

**EPA's Draft MOVES2009 Model  
&  
Transition From MOBILE6.2 To MOVES**

**Sunil Kumar  
Eulalie Lucas**

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# MOVES Model – Introduction

- **MOVES** - **Motor Vehicle Emission Simulator**
- Designed to estimate both on-road & non-road emissions.
- DRAFT MOVES2009 version currently estimates on-road emissions only.
- EPA plans to incorporate non-road emissions estimation capability in a future version (2011 ?).

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# MOVES Model – Introduction

- MOVES designed to operate as a complete emissions estimation package. It produces total emissions.
  - Mobile6.2 model only produced emissions factors and not total emissions.
- MOVES allows designed to perform various “What-if scenarios” related to different fuel types and vehicle technology types. Can also estimate benefits from I/M programs, diesel retrofits, etc. very easily.
- Emissions estimation available at three (3) different levels –
  - National
  - County
  - Project

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## MOVES vs. MOBILE6.2

- **MOVES** designed to allow easier incorporation of large amounts of in-use data from a variety of sources.
- **MOBILE6.2** has a limited ability to incorporate new input data.
  
- **MOVES** uses a Graphical User Interface.
- **MOBILE6.2** uses Text Input and Output files
  
- **MOVES** written in JAVA/MySQL and data elements are stored in database format
- **MOBILE6.2** written in Fortran (outdated), and many data elements are hard-coded.

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# MOVES vs. MOBILE6.2

## ➤ MOVES

- Produces Gram/mile emissions factors as well as grams/time for some processes.
- Has a post-processor capable of producing total emissions for specific areas and time periods.
- Easily customizable output (many levels of aggregation/disaggregation).

## ➤ MOBILE6.2

- Grams/mile only and fixed output formats

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# Some Factors Affecting Emissions in MOVES

- PM temperature effects
- PM speed effects
- Heavy duty deterioration effects
- Extended idle emissions
- Permeation emissions
- I/M benefits are comparable to MOBILE6.2 now, but will shrink over time.

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# MOVES vs. MOBILE6.2

## ➤ Emissions Rates

- **MOVES** – Based on “operating modes”
- **MOBILE6.2** - Based on aggregate driving cycles

## ➤ MOVES Road (Facility) Types – Total 5

- Urban Restricted Access
- Rural Restricted Access
- Urban Unrestricted Access
- Rural Unrestricted Access
- Off-Network

## ➤ MOVES Fuel Types - Total 6

- Gasoline, Diesel, Ethanol (E85), Methanol (M85), CNG, LPG, Electricity, Gaseous H<sub>2</sub>, Liquid H<sub>2</sub>

## ➤ MOVES Vehicle (Source) Types – Total 13

- Passenger Car, Passenger Truck, Light Commercial Truck, School Bus, Transit Bus, Intercity Bus, Combination Short-Haul Truck, Combination Long-Haul Truck, Single Unit Short-Haul Truck, Single Unit Long-Haul Truck, Refuse Truck, Motor Home, Motorcycle
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## ➤ **MOVES Emissions Process**

- ✓ **Running Exhaust**
- ✓ **Start Exhaust**
- ✓ **Extended Idle**
- ✓ **Evaporative Processes**
  - Permeation, Vapor Venting, Leaks, Refueling Displacement, Refueling Spillage
- ✓ **Crankcase**
- ✓ **Tire Wear**
- ✓ **Brake Wear**
- ✓ **Well-To-Pump (energy only)**

## ➤ MOVES Emissions by Source, Age, Mode

✓ MOVES uses a different rate for each combination of:

- Source,

- Age group, and

- Operating mode

Gas-LDV-MY1998

Gas-LDT-MY2002

8-9 years

4-5 years

"low-speed" coast  
"cruise/accel" (speed 25-50 mph, VSP 12-15  
kW/tonne)

# How MOVES handles vehicle activity

- **Vehicle Specific Power (VSP) – a measure of the energy the vehicle is using at a moment in time**
  - Affected by acceleration, road grade, resistance, etc.
- **Operating Mode – what the vehicle is doing, i.e., accelerating, braking, cruising, idling**
  - Vehicles use different VSP in different operating modes
  - MOVES defines 23 operating mode bins – combinations of speed and VSP for different running conditions plus additional operating modes for starts and evaporative emissions
- **Drive Cycle – a second-by-second description of vehicle activity over time, typically including multiple operating modes**
- **Total Activity Distribution By Process (based on VMT, Age dist., vehicle pop., sales & VMT growth rates, etc.)**
  - Running, Tire/Brake Wear – Source Hours Operating (SHO)
  - Evaporative Fuel Permeation, Vapor Venting & Leaking – Source Hours
  - Start – Number of Starts
  - Extended Idle - Extended Idle Hours

- Operating Mode Bins

	Speed Class (mph)		
	1-25	25-50	50 +
<b>30 +</b>	<b>16</b>	<b>30</b>	<b>40</b>
<b>27-30</b>			
<b>24-27</b>		<b>29</b>	<b>39</b>
<b>21-24</b>		<b>28</b>	<b>38</b>
<b>18-21</b>			
<b>15-18</b>			<b>37</b>
<b>12-15</b>		<b>27</b>	
<b>9-12</b>	<b>15</b>	<b>25</b>	
<b>6-9</b>	<b>14</b>	<b>24</b>	<b>35</b>
<b>3-6</b>	<b>13</b>	<b>23</b>	
<b>0-3</b>	<b>12</b>	<b>22</b>	<b>33</b>
<b>&lt; 0</b>	<b>11</b>	<b>21</b>	

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# Running Operating Modes in MOVES

- **MOVES uses second-by-second emissions data categorized in operating mode bins based on combination of speed and VSP**
- **MOVES includes default operating mode distributions based on typical driving cycles**
  - Different road types in MOVES have different default operating mode distributions
- **Users can create other operating mode distributions based on other driving cycles**
  - Unlike MOBILE, any driving pattern can be modeled in MOVES

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## Draft MOVES2009 version of MOVES:

- Produces emission rates only for the exhaust component of an inventory and does not include factors for motorcycles.
- Well-to-Pump emission processes are not included.
- MOVES calculations can take a long time
- Aggregation of inputs (hour, day, month, year) is one way to reduce the number of calculations and speed up a run, though this will affect results. Policy guidance for aggregating inputs for SIP/conformity will be provided with the final MOVES version due in end of 2009/early 2010.
- EPA has developed some importers to input local data
- Early feedback is important – EPA wants to know if MOVES meet our needs.
- Cannot be used for SIPs or conformity analyses

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# MOVES Schedule

## April 2009

Release of Draft MOVES2009

## End of 2009

Planned release of official MOVES2009

Final onroad criteria pollutant model

SIP and Conformity Technical Guidance

SIP and Conformity Policy Guidance

## Use will be required for

---- SIPS

---- Regional conformity analysis

Following regional conformity grace period range from 3 to 24 months

---- Project level conformity analysis for PM and CO

## 2009+

Nonroad emissions will be added

## MOVES website

<http://www.epa.gov/otaq/models/moves/index.htm>

# Transition – Mobile6.2 To MOVES & Local Data Needs

- MOVES can be run on default datasets, but local data must for a few parameters for SIP/Conformity.
  - Fuel Characteristics (select from various “fuel formulations” available)
  - Meteorology
  - Age Distribution (Registration data)
  - Population of MOVES Vehicle Types  
(for each county in a calendar year)
  - Total Base Year VMT for HPMS Type Vehicles  
(for each county in a calendar year)
  - Road Type VMT Fraction  
(VMT fraction across MOVES road types for individual MOVES vehicle types for each county in a calendar year)
  - Speed Distribution (fraction of time spent in 16 speed-bins every hour for 24 hours for different road types and MOVES vehicle types)  
(Default data available, local data substitution possible)
- Operating modes  
Local operating modes or second-by-second activity not required, but can be provided for running emissions