

**MOVES2014 and MOVES2014a  
Technical Guidance:  
Using MOVES to Prepare Emission  
Inventories for State Implementation  
Plans and Transportation Conformity**

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Assessment and Standards 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 made minor revisions to this version in releases of MOVES2010a and MOVES2010b. Guidance on the use of all versions of MOVES2010 is available at [www.epa.gov/otaq/models/moves/moves-docum.htm](http://www.epa.gov/otaq/models/moves/moves-docum.htm).

MOVES2014 is the first major revision to the MOVES series since the original release of MOVES2010. MOVES2014 incorporates new emissions test data, the impacts of new emissions standards, new features, and other functional improvements, all of which contribute to improved estimates of criteria pollutant emissions compared to MOVES2010. In 2015, EPA released a minor revision called MOVES2014a. This guidance covers the use of MOVES2014 and MOVES2014a, and hereafter we use the term "MOVES" to mean either of these two versions unless otherwise noted.

One new feature in MOVES2014 is the incorporation of NONROAD2008, EPA's nonroad emissions model, into the MOVES modeling framework. As a result, MOVES2014 can also be used to estimate emissions from all nonroad engines and equipment, with the exception of commercial marine, locomotives, and aircraft. This current technical guidance only addresses the use of MOVES for estimating on-road emissions.

## 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 applies to MOVES2014 and MOVES2014a and supersedes the previous technical guidance for MOVES2010<sup>2</sup>. 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

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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> Using MOVES to Prepare Emission Inventories in State Implementation Plans and Transportation Conformity: Technical Guidance for MOVES2010, 2010a, and 2010b, EPA-420-B-12-028, April 2012.

this document. MOVES can estimate motor vehicle emissions at 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.<sup>3</sup>

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 may not be 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>4</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 locally specific data such as local meteorology, fleet and activity

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<sup>3</sup> See Section 1.5 for a list of guidance documents that address use of MOVES at the Project scale.

<sup>4</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.

data, fuel specifications, and Inspection and Maintenance (I/M) program information if applicable.

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 Listserv to receive announcements related to MOVES and MOVES guidance ([www.epa.gov/otaq/models/mobilelist.htm](http://www.epa.gov/otaq/models/mobilelist.htm)).

### **1.3 How do MOVES2014 and MOVES2014a compare with MOVES2010b?**

MOVES2014 is a major revision to the MOVES series of models and is considered to be a new emissions model for SIP and conformity purposes. Its release begins a new conformity grace period under 40 CFR 93.111. MOVES2014 includes many changes, including new vehicle standards, new emissions and activity data, and new features. As a result of these changes, estimates of past, current, and future emissions from MOVES2014 may be different from MOVES2010b.

Changes in MOVES2014 that affect user inputs and that are addressed in this guidance include:

- New option for separating restricted access road types and ramps in output
- Automatic chaining of pollutants in the Pollutants and Processes Panel
- New input options for start activity and new rate per start output option
- New input method for retrofit programs
- New input option for entering local hoteling activity data for long-haul combination trucks
- New Fuels Wizard to adjust unknown fuel properties based on known fuel properties

In addition to new guidance to address those changes in MOVES2014, this document also includes changes from previous guidance for developing inputs for future age distribution inputs, local ramp fractions, and fuels.

MOVES2014a is a minor revision to MOVES2014. It is not considered to be a new model for SIP and conformity purposes and thus does not begin a new emissions model grace period under 40 CFR 93.111. MOVES2014a corrects some minor problems with MOVES2014, and includes some additional improvements.<sup>5</sup> The most important changes in MOVES2014a apply to nonroad emissions with the addition of new output options for volatile organic compounds (VOCs) and air toxics and an update to the default nonroad fuel supply. MOVES2014a includes one new feature that applies to this document, which is the addition of new flexibility for input of VMT. This is discussed in Section 4.5 of this document. It also includes some updates to the default fuels and I/M programs in MOVES which are discussed in Sections 4.9 and 4.10.

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<sup>5</sup> These improvements are listed in "EPA Releases MOVES2014a Mobile Source Emissions Model: Questions and Answers", available at [www.epa.gov/otaq/models/moves/index.htm#generalinfo](http://www.epa.gov/otaq/models/moves/index.htm#generalinfo).

MOVES2014 or MOVES2014a can be used 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 MOVES2014a 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 MOVES 2014 SIP and Conformity Policy Guidance and in the MOVES2014a Q&A document, both available at [www.epa.gov/otaq/models/moves/index.htm](http://www.epa.gov/otaq/models/moves/index.htm).

This guidance applies to both versions of MOVES2014. It has been updated to reflect MOVES2014a, and where MOVES2014 and MOVES2014a differ, it is noted.

### ***1.4 Using MOVES2010b input databases in MOVES2014 and MOVES2014a***

MOVES2014 includes a script in the “Tools” menu that will convert MOVES2010b input databases to the proper format required for MOVES2014.<sup>6</sup> However, MOVES2014 includes significant updates to default fleet, activity, fuels, and I/M program data and should be used instead of the default information in MOVES2010b. Therefore, a MOVES2010b input database that includes default information that a user converts to MOVES2014 format should not be used for any SIP or regional conformity analysis done with MOVES2014 as-is. Instead, the user needs to update the converted database with the new MOVES2014 defaults for any inputs previously based on MOVES2010b defaults. This includes any defaults that may be used directly (e.g. long haul combination truck age distributions), defaults which are modified somewhat (e.g. some fuel inputs), or defaults used to calculate or adjust local data (e.g. using model defaults to estimate the relative contributions of short-haul and long-haul trucks to local population or VMT estimates).

An input database converter is included with MOVES2014a that allows users to convert input databases created with MOVES2014 into a format compatible with MOVES2014a. However, MOVES2014a includes updates to the default fuels and I/M program data. Similarly as described above, the user needs to update a converted database with new MOVES2014a defaults for any fuels or I/M program inputs previously based on MOVES2014 defaults.

### ***1.5 What other MOVES guidance and documentation 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 MOVES2014 for State Implementation Plan Development, Transportation Conformity, and Other Purposes,” EPA-420-B-14-008, July 2014, addresses general policy issues for MOVES such as timing of the use of

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<sup>6</sup> For MOVES2010 or MOVES2010a input databases, there is an additional script in the “Tools” menu that will convert these files to the MOVES2010b format. These files would then need to be converted to MOVES2014 format using the script discussed in this section.

MOVES in SIPs and regional conformity analyses. This latest version of this guidance is available at [www.epa.gov/otaq/models/moves/index.htm#sip](http://www.epa.gov/otaq/models/moves/index.htm#sip).

- “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-15-084, October 2015, provides guidance on using MOVES2014 for quantitative PM<sub>10</sub> and PM<sub>2.5</sub> hot-spot analysis for transportation projects. This guidance is available at [www.epa.gov/otaq/stateresources/transconf/projectlevel-hotspot.htm](http://www.epa.gov/otaq/stateresources/transconf/projectlevel-hotspot.htm).
- “Using MOVES2014 in Project-Level Carbon Monoxide Analyses,” EPA-420-B-15-028, March 2015, provides guidance on using MOVES2014 for CO emissions from transportation projects. This guidance is available at [www.epa.gov/otaq/stateresources/transconf/projectlevel-hotspot.htm](http://www.epa.gov/otaq/stateresources/transconf/projectlevel-hotspot.htm).
- “Using MOVES for Estimating State and Local Inventories of On-Road Greenhouse Gas Emissions and Energy Consumption,” (EPA-420-B-12-068, November 2012) describes how to use MOVES2010 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). Updated guidance for MOVES2014 will be available at the same location.

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).

## ***1.6 Does This Guidance Create New Requirements?***

No. The discussion in this document is intended solely as guidance. The statutory provisions and EPA regulations described in this document contain legally binding requirements. This document is not a regulation itself, nor does it change or substitute for those provisions and regulations. EPA retains the discretion to adopt approaches on a case-by-case basis that may differ from this document, but still comply with the statute and regulations. Any decisions regarding a particular SIP or conformity determination will be made based on the statute and regulations. This document may be revised periodically without public notice.

## ***1.7 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 [www.epa.gov/otaq/stateresources/transconf/contacts.htm](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 area or 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 budgets, 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 4 of this guidance describes the information that is needed and how users can enter it.

For most inputs, users need to provide local data, but there are some inputs where relying on MOVES defaults is acceptable or recommended. 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. For some of the inputs, the data in the MOVES database will not be the most current or best available for a specific county. However, there are some instances where the use of default data is recommended, and some instances where default information can be used without affecting the quality of the results. Section 4 discusses the data fields for which it would be acceptable or recommended 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 local activity data (e.g., VMT and vehicle population data, and/or optional start and/or hoteling data) into MOVES and the model calculates the inventory. Output is total emissions in units of mass.
- With the Emission Rates approach, users multiply the appropriate local activity data (e.g., VMT and vehicle population and/or optional start and/or hoteling data) by 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 hotelling emissions. Alternatively, start emissions can be calculated as rate per start and hotelling emissions as rate per hour. Users must take care to ensure that the proper measure of activity is used for each emission process.

Users may select either the Inventory or Emission Rates approach to develop emissions estimates for SIPs and regional conformity analyses.<sup>7</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. If the Emission Rate approach is selected, users will need to prepare emissions inventories outside of the MOVES model.

### ***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

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<sup>7</sup> Section 3.2.3 includes a discussion of the equivalency of the Inventory and Emission Rates options in calculating emissions.

SIP and regional conformity analyses; within the County scale, users have the options of modeling an individual county (the “County” option) or a group of counties (the “Custom 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. In addition, the user can vary vehicle activity by zone within a Custom Domain, and generate output by zone. Zones can be the individual counties within the Custom Domain. Vehicle age distribution, fuel information, 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 provided by the user. 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.

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

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, using either the Inventory or Emission Rates approach, 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. MOVES2014 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 the Emission Rates approach 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>• Running, start, evaporative, and hotelling 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 4.9 (fuels) and Section 4.10 (I/M programs) for more information.</li> <li>• Running, start, evaporative, and hotelling rates must be post-processed to create an inventory</li> </ul>
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>• 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 vehicle age distribution, fuels, and I/M program must apply throughout the area of the custom domain</li> </ul>

Geographic Area	Approach	Advantages	Considerations
	Use Emission Rates and Custom Domain to model the entire area, and create inventories from rates with activity data for each county	<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 Emission Rates output 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 vehicle age distribution, fuels, and I/M program must apply throughout the area of the custom domain</li> <li>• Running, start, evaporative, and hotelling 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>• Running, start, evaporative, and hotelling 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. 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 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 Emission Rates)
- 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. 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

The Description Panel allows the user to enter a description of the RunSpec using up to 5,000 characters of text.<sup>8</sup> 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.

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<sup>8</sup> Due to restrictions in MySQL software, no quotation marks, ampersands, or backslashes are allowed.

## 3.2 Scale and Calculation Type

Selecting Scale on the Navigation Panel in MOVES brings up the Model, Domain/Scale, and Calculation Type Panel. MOVES allows users to choose either onroad or nonroad emissions. 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 necessary for SIPs and for regional conformity analyses.*

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### 3.2.1 Model

Unlike previous versions of MOVES, MOVES2014 and MOVES2014a include the capability of estimating emissions of nonroad equipment and engines. Within MOVES2014 and MOVES2014a, the onroad and nonroad capabilities exist as separate modules, and users must select one or the other. For this first implementation of nonroad capabilities, MOVES2014 simply adds existing NONROAD2008 code into the MOVES GUI and database structure. MOVES2014a adds new VOC and air toxics options to MOVES and updates the default nonroad fuels database. Future versions of MOVES will update the underlying nonroad code and data and more fully integrate the onroad and nonroad capabilities of MOVES. Until then, this guidance only covers the onroad capabilities of MOVES.

### 3.2.2 Domain/Scale

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

- The National scale can be used to estimate emissions for the entire country, for a state, for a group of counties, or for individual counties. At the National scale, MOVES uses a default national database that allocates emissions to the county level based on a mix of national data, allocation factors, and some pre-loaded local data. In general, EPA cannot certify that the default data in the national database is the most current or best available information for any specific county. Because of this, **users must not use the National scale option when developing emission estimates for SIPs or 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 (CDM). The CDM 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 for the CDM, 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 separate guidance documents which are available at [www.epa.gov/otaq/stateresources/transconf/projectlevel-hotspot.htm](http://www.epa.gov/otaq/stateresources/transconf/projectlevel-hotspot.htm).

### 3.2.3 Calculation Type

The Scale Panel also requires that the user select a calculation type of either Inventory or Emission Rates. If Inventory is selected, MOVES provides emission 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 considerations, 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 same results if the user calculates an inventory from rates in the same way that MOVES does this internally. Table 1 in Section 2 above provides a summary of modeling approaches.

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. 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 using the Emission Rates approach. The most common mistakes when using the Emission Rates approach are not including all pollutant processes or multiplying emission rates by the wrong activity. To correctly compile an emission inventory using rates, running rates must be multiplied by VMT, while emission rates from processes that occur when the vehicle is parked (such as start, evaporative, and extended idling rates) must be multiplied by the total population of vehicles in the area. Note that there are alternative rates for some of the processes that occur when the vehicle is parked:

- Start emission inventories can be calculated either by multiplying the rate per vehicle by the total population of vehicles in the area, or by multiplying the rate per start by the total number of starts;
- Hotelling emissions can be calculated by multiplying the rate per vehicle by the total population of long-haul combination trucks in the area or by multiplying the rate per hour by the hours of hotelling activity.<sup>9</sup>

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<sup>9</sup> More information about creating complete inventories using the Emission Rates calculation type can be found in the presentations used in EPA's 2-day training course, available for download on the web at: [www.epa.gov/otaq/models/moves/training.htm#2](http://www.epa.gov/otaq/models/moves/training.htm#2).

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 motor vehicle emissions 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 SIP submission and conformity determinations.

EPA has developed tools to automate the use of the Emission Rates approach 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**

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, as discussed in the previous paragraph.

#### **3.3.2 Calendar Year of Evaluation**

MOVES can model calendar years 1990 and 1999 through 2050. 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.

### 3.3.3 Month of Evaluation

MOVES allows users to calculate emissions for any month of the year. A single RunSpec may produce emissions for multiple months. Users should choose the appropriate months for the pollutant being analyzed, i.e., the summer ozone season for NO<sub>x</sub> and HC, or the winter CO season. To develop an annual inventory, select all months.

In cases where the user intends to model multiple months within a single year, 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 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 3.10.2 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 AADVMT Converter for MOVES2014 (described in Section 4.5 of this

document). If only one type of day is selected, the calculator will appropriately adjust the day fraction to account for VMT for a single weekday or weekend day.

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 by MOVES to evaluate non-running evaporative hydrocarbon emissions because they depend on the daily temperature variance.

### **3.3.6 Time Span Panel Selections: Emission Rates Mode**

When the Emission Rates is selected, users may choose to approach the selection of options in the Time Spans Panel differently than when running MOVES in 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.<sup>10</sup>

## **3.4 Geographic Bounds**

Once the County scale is selected (as needed 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 only one county is being analyzed or when modeling multiple counties that have unique age distributions, unique I/M programs or unique fuel formulations or supplies, in which case each county would be modeled in an individual run. See Table 1 in Section 2.5 for a summary of modeling approaches.

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 estimates for multiple counties.

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<sup>10</sup> See EPA's 2-day training course for additional information, available for download at: [www.epa.gov/otaq/models/moves/training.htm#2](http://www.epa.gov/otaq/models/moves/training.htm#2).

Use of the County option has the following advantages. The County option allows the user to more easily employ 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 information, and I/M program must apply throughout the custom domain while vehicle activity can vary across zones (see Section 4.11 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 as described in Section 4.11).

Unique fractions of running, start, parked (evap), and hoteling activity can be applied to each zone within the custom domain, and 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).

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 Section 4.15 of this document for additional discussion of Stage II refueling programs.

### 3.4.3 Domain Input Database

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).

*Tip: It is important to note that modelers should complete the rest of the RunSpec panels before importing data in the CDM.*

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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

MOVES describes vehicles by a combination of vehicle characteristics (e.g. passenger car, passenger truck, light commercial truck, etc.) and the fuel that the vehicle is capable of using (gasoline, diesel, etc.). The Vehicles/Equipment 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 vehicles), and six different fuel types (gasoline, ethanol (E-85), diesel, compressed natural gas (CNG), electricity, and liquefied petroleum gas (LPG)<sup>11</sup>). Some source/fuel type combinations are not included in the MOVES database (e.g., diesel motorcycles). For more information about source types, see Sections 4.3 and 4.5 of this document.

For SIP and regional conformity analyses, users must select the appropriate vehicle and fuel type combinations in the On Road Vehicle Equipment Panel to reflect the full range of vehicles that will operate in the county. Users should always select all valid<sup>12</sup> diesel, gasoline, ethanol (E-85), and CNG (only transit buses) vehicle and fuel combinations. Ethanol should be selected even if there is no E-85 fuel sold in the area. Flex-fueled E-85 capable vehicles are a component of the vehicle fleet in every county in the U.S. and MOVES automatically assigns some VMT to these vehicles.

The vehicle and fuel combinations selected on this panel will be affected by the Fuel Tab (see Section 4.9 of this document) in the CDM. If no changes are made on the Fuel tab, default

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<sup>11</sup> The default MOVES database does not include any emission factors for onroad LPG vehicles.

<sup>12</sup> MOVES2014 will indicate which combinations are invalid (e.g. diesel motorcycles). MOVES2014a automatically selects only valid combinations.

gasoline, E-85, diesel, and CNG fractions will be used. If the user has data indicating that no E-85 fuel is available in the county, this would be specified in the Fuel Usage Fraction input of the Fuel tab. If the user has other data detailing the fleet and activity of alternative fuel/vehicle combinations, then those combinations should be selected using the AVFT input in the Fuel tab. In the Fuel Supply input of the Fuel tab, the user must provide valid fuel formulations that correspond to all vehicle-fuel combinations selected in the On-Road Vehicle Equipment Panel.

*Tip: Even if you do not have any E-85 sold in your area, be sure to include Ethanol (E-85) in your fuel/source type combinations. Otherwise, VMT and emissions from E-85 capable vehicles will not be included in your inventory. If there is no E-85 sold locally, use the Fuel Usage Fraction input in the Fuel Tab to indicate that. MOVES will then calculate emissions for E-85 vehicles using gasoline fuel.*

*Tip: If your local transit bus fleet uses only one type of fuel (CNG, diesel, or gasoline), use the AVFT input in the Fuel Tab to change the fractions of the bus fleet appropriately (e.g., with a fraction of 1.0 for that fuel and 0.0 for the others). Otherwise, MOVES will, by default, allocate some of the VMT to buses that use the other fuels and thus the results may underestimate emissions.*

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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**

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 Highway Performance Monitoring System (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, hotelling activity, and evaporative emissions. The Off-Network road type is automatically selected when start or hotelling 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., road types 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. Hotelling activity is determined in MOVES2014 by the user defined rural highway long-haul combination truck VMT.

MOVES uses Road Type to assign default drive cycles to activity on road types 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 4.6 and 4.7 below.

In Inventory mode, users also have the option of obtaining emissions for ramps and non-ramp highways separately when one or more restricted road types is selected.<sup>13</sup> To obtain output separated for highways and ramps, instead of combined together in the restricted road types, users would check the “Provide separate ramp output” box in the Road Type Panel of the RunSpec<sup>14</sup>. This option should only be selected if output is needed for ramps and highways separately. In general, most users should not select this option when developing regional emissions inventories. If this option is selected, MOVES will produce output for the following road types:

- Rural Restricted without Ramps (6) – rural highways excluding ramp activity and emissions
- Urban Restricted without Ramps (7) – urban highways excluding ramp activity and emissions
- Rural Restricted only Ramps (8) – rural highway ramp activity and emissions only
- Urban Restricted only Ramps (9) – urban highway ramps activity and emissions only

When the box is checked, MOVES will not produce output for the Rural Restricted Access road type (2) because output for this road type will be separated into road types (6) and (8). Similarly, MOVES will not produce output for the Urban Restricted Access road type (4) because output for this road type will be separated into road types (7) and (9).

### **3.7 Pollutants and Processes**

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

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<sup>13</sup> This option is disabled when using Emission Rates in the October 2014 release of MOVES2014, but may be added in a later release.

<sup>14</sup> In addition, “Road Type” must be selected in the Output Emissions Detail Panel (see Section 3.10.4 of this document)

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 12 separate pollutant processes in MOVES for hydrocarbon emissions. In most cases, all 12 of these processes must be selected to properly account for all hydrocarbon emissions from motor vehicles.<sup>15</sup>

In 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 Primary Exhaust PM<sub>2.5</sub>, users must also select Elemental Carbon and Composite NonECPM (non-elemental carbon particulate matter). MOVES will display error messages in the box on the Pollutants and Processes screen until all necessary base pollutants are selected. Clicking the button “Select Prerequisites” automatically selects all necessary pollutants and will clear the error messages.

For particulate matter (PM<sub>2.5</sub> or PM<sub>10</sub>), you must include Primary Exhaust PM –Total, Primary PM – Brakewear Particulate, and Primary PM – Tirewear Particulate to include all particulate emissions from onroad vehicles.

*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 rates that the user multiplies by different activity types for different emission processes. In order to properly calculate a total emissions inventory using the Emission Rates approach, 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. Following are the tables produced by an Emission Rates run and the processes included in each table. The rates labeled “alternative” below represent alternative forms (units) of some of the emissions reported in the Rate per Vehicle table, not additional emissions. Users should not apply both sets of rates to the same emissions processes, in order to avoid double-counting.

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<sup>15</sup> States must account for all emission processes in the SIP. However, two of the 12 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 on-road mobile source inventory and 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.**

- Rate per Distance Table - emissions in mass per distance (e.g., grams/mile); user multiplies these rates by 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); user multiplies these rates by total vehicle population by vehicle type:
  - Start exhaust
  - Crankcase start exhaust
  - Evaporative permeation (HC only)
  - Evaporative fuel leaks (HC only)
  - Refueling displacement vapor loss (HC only)<sup>16</sup>
  - Refueling spillage loss (HC only)
  - Exhaust extended idle emissions (long-haul combination trucks only)
  - Crankcase exhaust extended idle emissions (long-haul combination trucks only)
  - Auxilliary Power Exhaust (long-haul combination trucks only)
  
- Rate per Profile Table (HC only) – emissions in mass per vehicle (e.g., grams/vehicle); user multiplies this rate by total vehicle population by vehicle type:
  - Evaporative fuel vapor venting (HC only)
  
- Rate per Start (alternative to using Rate per Vehicle Table for start emissions) – emissions in mass per start (e.g., grams/vehicle-start); user multiplies these rates by the number of individual vehicle starts:
  - Start exhaust
  - Crankcase start exhaust
  
- Rate per Hour (alternative to using Rate per Vehicle table for extended idle and auxiliary power emissions) – emissions from hotelling activity in mass per hour (e.g., grams/hour); user multiplies these rates by the number of hours of hotelling activity:
  - Extended idle exhaust (long-haul combination trucks only)
  - Extended idle crankcase exhaust (long-haul combination trucks only)
  - Auxilliary Power Exhaust (long-haul combination trucks only)

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<sup>16</sup> Refueling displacement vapor loss and refueling spillage loss in MOVES are calculated based on fuel consumption associated with both running and start activity. As a result, these emissions appear in both the Rate per Distance Table and the Rate per Vehicle. Total refueling emissions are the sum of emissions calculated from both tables.

### **3.8 Manage Input Data Sets**

This panel allows users to create alternate data tables that are used in place of data from the MOVES default database. In most cases, SIP and conformity users will not use this panel at all because they will not have to input any databases other than the one created with the CDM (the County database is input in the Domain Input Database section of the Geographic Bounds Panel, see Section 3.4.3 of this document). The Generic Tab in the CDM (see Section 4.16 of this document) can be used to apply local inputs to tables not listed in the other CDM tabs. Users should consult with EPA before using the Manage Input Data Sets Panel to input other additional data.

### **3.9 Strategies**

The Strategies Panel provides access to the Rate of Progress option.

#### **3.9.1 Rate of Progress**

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 NO<sub>x</sub> 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 Rate of Progress Panel includes a checkbox which, when checked, disables all motor vehicle requirements of the 1990 Clean Air Act Amendments. States using MOVES to generate rate of progress plans will need to use this feature to estimate adjusted base year emissions. More generally, comparing MOVES runs with and without this checkbox selected can also be used to estimate the total benefits of all control programs required by the Clean Air Act Amendments of 1990.

### **3.10 Output**

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

#### **3.10.1 General Output**

The General Output Panel includes three sections: Output Database, Units, and Activity.

##### **3.10.1.1 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.

### **3.10.1.2 Units**

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, such as modeling criteria pollutants and their precursors, or mobile source air toxics, grams should be selected to avoid these rounding losses.

### **3.10.1.3 Activity**

MOVES allows the user to select multiple activity output options. These options are:

- Distance Traveled,
- Source Hours,
- Hotelling Hours,
- Source Hours Operating,
- Source Hours Parked,
- Population, and
- Starts.

For Inventory calculations, activity output is not required, but can be useful to verify whether activity was properly entered in MOVES. Therefore EPA recommends selecting “Distance Traveled” and “Population,” so that the user can compare these outputs with the VMT and population that the user included in the input database. Users providing vehicle start information through the Starts Importer of the CDM should always select the Starts option. Likewise, users providing hotelling information using the Hotelling Importer of the CDM should always select the Hotelling Hours option. For Emission Rates calculations, distance and population are reported automatically.

## **3.10.2 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 the user can later aggregate these results 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.

Time: 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.

Location: The County scale only allows one county or custom domain to be modeled at a time, so selection of County is recommended.

For All/Vehicle Equipment Categories: In most cases, the user does not have to select Model Year, unless the user has activity information by model year. Note that selecting Model Year will increase the rows of output 31 times. 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. Users can select Emission Processes to obtain output for each emissions process; otherwise MOVES will aggregate the results.

On Road: Detail for Source Use 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. If you checked the “Provide separate ramp output” box in the Road Type Panel, then select Road Type here (otherwise, you will get output aggregated for all road types and not get separate ramp output).

MOVES offers two additional output options, SCC and Regulatory Class, which are generally not recommended for SIPs and regional conformity analyses. SCC is an abbreviation for Source Classification Code, a system that EPA uses 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 MOVES source type and roadtype IDs. Regulatory Class is a system EPA uses to classify vehicles for emission standards purposes. EPA recommends using Source Use Type and Road Type instead of SCC or Regulatory Class.

#### ***3.10.4.1 Output Emission Detail When Using Emission Rate Mode***

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 CDM). Thus, the output emissions rates would only be valid for the specific mix of VMT and population by source type input. 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, it is recommended to leave model year and fuel type unchecked, unless the user has VMT and population by model year or fuel type that could be applied to these more specific rates. 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 speed). For start, hotelling, 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 (or alternative gram per start table for starts or gram per hour table for hotelling.) Additional detail on the applicability of data entered in the CDM when using the Emission Rates approach is provided in the individual parts of Section 4 of this document.

### ***3.11 Advanced Performance Features***

The Advanced Performance Features Panel is used to invoke features, which may be used to improve the run time for long model runs by saving and reusing intermediate results. It is not necessary 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 the appropriate sections 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?***

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 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 rates 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 the appropriate sections 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 Data
- Source Type Population
- Age Distribution
- Vehicle Type VMT
- Average Speed Distribution
- Road Type Distribution
- Ramp Fraction
- Fuel
- I/M Programs
- Zone (Custom Domain only)
- Starts
- Retrofit Data
- Hotelling
- Generic

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 analysis or determines that the default data need to be changed and makes those changes, the user then imports that data into MOVES. Details of the mechanics of using the data

importers are provided in the MOVES User Guide. Guidance for the use of these importers for SIPs and regional conformity analyses is given below.

In Emission Rates runs, vehicle activity inputs affect 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 and resting 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 4.15 on entering local information of Stage II refueling programs in MOVES.

## **4.2 Meteorology**

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 RunSpec. 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 motor vehicle emissions budget in the SIP as required in the transportation conformity rule, 40 CFR §93.122(a)(6). 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 average temperatures for each county from the National Climatic Data Center for the period from 2001 to 2011. 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. Detailed local meteorological data are available from the National Climatic Data Center at [www.ncdc.noaa.gov](http://www.ncdc.noaa.gov).

### **4.2.1 Meteorology: Guidance for Inventory Mode**

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 (e.g., for SIP attainment modeling), actual hourly meteorological data for the episode or for a longer period may be necessary. 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 Meteorology: Guidance for Emission Rates Mode**

Users can use Emission Rates with either a single county or a Custom Domain. If the Emission Rates 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 for running emission processes. Emission rates for all running processes that vary 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, i.e., 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 18 in January, for example, will result in the same emission rate as a temperature of 40 degrees for Hour 6 in July (assuming identical fuels).

However, for emissions from any non-running processes that occur on the “off-network” road type, including evaporative, start, and hotelling 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**

Source type (vehicle type) population is used by MOVES to calculate start and evaporative emissions.<sup>17</sup> Start and evaporative emissions depend more on how many vehicles are parked and started than on how many miles they are driven. In MOVES, start and resting evaporative emissions are related to the population of vehicles in an area. Because vehicle population directly determines start and evaporative emissions, users must develop local data for this input.

MOVES categorizes vehicles into 13 source types, which are subsets of 5 HPMS<sup>18</sup> vehicle types in MOVES, as shown in Table 2.

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<sup>17</sup> Alternatively, MOVES can calculate start emissions based on user-supplied start activity information (see Section 4.12)

<sup>18</sup> There are actually 6 HPMS vehicle Type IDs, but MOVES uses Vehicle Type ID 25 to substitute for HPMS Type IDs 20 (short wheelbase light-duty) and 30 (long wheelbase light-duty) for VMT input only.

Source Type ID	Source Types	HPMS Vehicle Type ID	HPMS Vehicle Type
11	Motorcycle	10	Motorcycles
21	Passenger Car	25	Light Duty Vehicles - Short and Long Wheelbase
31	Passenger Truck		
32	Light Commercial Truck		
41	Intercity Bus	40	Buses
42	Transit Bus		
43	School Bus		
51	Refuse Truck	50	Single Unit Trucks
52	Single Unit Short-haul Truck		
53	Single Unit Long-haul Truck		
54	Motor Home		
61	Combination Short-haul Truck	60	Combination Trucks
62	Combination Long-haul Truck		

### 4.3.1 Source Type Population: Guidance for Inventory Mode

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 source type population to estimate VMT per vehicle, and then determine whether these estimates are reasonable.*

<sup>19</sup> HPMS vehicle Type IDs are only used in MOVES for VMT input. All other applicable inputs, including vehicle population, are by MOVES Source Type and MOVES continues to calculate emissions separately for all Source Types. See Section 4.5 for addition details. This table is only presented here to show the mapping of Source Types to HPMS IDs.

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

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, hotelling and non-running evaporative emissions by source type in terms of grams per vehicle. Total start, hotelling 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 the non-running portion of the inventory from rates, multiply the rates from the ratepervehicle and rateperprofile tables by vehicle population. Alternatively, for start emission processes, use the rateperstart output, which requires multiplying by the number of vehicle starts and/or for hotelling processes, use the rateperhour output, which requires multiplying by the number of hotelling hours).

### **4.4 Age Distribution**

The age distribution of vehicle fleets can vary significantly from area to area. Fleets with a higher percentage of older vehicles will have higher emissions for two reasons. Older vehicles have typically been driven more miles and have experienced more deterioration in emission control systems. A higher percentage of older vehicles also 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, which is not reflected in the default age distributions in MOVES. MOVES uses a single national default age distribution for each vehicle type in each year for every county.

Therefore, for SIP and conformity purposes, EPA recommends and encourages states to develop local age distributions. EPA recommends compiling data according to MOVES vehicle classifications and model year breakdown. This guidance applies whether using the Inventory or Emissions Rates approach. For Custom Domain runs, users can define only one age distribution for each source type, which applies to the entire domain and cannot vary by zone.

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 (see Table 2 in Section 4.3 for a comparison of MOVES source types to HPMS vehicle classes). 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, in future years, include projections of changes in age distributions over time. If local registration age distributions are used, past guidance was that they should not change across calendar years and that EPA would 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. However, very large temporary changes in vehicle sales and scrappage rates as a result of the recession that began in 2008, may call for a different approach. EPA has created the "Age Distribution Projection Tool for MOVES2014" (found at [www.epa.gov/otaq/models/moves/tools.htm](http://www.epa.gov/otaq/models/moves/tools.htm)) which will take a local age distribution and apply the same methods that EPA uses for projecting default national age distributions in MOVES to change the local age distribution in future years. Users can choose to follow past guidance and use the same local age distribution for all years, or use the age distribution projection tool to develop future age distributions, even though those future age distributions may have a younger average age. Regardless of which approach is used, 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. States wishing to use a method other than the EPA tool described here to project future age distributions should consult with EPA early in inventory development.

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

EPA expects users to develop local VMT estimates for SIPs and regional conformity analyses, regardless of whether using the Inventory or Emission Rates approach. 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 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)).

MOVES2014 requires *annual* VMT by HPMS vehicle class as an input. However, many areas have average annual daily VMT. MOVES2014a allows the option of entering either annual VMT or daily VMT. EPA recommends that users with average annual daily VMT use MOVES2014a to take advantage of the daily VMT input option. For users who still need to use MOVES2014 or who want to use annual VMT in MOVES2014a to take advantage of capabilities in MOVES to allocate VMT across different time periods, EPA has created a spreadsheet-based tool, the “AADVMT Converter for MOVES2014,” 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 MOVES2014.<sup>20</sup> 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 motor vehicle emissions 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 used to develop inventories should be fully documented in the SIP submission and conformity determinations.

After the release of MOVES2010, the Federal Highway Administration modified the methodology used to generate VMT estimates in HPMS. As a result of that change, the old categories 20 and 30, which previously represented passenger cars and 2-axle, 4-tire trucks respectively, now represent short wheelbase and long wheelbase light-duty vehicles. Because the short wheelbase/long wheelbase distinction does not map well to MOVES source types, MOVES2014 uses a single category 25 to include all light-duty cars and trucks for VMT only. In MOVES2014, all VMT for HPMS categories 20 and 30 should be summed, and entered as category 25. Note that although HPMS categories 20 and 30 are combined for VMT entry purposes in MOVES2014, all other fleet and activity inputs (vehicle population, age distribution, average speed distribution, etc.) for Source Types 21, 31, and 32 are still handled separately in MOVES and all emission calculations and results are based on the emission and activity characteristics of each of these source types.

MOVES2014a includes the option to enter VMT by either the modified HPMS vehicle classes or by MOVES Source Types shown in Table 2 above. For users who are able to develop VMT data by broken down by the MOVES Source Types, entering VMT by Source Type will bypass the default allocation of VMT from HPMS class to Source Type that MOVES does internally. Either option is acceptable for SIP and conformity purposes, but differences between the default allocation of VMT from HPMS classes to source types in MOVES and the user supplied source type VMT could result in differences in results between the two options. 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 motor vehicle emissions 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

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<sup>20</sup> The AADVMT Converter for MOVES2014 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 converter can be found within the spreadsheet.

determine how to address (and minimize) any differences in results. The methods used to develop inventories should be fully documented in the SIP submission and conformity determinations.

#### **4.5.1 Vehicle Type VMT: Guidance for Emission Rates Mode**

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**

Vehicle power, speed, and acceleration have a significant effect on vehicle emissions. At the County scale, MOVES models these 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 emission rates. The guidance in this section concerning the use of local speed distribution data still applies whether local average speed distributions are applied within MOVES using the Inventory option or outside of MOVES using the Emission Rates option.

##### **4.6.1 Average Speed Distribution: Guidance for Inventory Mode**

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 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. One 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.

An alternative approach to develop a local average speed distribution is to process on-vehicle GPS data. There are a number of commercial vendors that can provide raw, or processed vehicle speed data from cell phone and other on-vehicle GPS collection devices. This information can be used to calculate a MOVES average speed distribution. As part of the MOVES2014 model, EPA used GPS data to calculate a national default average speed distribution. Users wishing to process their own GPS data into an average speed distribution should ensure that the data are representative of the modeling domain, and accurately capture variation in vehicle average speeds across the day, and year.

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 source types. If a local 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.

#### ***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. However, generating a daily average speed distribution for a highway network with a considerable number of highly congested links at certain times of day is not generally recommended. Because the relationship between speed and emissions is not linear, and emissions tend to be highest in congested conditions, using a daily average speed distribution in an area with significant congestion at certain times of day, can result in significant underestimation of emissions. In this case, using peak and off-peak speed distributions is recommended at a minimum. 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. 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. Faster or slower highway speeds result in faster or slower ramp speeds (and higher or lower acceleration rates) 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. MOVES also allows users to separate emissions between ramps and highways.

Section 4.8 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 Distribution: Guidance for Emission Rates Mode**

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.

#### ***4.7 Road Type Distribution***

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 road type. For each source type, the Road Type Distribution table of the input database 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 Road Type Distribution: Guidance for Inventory Mode**

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.

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 Distribution: Guidance for Emission Rates Mode**

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 Rates option.

### ***4.8 Ramp Fraction***

The default ramp fraction on both rural restricted roads (Road Type 2) and urban restricted roads (Road Type 4) is 8% of VHT. Use of the Ramp Fraction Tab is optional (the default value of 8% will be automatically applied if the user does not import local data), although EPA strongly recommends users input a local ramp fraction. This can typically be calculated using a travel demand model.

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.

For both Inventory and Emission Rates modes, the default output from MOVES combines highway and ramp activity. However in Inventory mode, users can have MOVES report results for ramps separately from highways. To obtain results for ramps and highways separately, users would check the “Provide separate ramp output” box in the Road Type Panel of the RunSpec, and select “Road Type” on the Output Emissions Detail Panel. This option should only be

selected if there is a need to separate ramp emission from highway emissions. Typically, when developing an emissions inventory, this level of detail is not necessary.

Separate ramp output is not available in Emission Rates mode in MOVES2014. In Emission Rates mode, aggregate ramp/highway emission rates will be produced that should be combined with aggregate ramp/highway VMT.

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

#### **4.9 Fuels (Fuel Supply, Fuel Formulation, Fuel Usage Fraction, and AVFT)**

MOVES has four tables – called fuelsupply, fuelformulation, fuelusagefraction, and AVFT (fuel type and vehicle technology) – that interact to define the fuels used in the area being modeled. The MOVES defaults for all four tables are accessible using the Export Default Data button in the Fuel Tab of the CDM.

- The fuelsupply table identifies the fuel formulations used in a region (the regionCounty table defines which specific counties are included in these regions) and each formulation's respective market share;
- The fuelformulation table defines the properties (such as RVP, sulfur level, ethanol volume, etc.) of each fuel;
- The fuelusagefraction table defines the frequency at which E-85 capable (flex fuel) vehicles use E-85 vs. conventional gasoline; and
- The AVFT table is used to specify the fraction (other than the default included in the sampleVehiclePopulation table) of fuel types capable of being used (such as flex fuel vehicles) by model year and source type.

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. Finally, the emission rates are applied to the appropriate activity defined through the fuelusage and AVFT tables.

For all fuel tables, users should begin by exporting and reviewing the MOVES default fuel tables for the county being analyzed. In general, users should rely on the default county-level information in MOVES. The default fuel tables in MOVES2014 have been revised and updated significantly compared to MOVES2010b and were revised again in MOVES2014a. As a result, converted default fuel tables from any previous version of MOVES should not be used in MOVES2014 or MOVES2014a for SIPs or conformity analyses.<sup>21</sup>

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<sup>21</sup> This applies to MOVES2010 fuel tables that have been modified to reflect differences in local fuels as well. Instead, users should export the default MOVES2014a fuel tables, make any changes needed to reflect local fuel differences consistent with the guidance in this document, and then re-import those modified MOVES2014a fuel tables back into MOVES2014a. If MOVES2014 is being used for analysis, the user should export the default MOVES2014 tables, make the appropriate changes, and then re-import them into MOVES2014.

The following subsections of this document specify situations where changes to the MOVES default fuel data are appropriate. This guidance will apply for county or custom domain zones, and for Emission Rates and Inventory runs. When running MOVES for a custom domain, the same fuel formulation, fuel supply, fuel usage, and AVFT information must apply across the entire custom domain. If different counties in the domain have different fuel characteristics, the counties must be analyzed using separate runs.

MOVES has default gasoline and diesel fuel formulation and supply information for every county-year-month combination that can be selected. These default tables are based on volumetric fuel data for thousands of batches of fuel in each of the fuel regions. In MOVES2014, we have simplified the county-level fuel properties within the MOVES fuel supply. Many counties in MOVES2010b contained unique fuel properties not associated with neighboring counties that were sometimes based on very limited fuel survey data. For MOVES2014, EPA developed new fuel properties based on averages of survey data as well as data provided to us at the refinery gate as part of EPA fuel compliance programs. EPA believes this average data by region provides a more consistent and maintainable basis for the model and, by aggregating fuel survey data as well as incorporating refinery batch-by-batch fuel compliance data, a more representative fuel supply was created for the final default. These new fuel supply and fuel formulation tables better account for fuel production and distribution networks, natural borders, and regional/state/local variations in fuel policy and increase confidence that the default fuels in a particular region represent the actual fuels used in that region. The new fuel regions in MOVES2014 and MOVES2014a are shown and described in the figure and table below.

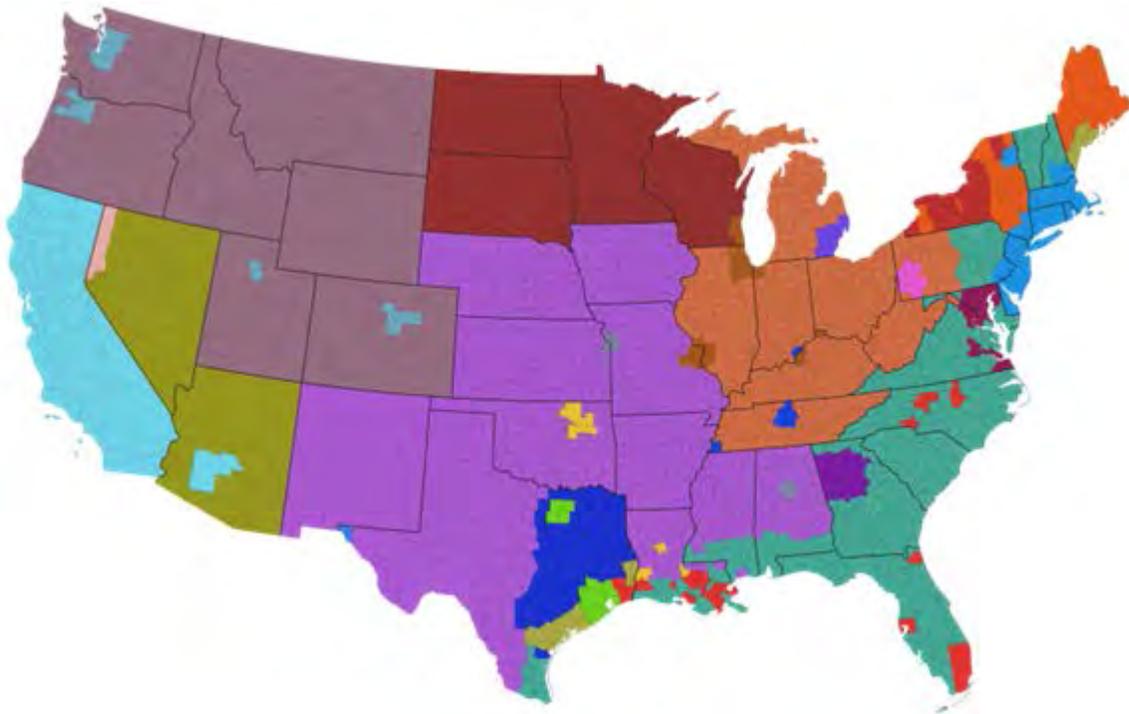


Figure 1. MOVES2014 and MOVES2014a Fuel Regions

Region ID#	Region Name	Description
1	East Coast	East coast states up to Appalachians, Florida, and gulf coast region
2	Midwest	Midwest states up to Appalachians (not including Wisconsin), Tennessee, Kentucky
3	South	Southern states not including gulf coast, Nebraska, Iowa
4	North	North and South Dakota, Minnesota, Wisconsin
5	Rocky Mts	Pacific northwest, Rocky mountain states, Utah
6	CA/NV/AR	California, Nevada, Arizona, AK, and HI NOT using Reformulated Gasoline (RFG)
11	East Coast RFG	East coast states and regions using RFG fuel or under a controlled fuel program

12	<b>MD/VA</b>	Maryland and Virginia regions using RFG fuel or under a controlled fuel program
13	<b>Texas RFG</b>	Texas regions using RFG fuel or under a controlled fuel program
14	<b>Midwest RFG</b>	Midwest regions using RFG fuel or under a controlled fuel program
15	<b>California</b>	California using California fuel, Nevada and Arizona regions using California Fuel

### 4.9.1 Fuel Formulation and Fuel Supply Guidance

In general, users should first review the default fuel formulation and fuel supply, and then make changes only where precise local volumetric fuel property information is available. EPA strongly recommends using the default fuel properties for a region unless a full local fuel property study exists. EPA does not consider single or yearly station samples adequate for substitution.

The lone exception to this guidance is in the case of Reid Vapor Pressure (RVP) where a user should change the value to reflect any specific local regulatory requirements and differences between ethanol- and non-ethanol blended gasoline not reflected in the default database. Any changes to RVP (or to any other fuel formulation parameters) should be done using the “Fuels Wizard” tool in the Fuel Tab of the CDM. This tool can be used to adjust unknown fuel formulation properties based on known fuel properties. For instance, changing a fuel’s RVP will affect other fuel properties due to changes in refinery configuration in order to create that new fuel. The Fuels Wizard calculates the appropriate values consistent with EPA’s refinery modeling. The Fuel Wizard should be used whenever changing any default fuel property for gasoline and gasoline-ethanol blends in the Fuel Formulation table.<sup>22</sup>

#### 4.9.1.1 Fuel Formulation Data Fields

The key fields in the fuel formulation that a user might modify based on the guidance above are described below.

Fuel Formulation ID identifies the fuel and is entered in the fuelsupply table to define the fuel(s) used in the fuel region 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 (for gasoline and ethanol-gasoline blends, 1000-20000; for diesel, > 25000). New fuel formulations should not be created for compressed natural gas (CNG) or electricity as there is only one form of these fuels.

<sup>22</sup> The Fuel Wizard is not used for E-85, Diesel, or CNG fuels.

Fuel sub-type ID provides an additional 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 (E-10) (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 on 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 E-10 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.

*Tip: Please note that ethanol blends above E-10 (such as E-15 blends) do not receive the 1psi ethanol waiver and should not be adjusted.*

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Sulfur level is measured in parts per million (ppm) in terms of weight. Sulfur levels must be entered for all gasoline and diesel fuel. Recent rulemakings (see Tier 2 and Tier 3 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 sulfur level: 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). The Tier 3 rule

establishes a national average of 10 ppm sulfur beginning in 2017. 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 for years before 2017. Areas where the MOVES default gasoline sulfur level is above 30 should use this value unless local data on sulfur content are available. After 2017, MOVES2014 assumes a sulfur level of 10 ppm for all regions. MOVES2014 can provide benefits of sulfur reduction down to 5ppm. Do not use values for gasoline sulfur below 5ppm.

Diesel sulfur level: 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); MOVES2014 assumes full compliance with the ULSD rule, with a 15 ppm sulfur level for diesel fuel in all years after 2010. 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.

ETOH Volume is the percent by volume of ethanol the gasoline/ethanol mixture. The Renewable Fuel Standard 2 rule (RFS2 75 FR 14670, March 26, 2010) greatly increased the amount of ethanol used in blending in the gasoline fuel supply. EPA expects wide adoption of E-10 blends in all regions, with a near 100% adoption rate by 2013. Beginning in years beyond 2013, MOVES2014 assumes some E-15 and E-85 blending to account for the additional ethanol added by the RFS2 rule. E-15 blending rates vary by region depending on local supply. Marketshares of E-10, E-15 and E-85 for future years are based on the projections made in the Annual Energy Outlook 2014 report (AEO2014ER). 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.

#### ***4.9.1.2 Fuel Supply Data Fields***

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 regionID field identifies the area being modeled (see Figure 1, describing fuel regions above). 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 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	E-85
9	Electricity

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).

#### 4.9.2 Fuel Usage Fraction Guidance

E-85 capable vehicles, also known as flex-fuel vehicles (FFVs) exist throughout the country and are capable of using either conventional gasoline or E-85 fuel (a blend of 85% ethanol and 15% gasoline). The fuel usage table allows the user to change the frequency at which E-85 capable vehicles use E-85 fuel vs. conventional fuel, when appropriate. MOVES2014 contains default estimates of E-85 fuel usage for each county in the U.S. In most cases, users should rely on the default information. If local data are available that indicate different E-85 usage, the fraction of gasoline (fuelsupplyfuelID = 1) and E-85 (fuelsupplyfuelID = 5) can be specified for sourceBinFuelTypeID = 5. Usage fractions for sourceBinFuelTypeIDs 1,2, and 3 (gasoline, diesel, and CNG) should not be changed.

Please note that this table defines the fraction of E-85 use among E-85 capable vehicles, not the fraction of use among all vehicle or the fraction of E-85 capable vehicles in the fleet. A fuel usage fraction table entry of 1.0 for fuel supply fuel type ID = 5 would mean that E-85 capable vehicles (FFVs) are using E-85 100% of the time. A fraction of 0.0 for fuel supply fuel type ID = 5 would mean that FFVs are using conventional gasoline 100% of the time, e.g., if there is no E-85 available in the local fuel supply. For example, if you know that no E-85 is used in the county you are modeling, for sourceBinFuelTypeID 5, for fuelsupply 1 (gasoline), you would change the usagefraction to 1, and for fuelsupply 5 (E-85), you would change the usagefraction to zero.

As noted in Section 3.5 of this document, Ethanol (E-85) should always be selected in the On-Road Vehicle Equipment Panel because FFVs are present throughout the national fleet; the Fuel Usage Fraction inputs are the appropriate place to account for the amount of actual E-85 usage by these vehicles.

#### 4.9.3 AVFT Guidance

The AVFT (fuel type and vehicle technology) table allows users to modify the fraction of vehicles capable of using different fuels and technologies in each model year. Specifically, the AVFT table allows users to define the split between diesel, gasoline, E-85, CNG, and electricity, for each vehicle type and model year.<sup>23</sup> For example, if in a certain county, registration data show that more diesel vehicles are in operation than indicated by the default AVFT table for a particular source type, this table could be used to make the adjustment. This table should only be

<sup>23</sup> In MOVES2014, the only vehicles that can be fueled by CNG are transit buses.

modified if local data are available. If local data are used for present years, that information can be assumed for future years.

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>24</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. In most cases, the default VMT split between diesel, gasoline, CNG, and E-85 should be used.

For transit buses, the default table assumes that gasoline, diesel, and CNG buses are present in the fleet for most model years. Note that if the user relies on the model's default allocation of vehicle activity, portions of the transit bus activity are always assumed to be diesel, gasoline, and CNG. This is true even if the one or more of these combinations is not selected in the On Road Vehicle Equipment Panel. That is, if the user selects only gasoline and diesel vehicles in the On Road Vehicle Equipment Panel, MOVES still assumes some transit bus CNG VMT.

If the user has information about the fuel used by the transit bus fleet in the county modeled, the user should be sure it is reflected in the AVFT table. For example, 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 AVFT table to calculate the correct emission results for transit buses. Otherwise, some VMT will be allocated to CNG transit buses and the emissions associated with this VMT will not be included in the output, as only gasoline and diesel vehicles were selected in the On Road Vehicle Equipment Panel. Or if the transit bus fleet in a county is entirely diesel, then the user should assign 100 percent of the transit bus activity to diesel (i.e., a "1"), and assign a zero for gasoline and CNG transit bus activity. The same general principle applies to school buses, which are a mix of gasoline and diesel in the default distribution. After making appropriate adjustments to reflect fuel usage by the transit bus fleet, ensure that the AVFT fractions sum to 1.0 for each model year.

Similar concerns apply to E-85 capable flex-fueled vehicles (FFVs). As noted in Section 3.5 of this document, Ethanol (E-85) should always be selected in the On-Road Vehicle Equipment Panel because FFVs are present throughout the national fleet. However, in contrast to transit buses, in general users should rely on default AVFT assumptions of the fractions of local FFVs, and use the fuel usage fraction table to adjust for any differences in the local availability of E-85 fuel.

#### ***4.10 Inspection and Maintenance Programs***

Inspection and maintenance programs continue to be important local control programs in many nonattainment areas. MOVES includes the capability of modeling the essential design elements of an I/M program.

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<sup>24</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.

EPA recommends that users attempting to characterize the emissions impact of an I/M program use the same approach, as described below, for Inventory or Emission Rates 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 CDM. 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 4.10.5 of this document. **The default I/M files do not incorporate grace periods or exemption ages.**

Note that the default I/M data were significantly updated in MOVES2014 and updated again in MOVES2014a. As a result, a converted I/M data table based on defaults in MOVES2014 should not be used with MOVES2014a.<sup>25</sup>

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.

#### **4.10.1 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.

#### **4.10.2 Source Type ID and Fuel Type ID**

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

I/M programs have historically applied to vehicles by regulatory weight class; however, MOVES applies I/M benefits by source type. This can lead to discrepancies between the number of vehicles covered in the actual I/M program and the number of vehicles that MOVES assumes is covered. For example, an I/M program that targets trucks less than 8501 lbs. Gross Vehicle Weight Rating (GVWR) (i.e. regulatory classes LDT1, LDT2, LDT3, and LDT4) would include

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<sup>25</sup> This applies to MOVES2010 I/M tables that have been modified to reflect actual local programs as well. Instead, users should export the default MOVES2014a I/M coverage table, make any changes needed to reflect local programs consistent with the guidance in this document, and then re-import the modified MOVES2014a I/M coverage table back into MOVES2014a. If MOVES2014 is being used for analysis, the user should export the default MOVES2014 table, make the appropriate changes, and then re-import it into MOVES2014.

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, the benefits of the I/M program are applied to all of the vehicles in these source types. Users need to 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 4.10.6.3 of this document.

### 4.10.3 Inspection Frequency

MOVES allows users to enter either annual or biennial test frequency. MOVES also includes an option for continuous I/M, however, there are currently no emission benefits assigned to this option in MOVES and it should not be selected.

### 4.10.4 Test Standards and I/M Program ID

MOVES allows users to choose between 12 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.
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

Test Standards ID	Test Standards Description	Description
		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.

#### 4.10.5 Beginning and Ending Model Years

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

For I/M programs with a grace period for new vehicles or an exemption period for older vehicles, this entry should reflect the actual model years covered by the program in the calendar year of evaluation. As a result, the beginning and ending model years for an I/M program may vary depending on the calendar year of analysis. For example, a typical OBD I/M program might apply to all model years beginning with 1996. However, if that program also includes a grace period during which newer vehicles are exempt from the program, the ending model year of the program should reflect the most recent model year included in the program based on the calendar year of analysis. For example, if in calendar year 2015, the most recent model year being tested in a program with a three-year grace period is the 2012 model year, a MOVES run

for calendar year 2015 would have an ending model year of 2012. An analysis of the same program for calendar year 2020 would have an ending model year of 2017.

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 2015, the oldest model year still being tested in a program with exemptions for older vehicles is the 1995 model year, a MOVES run for calendar year 2015 would have a beginning model year of 1995. An analysis of the same program for calendar year 2020 would have a beginning model year of 2000.

*TIP: 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.*

#### **4.10.6 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 (these last adjustments will be referred to here as the “regulatory class coverage adjustment”). The compliance factor is entered as 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:

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

##### **4.10.6.1 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 (vehicles that receive a certificate of compliance or waiver/total vehicles that should be subject to I/M testing). 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.

##### **4.10.6.2 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 (calculated as the number of vehicles that do not pass a retest but receive a certificate of compliance divided by the number of vehicles that fail an initial I/M test). 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.

##### **4.10.6.3 Regulatory Class Coverage Adjustment**

I/M programs entered in MOVES can only be applied to source types. However, as discussed in Section 4.10.2, 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.1 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 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.1 defaults should provide documentation in the SIP or regional conformity analysis of the local data and methods used to derive those adjustments.

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

Using the example from Section 4.10.2, 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.1 in the Appendix to this document. For source type 31, the regulatory class coverage adjustment is 98%. For source type 32, the regulatory class coverage adjustment is 93%.

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

$$\begin{aligned} \text{Compliance factor} &= \text{compliance rate} \times (100 - \text{waiver rate}) \times \text{regulatory class coverage} \\ 87\% &= 96\% \times (100-8)\% \times 98\% \end{aligned}$$

The compliance factor for source type 32 is

$$\begin{aligned} \text{Compliance factor} &= \text{compliance rate} \times (100 - \text{waiver rate}) \times \text{regulatory class coverage} \\ 82\% &= 96\% \times (100-8)\% \times 93\% \end{aligned}$$

These values would be entered as compliance factors of 87 for source type 31 and 82 for source type 32.

### ***4.11 Zone (Custom Domain Only)***

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 4.2.

Table 5. MOVES2014 Custom Domain Inputs by Zone

<b>MOVES input</b>	<b>Can be varied by zone?</b>	<b>How is the input changed?</b>
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
Starts	Yes	Starts can be varied using the starts fraction of the "Zone" input
Hotelling	Yes	Hotelling can be varied using the extended idle fraction of the "Zone" input
Age Distribution	No	Not applicable
Retrofit	No	
Average Speed Distribution	No	
Road Type Distribution	No	
Ramp Fraction	No	
Fuels	No	
I/M Programs	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), hotelling (idleAllocFactor), and parking (SHPAallocFactor) for each defined zone. Since most 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 1 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 is only used when selecting output by SCC. Because output by SCC is not recommended for SIP and regional conformity analyses, most users should not import this table.

#### **4.12 Starts**

The Starts Tab is used to import local information on vehicle start activity. This input is optional and should only be used if local data are available. There are several sources for vehicle start information, but typically this is derived from origin/destination surveys used for travel demand modeling. If no starts information is available, this importer should not be used and MOVES will calculate start activity based on user-supplied vehicle populations (sourcetypeyear input) and default assumptions of vehicle activity.

The Starts Tab contains multiple importers. Depending on the information available, one or more of these importers can be used to supply local start information. These importers include:

- Starts,
- StartsPerDay,
- StartsPerHourFraction,
- StartsSourceTypeFraction,
- StartsMonthAdjust, and
- StartsOpModeDistribution

The importers are used to create the starts table in MOVES. This is a very detailed table containing start information by source type, hour, day, and month. Typically, local data will not be available to populate the entire starts table. In a case where a user supplied only one table, MOVES will use that information to create the starts table, and will rely on default information for the inputs not provided. For instance, if total starts per day are provided through the startspcrday table, those values will be used, and will be distributed to source types, months, and hours based on MOVES default allocations.

Users should confirm in the output that MOVES used the correct number of starts. By selecting “Starts” Activity in the Output Emissions Detail Panel of the RunSpec, the number of starts used in the MOVES run will be reported in the MOVESactivityoutput table of the output database. This table can be used to confirm the correct number of starts and/or correct allocations were used in MOVES.

### **Starts**

The Starts table can be used to completely replace the MOVES generated Starts table. Information on starts must be provided by month, hourdayID, sourcetypeid, and vehicle ageID. To use this input, vehicle starts information must be available for all fields. This input should only be used independently, and should not be used in combination with other starts inputs. Note that a complete table must be provided that includes all combinations of month, hourdayID, sourcetypeid selected in the RunSpec. If you have some but not all of the information required for this table, use one or more of the tables described below, as appropriate.

### **StartsPerDay**

The Startspersday table can be used when vehicle start information is available for total starts for weekend and/or weekdays. Total starts should be provided for a typical weekday and weekend day (dayID 5 and 2 respectively.) This input can be used independently, or in combination with other start input tables.

### **StartsPerHourFraction**

The Startspershourfraction table can be used when local start information is available by hour of day. Fractions can be provided to correctly allocate starts to the appropriate hour. Fractions should be provided for both weekday and weekend day. The fractions should sum to one for each day type. This input can be used independently, or in combination with other start input options.

### **StartsSourceTypeFraction**

The Startssourcetypefraction table can be used when local start information is available by source type. Fractions can be entered in the table to allocate total starts to each of the 13 MOVES source types. Fractions should sum to one. This input can be used independently, or in combination with other start input options.

### **StartsMonthAdjust**

The Startsmoonthadjust table can be used to vary the vehicle starts between different months. An adjustment factor of 1.0 for each month will model a situation where annual starts are evenly divided between months. This is likely an unrealistic scenario. Usually, start activity increases in the summer and decreases in the winter. Local starts information can be used to adjust starts up or down depending on the month (or season) by changing the adjustment factors for each month. Users should make sure total starts are conserved by checking the MOVESactivityoutput table in the output database.

### **StartsOpModeDistribution**

The Startopmodedistribution table can be used to provide local soak-time distributions. A soak-time is the period between “key-off” and “key-on.” Longer periods of soak typically result in

higher start emission rates. If local data are available, the MOVES default soak-time assumptions can be overwritten by changing the opmodedistribution fractions in this table. This input can be used independently, or in combination with other start input options. Note that evaporative emissions will not be affected by changing this table.

### **4.13 Hotelling**

The Hotelling Tab is used to import information on combination truck hotelling activity. In MOVES2014 and MOVES2014a, hotelling can be divided into four operating modes: Extended Idle, Diesel Auxiliary Power (APU), Battery Power, and Engine-Off.<sup>26</sup> Extended Idle is defined as long-duration idling with more load than standard idle and a different idle speed. It is used to account for emissions during hotelling operation when a truck's engine is used to support loads such as heaters, air conditioners, microwave ovens, etc. Diesel Auxiliary Power refers to use of auxiliary power units that allow for heating/cooling/power for the cab without running the truck's engine. Engine-Off refers to hotelling when the truck's engine is off and an APU is not being used. This could include hotelling resulting from truck-stop electrification.

All hotelling processes only apply to long-haul combination trucks (sourcetype = 62).

The Hotelling Tab contains two importers: HotellingActivityDistribution and HotellingHours.

#### **HotellingActivityDistribution**

In most cases, users should rely on the national default hotelling operating mode fractions. In this case, no action is necessary for the Hotelling tab. However, if users have detailed local hotelling data, it can be used to define the fraction of hotelling hours that are in each of the hotelling modes by model year.

#### **HotellingHours**

In most cases, users should rely on the MOVES generated hotelling hours, which are determined based on the amount of rural restricted access VMT imported. However, the Hotelling Tab also includes an optional input for Hotelling Hours. This input can be used if users have detailed local information on total hotelling hours by hour of day, day type, month, and vehicle model year. Note that a complete table must be provided that includes all combinations of Month, HourDayID, and Hour selected in the RunSpec.

### **4.14 Retrofit Data**

The Retrofit Data Tab in MOVES allows users to enter retrofit program data that apply adjustments to vehicle emission rates. There are no default retrofit data in MOVES. However, users are not required to input retrofit data into MOVES unless they have a retrofit program that they wish to model. Users should consult EPA's SIP and Conformity Retrofit Guidance ([www.epa.gov/otaq/stateresources/transconf/policy.htm#quantify](http://www.epa.gov/otaq/stateresources/transconf/policy.htm#quantify)) for additional information.

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<sup>26</sup> Note that the Battery Power operating mode produces the same emissions as the Engine Off mode.

#### **4.15 Stage II Refueling Programs**

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

There is currently no dedicated importer for this in the CDM. Stage II information is included in the CountyYear table. An alternative CountyYear table can be imported using the Generic Importer Tab (described 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.htm](http://www.epa.gov/otaq/invntory.htm). 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.

#### **4.16 Generic**

The Generic Tab can be used to export, modify, and re-import any of the default MOVES tables not covered by specific tabs in the CDM. 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 EPA Regional Office before modifying any of the default MOVES tables accessible through the Generic tab.

## Appendix A

Table A.1: Users can apply the regulatory class coverage adjustments in the following table as described in Section 4.10.6.3.

Source Type Description	SourceTypeID	MOVES Reg Class Description	MOVES RegClass ID	Regulatory Class Coverage Adjustment (%)
Motorcycle	11	Motorcycles (Gasoline)	10	100%
Passenger Car	21	LD Gas Vehicles (Passenger Cars)	20	100%
Passenger Truck	31	LD Gas Trucks (less than 8,501 lbs. GVWR)	30	98%
		Class 2b 2-Axle 4-Tire Gas Trucks (8,501 - 10,000 lbs. GVWR)	40	2%
Light Commercial Truck	32	LD Gas Trucks (less than 8,501 lbs. GVWR)	30	92%
		Class 2b 2-Axle 4-Tire Gas Trucks (8,501 - 10,000 lbs. GVWR)	40	8%
Transit Bus	42	Light Heavy Duty Gas Vehicles (14,001 - 19,500 lbs. GVWR)	42	27%
		Medium Heavy Duty Gas Vehicles (19,501 - 33,000 lbs. GVWR)	46	10%
		Heavy Heavy Duty Gas Vehicles (Greater than 33,000 lbs GVWR)	47	63%
School Bus	43	Light Heavy Duty Gas Vehicles (8,501 - 14,000 lbs. GVWR)	41	1%
		Light Heavy Duty Gas Vehicles (14,001 - 19,500 lbs. GVWR)	42	1%
		Medium Heavy Duty Gas Vehicles (19,501 - 33,000 lbs. GVWR)	46	94%
		Heavy Heavy Duty Gas Vehicles (Greater than 33,000 lbs GVWR)	47	4%
Refuse Truck	51	Light Heavy Duty Gas Vehicles (8,501 - 14,000 lbs. GVWR)	41	6%
		Light Heavy Duty Gas Vehicles (14,001 - 19,500 lbs. GVWR)	42	84%
		Medium Heavy Duty Gas Vehicles (19,501 - 33,000 lbs. GVWR)	46	10%

Table A.1: Users can apply the regulatory class coverage adjustments in the following table as described in Section 4.10.6.3.

Single Unit Short-haul Truck	52	Light Heavy Duty Gas Vehicles (8,501 - 14,000 lbs. GVWR)	41	46%
		Light Heavy Duty Gas Vehicles (14,001 - 19,500 lbs. GVWR)	42	38%
		Medium Heavy Duty Gas Vehicles (19,501 - 33,000 lbs. GVWR)	46	16%
Single Unit Long-haul Truck	53	Light Heavy Duty Gas Vehicles (8,501 - 14,000 lbs. GVWR)	41	48%
		Light Heavy Duty Gas Vehicles (14,001 - 19,500 lbs. GVWR)	42	34%
		Medium Heavy Duty Gas Vehicles (19,501 - 33,000 lbs. GVWR)	46	18%
Motor Home	54	Light Heavy Duty Gas Vehicles (8,501 - 14,000 lbs. GVWR)	41	27%
		Light Heavy Duty Gas Vehicles (14,001 - 19,500 lbs. GVWR)	42	39%
		Medium Heavy Duty Gas Vehicles (19,501 - 33,000 lbs. GVWR)	46	30%
		Heavy Heavy Duty Gas Vehicles (Greater than 33,000 lbs GVWR)	47	4%
Combination Short-haul Truck	61	Medium Heavy Duty Gas Vehicles (19,501 - 33,000 lbs. GVWR)	46	97%
		Heavy Heavy Duty Gas Vehicles (Greater than 33,000 lbs GVWR)	47	3%