section 3.4.2.

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 employ more easily MOVES database default inputs for that county, if appropriate, as described in section 4 of this document. The County option also provides individual output for each county.

### **3.4.2 Custom Domain Option**

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. The same vehicle age distribution, fuel formulation and supply, and I/M program must apply throughout the custom domain whether using MOVES2010, 2010a, or 2010b. However, the inputs will differ between MOVES2010/2010a and MOVES2010b. When using MOVES2010/2010a, all the inputs apply throughout the custom domain. In contrast, with MOVES2010b, some fields can be varied by zone within the domain. See Section 4.13 for details. The custom domain area is described by a single RunSpec file. Using the Custom Domain option can reduce the number of MOVES runs required, as long as inputs are appropriate to the entire domain (or appropriately varied within the domain in MOVES2010b as described in Section 4.13).

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 MOVES2010 and MOVES2010a. In those versions of MOVES, 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, MOVES2010 and MOVES2010a 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 with MOVES2010/2010a.

However, in MOVES2010b, separate source type population and VMT can be applied to zones within the custom domain, and MOVES2010b output will be disaggregated by zone. Users who choose to define each county in a custom domain as a separate zone can then get separate output for each county (zone) from MOVES2010b.

As an alternative, when using the Emission Rates calculation option, MOVES produces a lookup table of emission rates. These emission rates can then be post-processed outside of 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 an 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 no data are available in the default database. Therefore, users must supply data for all the tabs in the CDM (see Section 4 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. 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.
- Barometric Pressure (in inches of mercury);
- Refueling Vapor and Spill Adjustment Factors. 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.

### **3.4.3 Domain Input Database**

(Section 2.3.3 of the MOVES User Guide)

In this section of the Geographic Bounds panel, the user can open the 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.

*Tip: Modelers should complete the rest of the RunSpec panels before importing data in the County Data Manager.*

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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.

### **3.5 Vehicles/Equipment: On-Road Vehicle Equipment**

(Section 2.2.5 of the MOVES User Guide)

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 4.3 and 4.5 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 Fuel Type and Technology tab when using MOVES2010b, or the Alternate Vehicle and Fuel Technology (AVFT) panel in MOVES2010/2010a, as well as the Fuel Supply tab of the County Data Manager in MOVES2010, or the Fuel tab in MOVES2010a or MOVES2010b. If no changes are made on the Fuel Type and Technology tab (or AVFT panel in MOVES2010/2010a), 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 AVFT panel/Fuel Type and Technology tab. 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.

*Tip: If you are restricting your analysis to only diesel fueled buses, for example, the MOVES default will still allocate some of the VMT to gasoline and CNG buses and thus the results may underestimate emissions. The Fuel Type and Technology tab is a way to correct the fraction of fleet by fuel type. See section 4.9 for more information.*

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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 4 of this document for more information.

### **3.6 Road Type**

(Section 2.2.6 of the MOVES User Guide)

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)

In general, users should select all road types. Limiting road types can sometimes lead to unintended consequences. 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 4.3 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.

### **3.7 Pollutants and Processes**

(Section 2.2.7 of the MOVES User Guide)

In MOVES, pollutant refers to particular types of pollutants or precursors of the pollutant, such as CO or NO<sub>x</sub>, while process refers to the mechanism by which emissions are created, such as running exhaust or start exhaust. Processes in MOVES are mutually exclusive types of emissions and 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 of these processes must be selected to properly account for all hydrocarbon emissions from motor vehicles.<sup>6</sup>

In emissions inventory mode, the total emissions for a particular pollutant are the sum of the emissions for all pollutant processes that apply to the pollutant. In emission rates mode, the total emissions for a particular pollutant are the sum of the product of emission rates and the appropriate activity measure (VMT or vehicle population) for each vehicle type for all pollutant processes that apply to that pollutant and vehicle type. For many pollutants, the emissions calculation in MOVES 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

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<sup>6</sup> States must account for all emission processes in the SIP. However, two of the 11 hydrocarbon emission categories, refueling displacement vapor loss and refueling spillage loss, are sometimes included in the SIP as an area source and left out of the motor vehicle emissions budget. In that case, the two refueling emission processes which are not included in the motor vehicle emission budget would not be included in a regional conformity analysis. The interagency consultation process should be used to confirm that there is consistency in the approach used to account for refueling emissions in the SIP and regional conformity analyses.

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.

*Tip: It may be necessary to use the bottom scroll bar to view all of the process choices.*

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### 3.7.1 Pollutants and Processes in Emission Rates Mode

Users should be aware that MOVES produces separate output tables with different activity measures for different emission processes:

- Rate per Distance Table - emissions in mass per distance (e.g., grams/mile), activity measure is total VMT by vehicle type
  - Running exhaust
  - Crankcase running exhaust
  - Brake wear (PM only)
  - Tire wear (PM only)
  - Evaporative permeation (HC only)
  - Evaporative fuel vapor venting (HC only)
  - Refueling displacement vapor loss (HC only)
  - Refueling spillage loss (HC only)
- Rate per Vehicle Table – emissions in mass per vehicle (e.g., grams/vehicle), activity measure is total vehicle population by vehicle type
  - Start exhaust
  - Crankcase start exhaust
  - Evaporative permeation (HC only)
  - Evaporative fuel leaks (HC only)
  - Exhaust extended idle emissions (long-haul combination trucks only)
  - Crankcase exhaust extended idle emissions (long-haul combination trucks only)
- Rate per Profile Table (HC only) – emissions in mass per vehicle (e.g., grams/vehicle), activity measure is total vehicle population by vehicle type
  - Evaporative fuel vapor venting (HC only)

In order to properly calculate a total emissions inventory using the emissions rate mode, users need to properly sum the products of emission rates and activity for each vehicle type, for each applicable pollutant process in each of the applicable tables.

### 3.8 Manage Input Data Sets

(Section 2.2.8 of the MOVES User Guide)

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 CDM (the County database is input in the Domain Input Database section of the Geographic Bounds panel, see section 3.3.3 of this document). The Generic tab in the County Data Manager (see Section 4.14 of this document) can be used to apply local inputs to tables not listed in the other CDM

tabs.3.2.1 of this document). Users should consult with EPA before using the Manage Input Data Sets panel to input other additional data.

### **3.9 Strategies**

(Section 2.2.9 of the MOVES User Guide)

The Strategies panel provides access to additional areas – On-Road Retrofit, and Rate of Progress and previously in MOVES2010 and MOVES2010a, Alternative Vehicle Fuels and Technologies (in MOVES2010b, the functions of this panel have been moved to the Fuel Type and Technology tab in the County Data Manager).

#### **3.9.1 Alternative Vehicle Fuels and Technologies (AVFT)**

(Section 2.2.9.6 or 2.3.3.4.9 of the MOVES User Guide)

This panel exists only in MOVES2010/2010a. In MOVES2010b, the functions have been moved to the Fuel Type and Technology tab in the CDM. Instruction on how use of the Alternative Vehicle Fuels and Technologies (AVFT) panel can be found in the MOVES2010 and MOVES2010a User Guides. Guidance on appropriate inputs for the AVFT panel can be found in Section 4.9 below. This guidance applies whether the user is entering this information in the AVFT panel in MOVES2010 or MOVES2010a, or in the CDM in MOVES2010b.

The Alternate Vehicle Fuels and Technologies panel (AVFT) in MOVES2010 and MOVES2010a has been moved to the County Data Manager (CDM) in MOVES2010b, under the Fuel Type and Technology tab.

#### **3.9.2 On-Road Retrofit Clean Diesel Technologies**

(Appendix D of the MOVES User Guide)

Use of the On-Road Retrofit panel will be addressed separately in an update to EPA's Quantifying Clean Diesel Technology Benefits in SIP and Conformity guidance, which will be posted at [www.epa.gov/otaq/stateresources/transconf/policy.htm](http://www.epa.gov/otaq/stateresources/transconf/policy.htm). In addition, spreadsheet converters found on EPA's MOVES website may make creating input files easier; visit our website at [www.epa.gov/otaq/models/moves/tools.htm](http://www.epa.gov/otaq/models/moves/tools.htm).

#### **3.9.3 Rate of Progress**

(Section 2.2.9.9 of MOVES User Guide)

Rate of Progress 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 NOx 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.

### **3.10 Output**

(Section 2.2.10 of the MOVES User Guide)

The Output panel provides access to two areas – 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.

#### **3.10.1 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.

#### **3.10.2 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.

#### **3.10.3 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, and whether the monthly and daily VMT fractions are correctly allocating the annual VMT inputs down to the daily level. 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.

### 3.10.4 Output Emission Detail

This panel allows the user to select the amount of detail that will be provided in the output. Selecting 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. Thus, users must 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 3.3, if the user only selected a single Type of Day in the Time Spans panel, 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, the 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.

#### ***3.10.4.1 Output Emission Detail in Emission Rate Calculations***

With Emission Rates, 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 and population 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 and population 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 and population estimates that have different amounts of activity by individual source type. Likewise, if model year or fuel type is selected, the user will need VMT and population by model year and fuel type in order to calculate an emissions inventory. Producing more detailed rates tables can provide flexibility, by allowing these rates to be applied across large geographic areas that have different age, fueltype or VMT distributions. However, smaller geographic areas may not have activity data in this level of detail, and they may find that more aggregated rates are easier to use in producing an inventory.

When Road Type and Source Type detail are selected, MOVES produces lookup tables of emission rates by source type and road type. For running emissions, users then post-process these lookup tables outside of MOVES to apply local VMT by source type, road type and speed bin 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 corresponding 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 parts of Section 4 of this document.

### **3.11 Advanced Performance Features**

(Section 2.2.11 of MOVES User Guide)

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 4: Adding Local Data via the County Data Manager

### ***4.1 How do users enter information with the County Data Manager?***

(Section 2.3.3.4 of the MOVES User Guide)

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 with County scale runs and is required for SIPs and regional conformity analyses. This section guides users on each element, noting differences between county and custom domain runs and inventory and emission rate runs, where applicable.

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 include the following:

- Meteorology
- Source Type Population
- Age Distribution
- Vehicle Type VMT
- Average Speed Distribution
- Road Type Distribution
- Ramp Fraction
- Fuels (separate Fuel Supply and Fuel Formulation tabs in MOVES2010)
- I/M Programs
- Zone (in MOVES2010b, Custom Domain only)
- Generic Importer (in MOVES2010a and MOVES2010b)
- Fuel Type and Technology (in MOVES2010b only)

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.

Earlier versions of this guidance indicated that for Emissions Rates runs, some of the activity inputs in the CDM are placeholders and/or are not used, since an emissions inventory is calculated outside of the MOVES model. However, these inputs do in fact impact the calculated emissions rates, and reasonable activity inputs are important even though activity data will be applied outside of MOVES to calculate an inventory. Vehicle activity inputs are important because they are used by MOVES to calculate the relative amounts of running activity, activity, which in turn affects the rates for start, evaporative and extended idle. As a general rule, users should input accurate activity for the scenario being modeled regardless of whether MOVES is being used in Inventory or Emissions Rates mode.

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 4.12 on entering local information of Stage II refueling programs in MOVES.

## **4.2 Meteorology**

(Section 2.3.3.4.1 of the MOVES User Guide)

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<sub>x</sub> 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](http://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.

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](http://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.

### **4.2.1 Inventory Guidance for Meteorology**

When modeling either a single county or custom domain using the inventory approach, a 24-hour temperature and humidity profile should be defined for each month selected in the RunSpec. 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 regional 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).

#### **4.2.2 Emission Rates Guidance for Meteorology**

(Appendix A of the MOVES User Guide)

Users can use Emission Rates with either a single county or a Custom Domain. 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 single MOVES run. In one run users may specify as many as 288 temperatures: 24 temperatures for 12 months. When using this approach for running emissions (rateperdistance), the hour and month being modeled are merely placeholders for particular temperatures. In other words, a temperature of 40 degrees for Hour 6 in January, for example, will result in the same emission rate as a temperature of 40 degrees for Hour 18 in July (assuming identical fuels).

However, for off-network emissions such as evaporative, start, and extended idle emissions, it is still necessary to define a temperature profile for each hour of the day. Unlike running emissions that depend entirely on temperature, off-network emissions depend on both temperature and hour of day, and for evaporative emissions, the temperature in the previous hour. It is possible to model both running and off-network emissions in one run by defining temperature intervals for several months (e.g., 1 degree through 96 degrees in one degree intervals using four monthly temperature profiles). The remaining eight months can be used to define diurnal temperature profiles for eight representative days. The resulting lookup table can be post-processed into an inventory for both running and off-network emissions.

#### **4.3 Source Type Population**

(Section 2.3.3.4.2 of the MOVES User Guide)

Source type (vehicle type) population is used by MOVES to calculate start, extended idle and evaporative emissions. Start and 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. Chained trips may involve multiple starts with relatively low VMT. Because vehicle population directly determines start, extended idle 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 2.

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

### 4.3.1 Inventory Guidance for Source Type Population

Users can use Inventory with either a single county or a custom domain. 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 or other appropriate methods.

*Tip: A useful quality check on population and VMT inputs is to divide VMT by source type by sourcetype population to estimate VMT per vehicle, and then determine whether these estimates are reasonable.*

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.

### **4.3.2 Emission Rates Guidance for Source Type Population**

Users can use Emission Rates with either a single county or a custom domain. 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, extended idle and non-running evaporative emissions by source type in terms of grams per vehicle. Total start, extended idle 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. However, users will still need to enter reasonable data using the Source Type Population Importer that represent the population of vehicles in the total area where the lookup table results will be applied. This is necessary because MOVES uses the relationship between source type population and VMT to determine the relative amount of time vehicles spend parking vs. running. If the lookup table results will be applied to a large number of counties, use the total source type population for all the counties covered. The guidance in this section concerning the use of local vehicle population data applies both for generating the total population as an input to the model and for generating more geographically detailed population values to use in applying the emission rate results. To generate an inventory from rates, multiply the rates by vehicle population (not the number of starts or the number of vehicles parked).

### **4.4 Age Distribution**

(Section 2.3.3.4.3 of the MOVES User Guide)

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 implies 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.

The basic guidance is unchanged from past guidance, and applies whether using Inventory or Emissions Rates. For custom domain runs, users will define one age distribution, which cannot vary by zone, for the entire domain. For SIP and conformity purposes, EPA recommends and encourages states to develop local age distributions. EPA recommends recording 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](http://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 regional conformity purposes.

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](http://www.epa.gov/otaq/models/moves/tools.htm).

#### **4.5 Vehicle Type Vehicle Miles Traveled (VMT)**

(Section 2.3.3.4.4 of the MOVES User Guide)

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 Metropolitan Planning Organizations (MPOs) and state Departments of Transportation (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.<sup>7</sup> 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.<sup>8</sup>

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.

#### **4.5.1 Vehicle Type VMT 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 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 MOVES by multiplying the emission rates by the VMT for each source type and road type. However, users will still need to enter data using the Vehicle Type VMT Importer that reflects the VMT in the total area where the lookup table results will be applied. This is necessary because MOVES uses the relationship between source type population and VMT to determine the relative amount of time vehicles spend parked vs. running. If the lookup table results will be applied to a large number of counties, use the total VMT for all the counties covered. The guidance in this section concerning the use of local VMT data applies both for developing the total VMT to input and for developing the geographically detailed VMT to use when applying the emission rates.

#### **4.6 Average Speed Distribution**

(Section 2.3.3.4.5 of the MOVES User Guide)

Vehicle power, speed, and acceleration have a significant effect on vehicle emissions. At the County scale, MOVES models those emission effects by using distribution of vehicles hour traveled (VHT) by average speed. MOVES in turn uses the speed distribution to select specific drive cycles, and MOVES uses these drive cycles to calculate operating mode distributions. The operating mode distributions in turn determine the calculated emissions rates.

#### **4.6.1 County Inventory Guidance for Average Speed Distribution**

For SIP development and 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 necessary. 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

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<sup>7</sup> This spreadsheet-based tool is called “AAD VMT Calculator HPMS” and can be found at [www.epa.gov/otaq/models/moves/tools.htm](http://www.epa.gov/otaq/models/moves/tools.htm). Instructions for use of the VMT calculator can be found within the spreadsheet.

<sup>8</sup> EPA’s Tools for MOVES website ([www.epa.gov/otaq/models/moves/tools.htm](http://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.

urges users to develop the most detailed local speed information that is reasonable to obtain. However, EPA acknowledges that average speed distribution 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 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.

Speed is entered in MOVES as a distribution rather than a single value. Table 3 shows the speed bin structure that MOVES uses for speed distribution input. 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.

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 an average speed distribution 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.

Data converters can assist users in applying current vehicle speed information for MOVES inventories, if this reflects the latest available information for a given area. Converters handle the conversion of a VMT-based speed distribution to a VHT-based speed distribution, for example. These data converters are available at [www.epa.gov/otaq/models/moves/tools.htm](http://www.epa.gov/otaq/models/moves/tools.htm). In addition, to ease the transition from MOBILE6.2 to MOVES, EPA has provided 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. Over time, EPA expects users to generate updated speed information for SIP or regional conformity analyses through updated travel demand modeling, rather than continuing to use data generated for the previous MOBILE6.2 model.

#### ***4.6.1.1 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 inventories for 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. 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.

#### ***4.6.1.2 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.<sup>9</sup> Therefore, 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, local roadways, 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.

#### ***4.6.1.3 Average Speed Distributions for Highways and Ramps***

For rural and urban restricted access highways, users should enter the speed distribution of vehicles traveling on the highway only, not including any activity that occurs on entrance and exit ramps. MOVES automatically calculates a speed distribution for ramp activity based on the speed distribution of vehicles traveling on the highway.<sup>10</sup> Faster or slower highway speeds result in faster or slower ramp speeds calculated by MOVES. MOVES then calculates emissions for ramp activity based on this internally-calculated speed distribution for the ramps, using the appropriate distribution of operating modes related to that speed distribution, and the fraction of VHT that occurs on ramps. At this point, MOVES adds emissions for ramp activity to emissions calculated for vehicles traveling on the highway itself to get the total emissions for restricted access roads.

Section 4.9 describes the ramp fraction input and how it might be used to model ramps separately from highways. As noted in that section, even when ramps are handled separately from highways, the speed distribution entered in MOVES should be the speed distribution for the associated highways, not a ramp-specific speed distribution.

#### **4.6.2 Average Speed Distributions in Emission Rates Calculations**

Users can use Emission Rates with either a single county or a custom domain. Users will define one average speed distribution for the entire domain. This cannot vary by zone.

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. However, vehicle speed inputs are still important because they are used by MOVES to calculate the relative amounts of running and non-running activity, which in turn affects the rates for the non-running processes. Speed inputs for Rates runs that include *only* running emissions can be treated as placeholders (for example, the MOVES default speed distribution could be used), but speed inputs for Emission Rates runs that include any non-running processes must reflect realistic activity for the area. 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.

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<sup>9</sup> In MOBILE6.2, local roadways were a separate category with a fixed speed of 12.9 mph.

<sup>10</sup> The algorithm that calculates the ramp speed distribution was incorporated in MOVES2010a.

## **4.7 Road Type Distribution**

(Section 2.3.3.4.6 of the MOVES User Guide)

The fraction 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. 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).

### **4.7.1 Inventory Guidance for Road Type Distribution**

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. 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](http://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.

EPA recommends using the same approach for custom domain zones. Users will define one road type distribution and allocate it via the Custom Zone Tab using reasonable local data.

### **4.7.2 Road Type Distributions in Emission Rate Calculations**

If the Emission Rates option is used, MOVES will automatically produce a table of running 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 still required, but is not used by MOVES to calculate the rates. However, road type distribution inputs are important for Emission Rates runs involving non-running processes, because they are used by MOVES to calculate the relative amounts of running and non-running activity, which in turn affects the rates for the non-running processes. Road type distribution inputs for Rates runs that include any non-running processes must reflect realistic activity for the area. 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.

## **4.8 Ramp Fraction**

(Section 2.3.3.4.7 of the MOVES User Guide)

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.

When the Emission Rates option is selected, the emission factors produced for any one highway speed apply both to highways and to ramps. In other words, the emission rate for a particular highway speed should be multiplied by the total of highway and ramp VMT. These emission factors are weighted based on the fractions of VHT on the highway and on ramps. The resulting emission factors table will give rates for combined highway and ramp emissions based on the highway speeds. For example, if the urban restricted highway (road type 4) average speed is 60 mph, the total highway and ramp VMT would be multiplied by the emission rate for urban restricted highways at an average speed of 60 mph.

#### **4.8.1 Inventory Guidance for Ramp Fraction**

Some users may wish to model ramp emissions separately from highway emissions. This can be accomplished with two separate runs. Emissions on the highways without including ramps would be modeled by setting Ramp Fraction to 0 in the first run. Emissions on ramps would be modeled by setting Ramp Fraction to 1 in a second run. 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).

However, the same average speed distribution, representing vehicle travel on the highway only, should be used in both runs because MOVES calculates an appropriate speed distribution for ramps based on the speed distribution on the highway (see Section 4.7.4 for more details). If in the second run where Ramp Fraction is 1, users try to enter a ramp speed distribution with the Average Speed Distribution Importer, MOVES will treat that speed distribution as if it were a highway speed distribution and use it to calculate the corresponding ramp distribution. This ramp distribution would be inappropriate because it would not reflect the user's ramp information, and would thus produce erroneous results for the run.

For those defining a custom domain, users will define one ramp fraction for the entire domain. This cannot vary by zone.

#### **4.9 Fuel Type and Technology Tab**

(Section 2.3.3.4.9 of MOVES User Guide)

EPA recommends the same approach for county or custom domain zones. For custom domains, users will define one Fuel Type and Technology for the entire domain. This factor cannot vary by zone.

The Fuel Type and Technology tab [formerly the Alternative Vehicle Fuels & Technologies (AVFT) strategy in MOVES2010 and MOVES2010a] allows users to modify the fraction of vehicles using different fuels and technologies in each model year.<sup>11</sup> Specifically, the Fuel Type and Technology

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<sup>11</sup> The Fuel Type and Technology tab, formerly the AVFT panel, 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 VMT fractions (not vehicle fractions). This means the most appropriate input is the

tab allows users to define the split between diesel, gasoline, CNG, and electricity, for each vehicle type and model year.<sup>12</sup> For example, if in a certain county, sales data show that more diesel vehicles are sold than gasoline vehicles, this tab could be used to make the adjustment. If local data is used for present years, that information will be assumed for future years.

*Tip: Fuel Engine Fraction must sum to one within each Source Type/Model Year combination.*

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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).<sup>13</sup> In making projections, users should assume no future changes in activity associated with alternate fuel or engine technologies unless those alternate fuels or technologies are required by regulation or law. Users should rely on local information, but in its absence, the default VMT split between diesel, gasoline, CNG, and electricity may be used.

For transit buses, the default is VMT activity in gasoline, diesel, and CNG fuel types, and so care must be taken in specifying a run. For example, if the transit bus fleet in a county is entirely CNG, then the user would assign 100 percent of the transit bus activity to CNG (i.e., a “1”), and assign a zero for gasoline and diesel transit bus activity. Note that if the user relies on the model’s default allocation of vehicle activity, some portion of the transit bus activity is always assumed to be CNG. This is true even if the combination of CNG Transit Bus is not selected in the On Road Vehicle Equipment panel. That is, if user selects only gasoline and diesel vehicles in the On Road Vehicle Equipment panel, MOVES still assumes some transit bus CNG VMT. If there are no transit buses fueled by CNG in the modeling area, the user needs to allocate zero activity to CNG transit buses in the Fuel Type and Technology tab for the correct results for transit buses. Otherwise, some VMT will be allocated to CNG transit buses and the emissions associated with this VMT are not included in the output (as only gasoline and diesel vehicles were selected in the On Road Vehicle Equipment panel). Likewise, MOVES assumes that some portion of the transit bus fleet is fueled by gasoline; if this does not reflect the transit fleet in a given area, the gasoline VMT fractions should also be set to zero. The same general principle applies to school buses, which are a mix of gasoline and diesel in the default distribution.

Similarly, the fractions entered in the Fuel Type and Technology tab directly affect the selections the user needs to make in the On Road Vehicle Equipment panel (see Section 4.5 above) and the Fuel Supply tab of the CDM. Any fuel or engine technology for which the Fuel Type and Technology tab 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 and associated VMT will not be included and results will be incorrect. With respect to the data input

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fraction of total VMT for each source type 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 as a proxy for VMT fraction.

<sup>12</sup> In MOVES2010a, the only vehicles that can be fueled by CNG are transit buses, but future versions may include other fuels and vehicle technologies for other source types. Please check the user guide and other appropriate documentation for explanation of updates to this tab.

<sup>13</sup> 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. For example, if diesel buses have a different activity from CNG buses, they cannot be estimated in the same run.

in the Fuel Supply tab, a fuel formulation must be supplied for all vehicle-fuel combinations selected in the On-Road Vehicle Equipment and Fuel Type and Technology tab.

#### **4.10 Fuel (Formulation and Supply)**

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 in the RunSpec. In MOVES2010, the *fuelformulation* and *fuelsupply* tables were accessed through two tabs in the CDM called Fuel Formulation and Fuel Supply respectively. In MOVES2010a and MOVES2010b, the *fuelformulation* and *fuelsupply* tables are both accessed through a single tab in the CDM called Fuels.

##### **4.10.1 Guidance for Fuel Formulation and Supply**

EPA recommends the same approach for county or custom domain zones, and for emission rates and inventory runs. When running MOVES for a custom domain, the same fuel supply and fuel formulation information must apply across the entire custom domain

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 gasoline.

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/properf/rfgperf.htm](http://www.epa.gov/otaq/regs/fuels/rfg/properf/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, the existing local fuel formulations can be modified using the available local data and using default values 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. Users should not attempt to create completely new fuel formulations with new fuel formulation IDs, but should instead only modify existing fuel formulations.

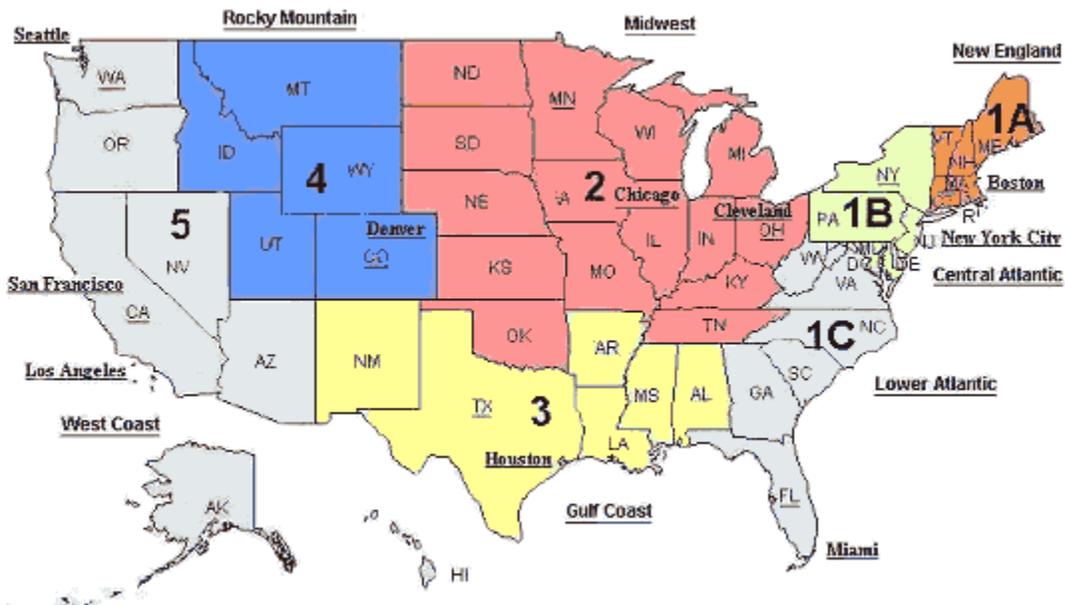


Figure 1. Petroleum Administration Defense Districts

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

#### 4.10.1.1 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 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 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 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 at 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 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 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 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 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 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 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 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.

Additional Fields in MOVES 2010b:

MOVES2010b adds two additional fields to the fuel formulation table: T50 and T90. As described below, T50/T90 and E200/E300 are different ways of expressing the evaporative characteristics of a fuel. In MOVES2010 and MOVES2010a, only E200 and E300 are used. In MOVES2010b, if zeros are entered for T50 and T90, the E200 and E300 values will be used. However, if any other values are entered for T50 and T90, those values will override the values used for E200 and E300. Fuel formulation tables that were created for MOVES2010 or MOVES2010a must be modified to add the T50 and T90 fields before they can be used with MOVES2010b.

E200 is 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. If values other than zero are entered for T50 and T90, the E200 value will be ignored.

T50 is the temperature in degrees Fahrenheit at which 50% of a sample of fuel will evaporate using a standard test procedure. Users can rely on default data. For diesel fuel, CNG, and Electricity, a value of zero should be entered.

T90 is the temperature in degrees Fahrenheit at which 90% of a sample of fuel will evaporate using a standard test procedure. Users can rely on default data. For diesel fuel, CNG, and Electricity, a value of zero should be entered.

VolToWtPercentOxy is 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 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 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 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.

#### **4.10.1.2 Fuel Supply**

(Section 2.3.3.4.8 of the MOVES User Guide)

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.

## **4.11 Inspection and Maintenance Programs**

(Section 2.3.3.4.6 of the MOVES User Guide)

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 using the same approach for inventory or emission rate runs. The emission rates calculated in MOVES will be based on the I/M program specified by the user. When running MOVES for a custom domain, the same I/M program information must apply across the entire custom domain.

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 exemption 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 ID, 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.

When making any changes to an existing I/M program, users should export the existing default I/M program, change the Y to N in the useIMyn field for any lines that are not correct for the local program, and create new lines with new I/M program IDs that incorporate the changes in the I/M program (including a Y in the useIMyn field). Making changes in an I/M program without turning off the existing program by changing the useIMyn field to N may result in an incorrect calculation of I/M program emissions.

### **4.11.1.1 Pollutant Process ID**

MOVES estimates emission reductions from I/M programs for hydrocarbons, NO<sub>x</sub>, 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.

### **4.11.1.2 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) and light commercial trucks (32). However, these source types 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. 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 3.10.6.3 of this document.

#### 4.11.1.3 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.

#### 4.11.1.4 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 4.

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 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.
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.

Test Standards ID	Test Standards Description	Description
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 evaporative 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 evaporative OBD check. This combination of tests can only be conducted on 1996 and newer, OBD-equipped vehicles.
46	Evaporative Pressure and OBD Check	The evaporative OBD test performed in conjunction with a separate fillneck pressure test.
47	Evaporative Gas Cap, Pressure and OBD Check	The evaporative 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.

#### ***4.11.1.5 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 three-year 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.

#### ***4.11.1.6 Compliance Factor***

MOVES uses the compliance factor input to account for I/M program compliance rates, waiver rates, and adjustments needed to account for the fraction of vehicles within a source type that are covered by the I/M program. The last will be referred to here as the “regulatory class coverage adjustment.” The compliance factor is entered a number from 0 to 100 and represents the percentage of vehicles within a source type that actually receive the benefits of the program. Since all three components of the compliance factor are calculated as multiplicative factors, the total compliance factor entered in MOVES is calculated as:

$$\text{Compliance Factor} = \text{percent compliance rate} \times (100 - \text{percent waiver rate}) \times \text{regulatory class coverage adjustment}$$

#### ***4.11.1.6.1 Compliance Rate***

The compliance rate is the percentage of vehicles in the fleet covered by the I/M program that complete the I/M program and receive 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.

#### ***4.11.1.6.2 Waiver Rate***

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 – percent waiver rate) is used as one input when calculating the compliance factor.

#### ***4.11.1.6.3 Regulatory Class Coverage Adjustment***

Inspection and Maintenance (I/M) programs entered in MOVES can only be applied to source types. However, as discussed in section 3.10.2, this association of I/M programs and source type may be inconsistent with state I/M program regulations that define I/M programs by the vehicle weight classes. MOVES source types are composed of several vehicle weight classes and, therefore, applying I/M benefits to the entire MOVES source type may be inappropriate. Table A.3 in the Appendix of this guidance can be used to develop adjustments to the compliance factor to account for this discrepancy. The adjustments are percentages of Vehicle Miles Traveled (VMT) by the various regulatory weight classes within a source type. After reviewing the table, users should sum the adjustments for weight classes within a source type that are covered by an I/M program. This sum provides users with a multiplicative factor that can be applied along with the compliance rate and waiver rate discussed above. An example of this process is provided in the next section of this document.

Users who believe regional regulatory class coverage adjustments are more appropriate than the Table A.3 defaults should provide documentation in the SIP or regional conformity analysis of the local data and methods used to derive those adjustments.

#### ***4.11.1.6.4 Example Application of Compliance Rate, Waiver Rate, and Regulatory Class Coverage Adjustment***

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). Users should first determine the compliance rate and waiver rate for the trucks covered by that program. For this example, we will assume that the compliance rate is 96% and the waiver rate is 8%.

The user would then determine the regulatory class coverage adjustment by summing the percentages of those regulatory classes less than 8501 lbs, GVRW separately for source types 31 and 32 using the information in Table A.3 in the Appendix to this document. For source type 31, the regulatory class coverage adjustment is 94% (31% + 31% + 16% + 16%). For source type 32, the regulatory class coverage adjustment is 88% (29% + 29% + 15% + 15%).

Using these results, the compliance factor for source type 31 is

$$\begin{aligned} \text{Compliance factor} &= \text{compliance rate} \times (100 - \text{waiver rate}) \times \text{regulatory class} \\ \text{coverage} & \\ 83\% &= 96\% \times (100-8)\% \times 94\% \end{aligned}$$

The compliance factor for source type 32 is

$$\begin{aligned} \text{Compliance factor} &= \text{compliance rate} \times (100 - \text{waiver rate}) \times \text{regulatory class} \\ \text{coverage} & \end{aligned}$$

$$78\% = 96\% \times (100-8)\% \times 88\%$$

These values would be entered as compliance factors of 83 for source type 31 and 78 for source type 32.

#### **4.12 Stage II Refueling Programs**

(Appendix F of the MOVES User Guide)

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 dedicated importer for this in the CDM. Appendix I of the MOVES User Guide explains how to review the appropriate data table in MOVES and develop alternative inputs for the CountyYear table, which contains the Stage II information. For MOVES2010 users, this appendix also explains 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). In MOVES2010a and MOVES2010b, an alternative CountyYear table can be imported using the Generic Importer tab (below). Using this tab, users can export the default CountyYear table for the county being modeled, modify the values as necessary, and import a revised table.

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](http://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.

#### **4.13 Zone (MOVES 2010b Custom Domain Only)**

(Section 2.3.3.4.10 of the MOVES User Guide)

The Zone Importer can be used to define multiple zones within a larger custom domain region. The Zone tab will appear only when a custom domain is selected in the geographic bounds panel. Table 5 lists which inputs can vary by zone. The zone option may be advantageous when modeling a region of multiple counties that share the same fuels, vehicle age distribution, and I/M program. Rather than modeling each individual county in separate runs, users can divide activity (e.g., VMT) between multiple zones and run MOVES only once. Emissions results will be produced for each defined zone. Although fuels, age distribution, and I/M programs cannot vary between zones, users can define specific temperature and humidity values for each zone

within the custom domain. This information should be imported through the Meteorology Importer – discussed in Section 3.2.

Table 5. MOVES2010b Custom Domain Inputs by Zone

MOVES input	Can be varied by zone?	How is the input changed?
Meteorology	Yes	Temperatures and Humidity are defined for each zone using the "Meteorology" input
Source Type Population	Yes	Population (starts, evaporative, and extended idle emissions) are allocated to each zone using the "Zone" input
Vehicle Type VMT	Yes	VMT (running emissions) are allocated to each zone and road type using the "ZoneRoadType" input
Age Distribution	No	Not applicable
Average Speed Distribution	No	
Road Type Distribution	No	
Ramp Fraction	No	
Fuels	No	
I/M programs	No	
Fuel Type and Technology	No	

The Zone Importer includes three input tables: Zone, ZoneRoadType, and SCCRoadTypeDistribution.

The Zone input is used to allocate off-network activity between each zone. Users should specify the distribution of starts (startAllocFactor), extended idle (idleAllocFactor), and parking (SHPAllocFactor) for each defined zone. Since off-network emissions are proportional to vehicle population in MOVES, the zone input is useful when modeling regions where starts may not be directly tied to population. For example, some urban centers may have a relatively low vehicle population as determined by vehicle registration data, but commuters may contribute to high start and evaporative (parked) emissions during the day. Using this input can address such situations. If specific start, extended idle, and parked fractions are not available, users can rely on the distribution of vehicle population among each zone to determine the allocation factors.

The ZoneRoadType input is used to vary on-road activity (VMT) by road type and zone. The source hours operating (SHOAllocFactor) must sum to one for each road type. The allocation factors should be based on the distribution of VMT for each road type and zone. Users can use

the ZoneRoadType input to model situations where one zone may have much more highway VMT but lower arterial/local VMT than other zones by changing the SHO allocation factors. If data are not available, these factors may be identical for each road type within each zone.

The SCCRoadTypeDistribution input describes the mapping of MOVES road type to SCC road types. This is used when modeling a custom domain and selecting output by SCC; it does not impact the emissions calculations within MOVES. For SIP and Regional Conformity analyses, where it is not recommended to select output by SCC, users should not import this table.

#### **4.14 Generic**

(Section 2.3.3.4 of the MOVES User Guide)

The Generic tab can be used to export, modify, and re-import any of the default MOVES tables not covered by the County Data Manager. Users should note that there are complex interactions between tables in MOVES, and there may be unintended consequences from changing any table. Generally, other than the Stage II inputs mentioned above, most tables should never be changed and results will not be acceptable if such tables are modified. EPA recommends that users consult with their regional office before modifying any of the default MOVES tables accessible through the Generic tab.

## Appendix A

Table A.1: 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.

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
17	HDDV3	31	Passenger Truck	0.43

Table A.1 Population Mapping from MOBILE6.2 Vehicle Types to MOVES Source Types				
MOBILE6.2 Vehicle Type		MOVES Source Type		
		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

Table A.2: 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

Table A.3: Users can apply the regulatory class coverage adjustments in the following table as described in section 3.10.6.3.

Table A.3 Gasoline I/M Regulatory Coverage Adjustments				
Source Type Description	SourceTypeID	MOBILE6 Vehicle Class Description	M6VClassID	Regulatory Class Coverage Adjustment (%)
Motorcycle	11	Motorcycles (Gasoline)	24	100%
Passenger Car	21	LD Gas Vehicles (Passenger Cars)	1	100%
Passenger Truck	31	LD Gas Trucks 1 (0 - 6,000 lbs. GVWR, 0 - 3,750 lbs. LVW)	2	31%
		LD Gas Trucks 2 (0 - 6,000 lbs. GVWR, 3,751 - 5,750 lbs. LVW)	3	31%
		LD Gas Trucks 3 (6,001 - 8,500 lbs. GVWR, 0 - 5,750 lbs. ALVW)	4	16%
		LD Gas Trucks 4 (6,001 - 8,500 lbs. GVWR, > 5,751 lbs. ALVW)	5	16%
		Class 2b HD Gas Vehicles (8,501 - 10,000 lbs. GVWR)	6	3%
		Class 3 HD Gas Vehicles (10,001 - 14,000 lbs. GVWR)	7	3%
Light Commercial Truck	32	LD Gas Trucks 1 (0 - 6,000 lbs. GVWR, 0 - 3,750 lbs. LVW)	2	29%
		LD Gas Trucks 2 (0 - 6,000 lbs. GVWR, 3,751 - 5,750 lbs. LVW)	3	29%
		LD Gas Trucks 3 (6,001 - 8,500 lbs. GVWR, 0 - 5,750 lbs. ALVW)	4	15%
		LD Gas Trucks 4 (6,001 - 8,500 lbs. GVWR, > 5,751 lbs. ALVW)	5	15%
		Class 2b HD Gas Vehicles (8,501 - 10,000 lbs. GVWR)	6	5%
		Class 3 HD Gas Vehicles (10,001 - 14,000 lbs. GVWR)	7	5%
		Class 4 HD Gas Vehicles (14,001 - 16,000 lbs. GVWR)	8	1%
		Class 5 HD Gas Vehicles (16,001 - 19,500 lbs. GVWR)	9	1%

Table A.3 Gasoline I/M Regulatory Coverage Adjustments (cont.)

Source Type Description	SourceTypeID	MOBILE6 Vehicle Class Description	M6VClassID	Regulatory Class Coverage Adjustment (%)
Transit Bus	42	Class 6 HD Gas Vehicles (19,501 - 26,000 lbs. GVWR)	10	50%
		Class 7 HD Gas Vehicles (26,001 - 33,000 lbs. GVWR)	11	50%
School Bus	43	Class 6 HD Gas Vehicles (19,501 - 26,000 lbs. GVWR)	10	50%
		Class 7 HD Gas Vehicles (26,001 - 33,000 lbs. GVWR)	11	50%
Refuse Truck	51	Class 6 HD Gas Vehicles (19,501 - 26,000 lbs. GVWR)	10	50%
		Class 7 HD Gas Vehicles (26,001 - 33,000 lbs. GVWR)	11	50%
Single Unit Short-haul Truck	52	Class 6 HD Gas Vehicles (19,501 - 26,000 lbs. GVWR)	10	49%
		Class 7 HD Gas Vehicles (26,001 - 33,000 lbs. GVWR)	11	49%
		Class 8a HD Gas Vehicles (33,001 - 60,000 lbs. GVWR)	12	1%
		Class 8b HD Gas Vehicles (> 60,000 lbs. GVWR)	13	1%
Single Unit Long-haul Truck	53	Class 6 HD Gas Vehicles (19,501 - 26,000 lbs. GVWR)	10	48%
		Class 7 HD Gas Vehicles (26,001 - 33,000 lbs. GVWR)	11	48%
		Class 8a HD Gas Vehicles (33,001 - 60,000 lbs. GVWR)	12	2%
		Class 8b HD Gas Vehicles (> 60,000 lbs. GVWR)	13	2%
Motor Home	54	Class 6 HD Gas Vehicles (19,501 - 26,000 lbs. GVWR)	10	50%
		Class 7 HD Gas Vehicles (26,001 - 33,000 lbs. GVWR)	11	50%
Combination Short-haul Truck	61	Class 6 HD Gas Vehicles (19,501 - 26,000 lbs. GVWR)	10	48%
		Class 7 HD Gas Vehicles (26,001 - 33,000 lbs. GVWR)	11	48%
		Class 8a HD Gas Vehicles (33,001 - 60,000 lbs. GVWR)	12	2%
		Class 8b HD Gas Vehicles (> 60,000 lbs. GVWR)	13	2%

