

# An Introduction to Draft MOVES2009

FHWA Resource Center  
EPA Office of Transportation and Air Quality



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## Course Outline

- **MOVES overview**
  - What is Draft MOVES2009?
  - Comparison to MOBILE6.2
- **Making the transition to MOVES**
- **How does MOVES work?**
- **Running MOVES**
  - Creating a RunSpec for a simple national scale run
  - Looking at MOVES output
  - Basics of MySQL
  - Using the County Data Manager to input local data
  - Modeling Custom Domains
  - Using the Project Level Data Manager
- **Tips and tricks**

## MOVES

- **MO**tor **V**ehicle **E**mission **S**imulator
- State-of-the-art modeling framework
- Will replace current models (MOBILE & NONROAD) and expand capabilities
- Designed to allow easier incorporation of large amounts of in-use data from a variety of sources
  - MOBILE structure limited ability to incorporate new emissions data

## Why is EPA developing MOVES?

- CAA requires EPA to regularly update emission factors and emission factor models
- FORTRAN code used in MOBILE6.2 is obsolete and increasingly difficult to maintain
- Modular database structure more modern, easier to update with new emissions, fleet and activity data
- MOVES will eventually incorporate functions of the current NONROAD model, providing a single, comprehensive modeling system

## Why is EPA developing MOVES?

- **National Research Council 2000 review of EPA's mobile source modeling program included several recommendations that are addressed by MOVES:**
  - Support for smaller-scale analyses (project-level analysis)
  - Improved characterization of high emitters, heavy-duty vehicles and nonroad sources
  - Improved characterization of particulate matter and toxics
  - Improved model evaluation and uncertainty analysis
  - Improved ability to interface with other models

# How is MOVES better than MOBILE?



## MOBILE6.2 Uses Text Input and Output Files

```

example6.in - Notepad
File Edit Format View Help
MOBILE6 INPUT FILE
PARTICULATES :
AIR TOXICS :
POLLUTANTS : HC CO NOX
SPREADSHEET :
RUN DATA :

->Example Run - Tests All M6.2 Pollutant Types
EXPRESS HC AS VOC :
EXPAND EVAP :
SCENARIO REC : Example Input File
CALENDAR YEAR : 2002
SULFUR CONTENT : 30.0
MIN/MAX TEMP : 68.0 84.0
FUEL RVP : 7.0
PARTICLE SIZE : 10.0
PARTICULATE EF : PMGDM1.CSV PMGDM3.CSV PM
DIESEL SULFUR : 500.0
GAS AROMATICS : 25.0
GAS OLEFINS : 15.0
GAS BENZENES : 1.5
E200 : 50.0
E300 : 85.0
OXYGENATE :
: MTBE 15.1 0.30
: ETBE 17.6 0.05
: ETOH 10.0 0.45
: TAME 6.0 0.00
ADDITIONAL MAPS :
: MAP_BASE.CSV
END OF RUN :
    
```

```

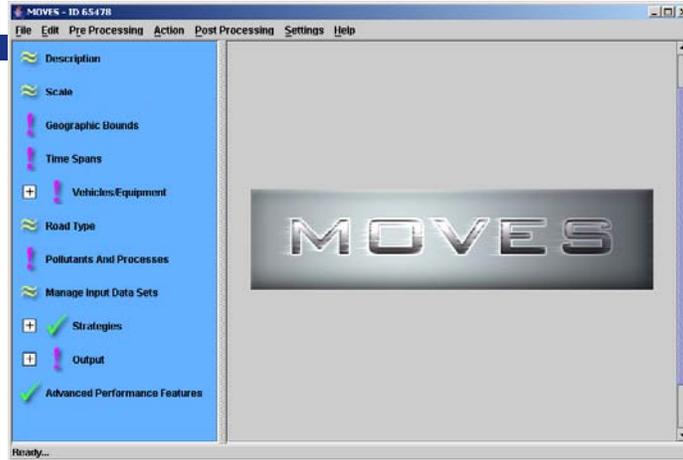
EXAMPLE6 - Notepad
File Edit Format View Help
Calendar Year: 2002
Month: Jan.
Altitude: Low
Minimum Temperature: 68.0 (F)
Maximum Temperature: 84.0 (F)
Absolute Humidity: 75. grains/lb
Nominal Fuel RVP: 7.0 psi
Weathered RVP: 7.0 psi
Fuel Sulfur Content: 279. ppm
Exhaust I/M Program: No
Evap I/M Program: No
ATP Program: No
Reformulated Gas: NA (See Air Toxics Output)
Ether Blend Market Share: 0.550 Alcohol Blend Market Share: 0.450
Ether Blend Oxygen Content: 0.027 Alcohol Blend Oxygen Content: 0.035
Alcohol Blend RVP Waiver: No

Vehicle Type: LDGV LDG12 LDG14 LDGT HDGV LDGV HDGV MC All Veh
GWE: -6000 -6000 (All)
Wt Distribution: 0.4638 0.3052 0.1042 0.0337 0.0008 0.0017 0.0827 0.0060 1.0000

Composite Emission Factors (g/mi):
Composite VOC : 1.580 2.535 1.822 2.115 0.727 0.983 0.710 2.14 1.534
Composite CO : 14.10 17.52 31.48 39.39 19.82 1.713 3.754 1.687 11.77 12.368
Composite NOX : 1.172 1.352 1.745 1.452 5.137 1.650 1.699 16.061 1.23 2.661

Non-Exhaust Emissions (g/mi):
Hot Soak Loss: 0.137 0.119 0.193 0.138 0.212 0.000 0.000 0.000 0.109 0.138
Diurnal Loss: 0.019 0.018 0.031 0.022 0.036 0.000 0.000 0.000 0.006 0.019
Resting Loss: 0.128 0.119 0.206 0.141 0.236 0.000 0.000 0.000 0.170 0.128
Running Loss: 0.262 0.210 0.275 0.226 0.294 0.000 0.000 0.000 0.000 0.234
Crankcase Loss: 0.908 0.010 0.032 0.011 0.012 0.000 0.000 0.000 0.000 0.909
Refueling Loss: 0.093 0.137 0.232 0.174 0.138 0.000 0.000 0.000 0.000 0.126
Total Non-Exhaust: 0.667 0.634 0.938 0.714 1.148 0.000 0.000 0.000 0.494 0.645
    
```

## MOVES Has a Graphical User Interface



(MOVES can also be executed from a command line interface without use of the GUI, for batch or unattended operation)

## New Software Structure

- **MOBILE6.2**
  - Written in Fortran, runs in DOS
  - Many data elements hard-coded (difficult to modify/update)
- **MOVES**
  - Java/MySQL software
  - Data elements stored in database tables (easy to modify/update)

## More Flexibility

- **MOBILE6.2**
  - Gram/mile emission factors
  - Fixed output formats
- **MOVES**
  - Gram/mile emissions factors (grams/time for some processes)
  - Total emissions: inventories for specific areas and time periods
  - Easily customizable output (many levels of aggregation/disaggregation possible)

## Multiple Geographic Scales

- **MOBILE6.2**
  - Emissions rates based on regional-scale trip patterns (no specific geographic area)
- **MOVES**
  - Emissions inventories from national level to county level to project level
  - Lookup table option for emission rates

## Modal Emissions

- **MOBILE6.2 rates based on aggregate driving cycles**
- **MOVES rates based on “operating modes”**
  - Second-by-second activity is captured by the model (does not need to be provided by users, but can be)

## MOVES Uses New Data

- ✓ **Activity**
  - In-use vehicle trip patterns
  - Rural area activity data
- ✓ **Light-duty vehicles**
  - Assessed millions of light-duty vehicles
  - Landmark gasoline PM study (Kansas City)
  - Remote Sensing Data
- ✓ **Heavy-duty vehicles**
  - More than 100 in-use vehicles from WVU
  - New on-board real-world driving data from over 300 vehicles

## Energy and GHG analysis

- **MOBILE6.2 had simplistic fuel economy and CO2 calculations**
- **MOVES is designed from the ground up as an energy consumption model**
- **Also estimates greenhouse gases: CO2, methane, nitrous oxide, and CO2 equivalents of these**
- **While the energy and emissions rates are still officially “draft”, this is the best available tool for this type of analysis**

# How Do Emissions Estimates of Draft MOVES2009 Compare to MOBILE6.2?



## Early Draft MOVES Results

- **Data collected since MOBILE6 released drives differences between MOVES and MOBILE6**
- **National trends**
  - HC and CO emissions similar or lower than MOBILE6.2
  - Total NOx emissions higher than MOBILE6.2
  - Total PM emissions substantially higher than MOBILE6.2
- **Local results may vary**
  - Local fleet mix, fuels, activity are important
  - Temperature drives PM emissions
- **For attainment analysis, relative change in emissions between base year and attainment year is more important than absolute emissions**

## Why are emissions different?

- New car and light truck emissions data
- New heavy truck emissions data
- New emissions processes not included in MOBILE6
- Updated fuel and vehicle standards

## Significant new data in MOVES

- **Updated emission rates**
  - Test results on millions of vehicles considered for MOVES
    - Passenger Cars & Trucks
    - Heavy Duty Trucks
- **New fleet & activity defaults**
  - National defaults:
    - Vehicle fleet from state registration data, VIUS
    - Vehicle Miles Traveled (VMT) from HPMS
    - Driving patterns from instrumented vehicle surveys
  - For local modeling, local data is likely to be most accurate & up-to-date

## Extensive analysis of Car & Light Truck emissions

- **HC/CO/NOx rates based on ~ 70,000 vehicles randomly selected from Arizona IM program**
  - Able to tease out emissions from I/M and non I/M areas
- **Checked against data from multiple sources**
  - I/M data from Illinois, New York, Missouri and Colorado
  - Roadside remote sensing data from several cities
  - Kansas City Study
- **Extended to newest technology vehicles using compliance data**
  - In-use emissions data manufacturers required to collect
  - About 2,000 laboratory tests per year

## Gasoline PM a major focus

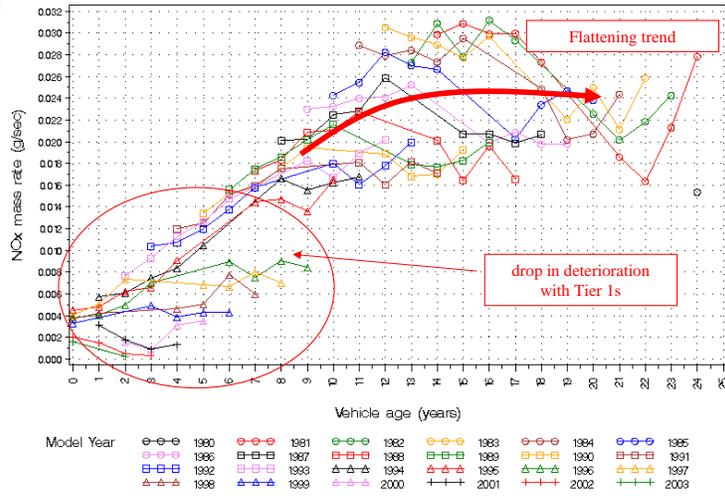
- **Landmark study conducted in Kansas City 2004-05 to address need for improved gas PM estimates**
  - Collaboration between EPA, DOE, DOT, States, Auto/Oils
- **496 gasoline light-duty cars and trucks tested**
  - Model Years 1968-2005
- **Summer and winter testing**
  - ~ half of the vehicles tested each season @ ambient temps
  - 43 vehicles tested in both winter and summer
- **More information at**  
<http://www.epa.gov/otaq/emission-factors-research/>

## What we've learned about Car & Light Truck emissions

- **New standards have been successful in reducing deterioration of HC/CO/NOx emissions**
- **On-Board Diagnostic (OBD) systems are a contributing factor to lower deterioration**
  - Owner response to repair identified malfunctions is better than MOBILE6 projected, particularly in non-I/M areas
- **Gas PM emissions are much higher than MOBILE6 projected**
  - Higher in-use deterioration
  - Significant increase at cold temperatures

### Arizona I/M NOx data by Model Year and Age

LDV, WEIGHTED  
NOx vs. Age (years), LDV



## Heavy Duty Diesel emissions updated based on real world data

- **MOBILE6 relied on certification data**
  - Engine tests only
- **Much research on in-use trucks since MOBILE6**
  - CRC E-55
    - 75 trucks on chassis dynamometer
    - Only real-time PM data of it's kind
  - On-Board Measurement: ~350 trucks on road
    - Provided most robust assessment of NOx emissions available
- **Extended idle, crankcase, starts, tampering & mal-maintenance factored in (not in MOBILE6)**

## What we've learned about Heavy Duty Diesel emissions

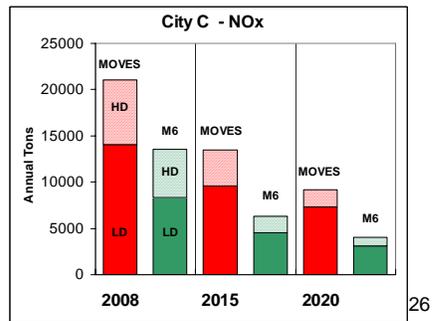
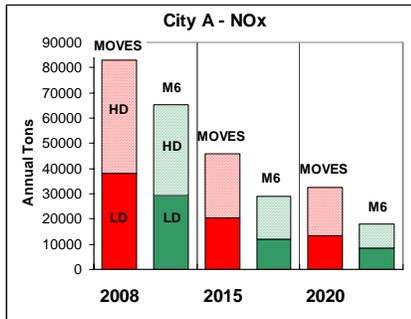
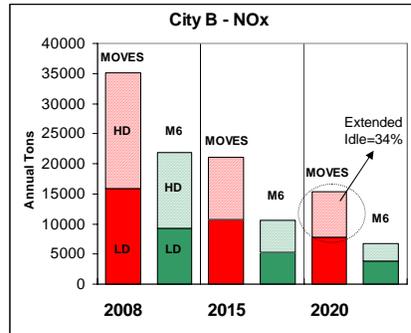
- **NOx**
  - In-use emissions moderately higher than MOBILE6 projected
  - Extended idle (hoteling) emissions are significant
    - And projected to grow as percent of NOx inventory
- **PM**
  - Significant speed effect
    - MOBILE6 did not model any speed impacts
    - Large increase in emissions at lower speeds vs. MOBILE6
  - Crankcase emissions significant

## Analysis of Local Area Impacts

- **Did preliminary comparison of MOVES and MOBILE6 using surrogate local data to represent 3 different urban counties**
  - Local data very limited, may not be consistent with what states will actually use
- **Local data varied by:**
  - Fleet age distribution
  - Fraction of light and heavy duty VMT
  - Local fuel specifications
  - Meteorology
  - Other input factors

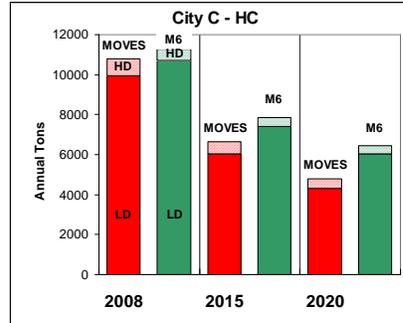
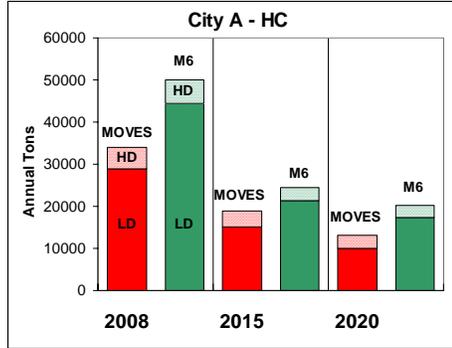
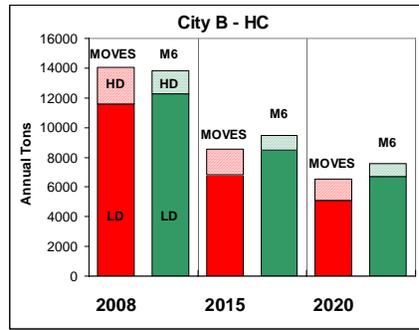
# NO<sub>x</sub>

- I/M program data shows MOBILE6 underestimated NOx emissions from light trucks
- On-road data on heavy trucks shows higher emissions than MOBILE6 estimated from cert data
- Extended idle emissions become significant share of heavy-duty inventory in future



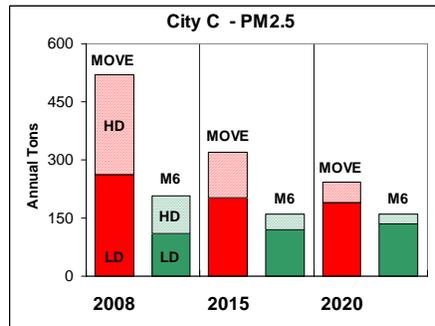
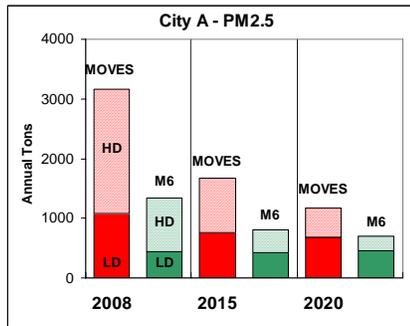
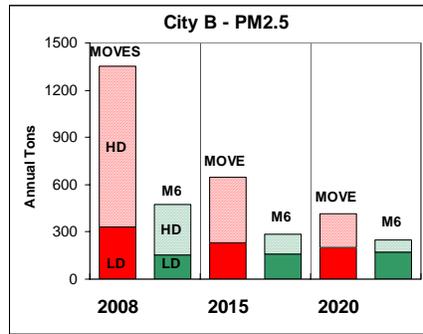
# HC

- I/M program data shows MOBILE6 overestimated HC emissions from newer technology cars
- Evaporative emissions on newer technology vehicles very low; re-evaluating leak emissions for final model



# PM<sub>2.5</sub>

- Kansas City program found high gas PM emissions esp. at cold temps
- New data on heavy trucks shows higher deterioration than MOBILE6
- MOVES accounts for impact of vehicle speed – MOBILE did not



# Percent Reduction in On-Road Emissions 2008 to 2015

	City A		City B		City C	
	MOVES	MOBILE6	MOVES	MOBILE6	MOVES	MOBILE6
HC	50%	50%	39%	32%	38%	31%
NOx	54%	56%	40%	52%	36%	53%
PM2.5	57%	40%	52%	40%	38%	23%

## What It Means

- **Higher NOx and PM emissions mean mobile sources have bigger role in attainment**
- **Percent reduction from base year is key to attainment analysis**
  - PM2.5 shows higher overall emissions and higher % reductions
    - Effect on attainment demonstrations could be positive
  - NOx shows higher overall emissions but lower % reduction
    - Harder to show attainment
    - Future NOx control measures will have a bigger impact
- **States may need to redo some motor vehicle emissions budgets to meet conformity requirements with MOVES**

## I/M Effects In MOVES

- **Benefits are comparable to MOBILE6 now, but will shrink over time.**
  - Conservative M6 OBD assumptions not supported by data
    - CRC did comprehensive survey of MIL response in non-I/M areas
    - Found high response even after warranty
  - Our analysis of I/M program data confirms that OBD works

# Making the Transition to MOVES



## MOVES Schedule

- **January 2005**
  - **MOVES2004 released**
    - Includes energy consumption, greenhouse gases
- **May 2007**
  - **MOVES Demo released**
    - Basic structure of MOVES without criteria pollutant emission factors
- **April 2009**
  - **Release of Draft MOVES2009**
    - Adds draft criteria pollutant emission factors
- **End of 2009**
  - **Planned release of official MOVES2009**
    - Final onroad criteria pollutant model
- **2009+**
  - **Begin adding nonroad emissions to MOVES**

## Draft MOVES2009 – New Capabilities

- First release of MOVES that includes criteria pollutant emissions and toxics
- Adds more features to simplify regional and project-level analysis for SIPs and conformity
  - **County Data Manager**
  - **Project Level Data Manager**
  - **Data Importers**

## Draft MOVES2009 - Limitations

- **Draft model**
  - **No official use requiring Draft MOVES2009**
  - **Cannot be used for SIPs or conformity analyses**
- **Does not include all data or features planned for official MOVES2009 and has known and unknown bugs, for example:**
  - Motorcycle emissions not yet included
  - Plan to add more flexibility for VMT input
  - Known bugs in refueling vapor and spillage processes and project level scale

## Why release Draft MOVES2009?

- **Help us identify problems with MOVES**
- **Provide feedback on whether MOVES meets user needs**
  - What we can do to improve it?
- **Identify guidance issues**
- **Start learning MOVES now to be ready to use final MOVES2009 as soon as it is released**
  - Use MOVES2009 for SIPs due in 2012 and 2013

## Official MOVES2009

- Official MOVES2009 planned for release at the end of 2009
- Will be official version of MOVES for on-road vehicles outside of California
- Use will be required for:
  - State Implementation Plans (SIPs)
  - Regional conformity analysis
    - Following regional conformity grace period of 3 to 24 months
  - Project level conformity analysis for PM and CO
    - Following project level conformity grace period
    - NEPA analysis (e.g., air toxics)

## Easing the Transition to MOVES

- **Improved handling of different domain sizes**
  - Added GUI for nonattainment area and project level analysis to allow users to specify local inputs
- **Developed data importers which:**
  - Ease conversion of MOBILE inputs to MOVES inputs
    - More to come
  - Allow input of data as text files
- **Writing future guidance documents**
  - Technical guidance will address when and what type of local input is needed

## Levels of Analysis in MOVES

- **MOVES is designed to work at macro, meso, and micro scales**
- **These translate into different geographic domains:**
  - National
  - Nonattainment Area or County
  - Project
- **Added GUI to Draft MOVES2009 for local inputs for nonattainment area and project level analysis**

## Default County Level Data in Draft MOVES2009

- **National domain will produce results for the nation, specific states, or specific counties**
  - Current default county level data in MOVES is a mix of national defaults, national data disaggregated to county level with adjustment factors, and local data from various sources
  - Users cannot rely on default county level data to be accurate or up to date and it should not be used for SIPs or conformity analysis
- **For SIPs and regional conformity analysis, users should select the county domain and enter local data using the County Data Manager**

## What Are MOVES Data Importers?

- Software interfaces that can create alternate databases, tables, and data records for use by MOVES
- Draft MOVES2009 includes data importers to simplify creation of local input files
- Advantages
  - Do not require knowledge of database commands and syntax
  - Can assure the updates are made only to the appropriate tables
  - Can require complete information from users, preventing data gaps
  - Can include some error checks
  - Can be designed to convert data from MOBILE6 to MOVES format

## Future Guidance Documents

- **EPA expects to release several guidance documents that will help with the transition for final MOVES**
  - MOVES Technical Guidance for SIPs and conformity
  - Project Level Conformity Guidance for PM
  - MOVES SIP and Conformity Policy Guidance
- **Will release draft guidance for comment sometime after release of Draft MOVES2009**
- **Final guidance documents will be available when Official MOVES2009 is released**

## MOVES Technical Guidance for SIPs and Conformity

- **Answers these questions:**
  - When can model defaults be used?
  - When is local information needed?
  - What are acceptable sources of local information?
- **See MOBILE6.2 Technical Guidance for examples of past answers to these questions:**
  - Registration (age) distribution
  - Mileage accumulation

## Project Level Guidance for PM

- How to do project level analysis for PM<sub>2.5</sub> and PM<sub>10</sub> with MOVES for conformity
- Similar to Technical Guidance, but focused on specific needs for project level analysis
- Will also address how to use air quality models for project level analysis

## MOVES SIP and Conformity Policy Guidance

- **Answers these questions:**
  - When should MOVES be used for development of new SIPs?
  - When should MOVES be used for new conformity determinations?
    - **Conformity grace period can be 3 to 24 months**
  - Any other general policy questions for the transition from MOBILE to MOVES
- **Actual date that MOVES becomes official for SIP and conformity purposes is based on Federal Register notice announcing availability**

# MOVES Documentation



## MOVES Documentation

- **User Guide**
- **Software Design/Reference Manual**
- **Technical documentation**
- **Presentations and summaries**
- **Guidance**
- **Other documents**

MOVES documentation takes many forms.

## MOVES User Guide

- **The MOVES User Guide describes:**
  - Installation instructions
  - The features of the graphical user interface (GUI)
  - Instructions on how to access each feature
  - Step-by-step example run
  - Accessing results using MS Access
  - Running MOVES in a batch mode

## MOVES Software Design and Reference Manual

- **The Software Design and Reference Manual (SDRM) describes:**
  - The hardware and software requirements
  - Software design components
  - Overview of processing, data and control flow
  - Functional design:
    - Generators (process input data)
    - Calculators (generate results)
    - Aggregators (summarize input and outputs)
  - Input and output database tables and design

## MOVES Database

- **MOVES database documentation is included when MOVES is installed**
- **The documentation is located in the “ReadMe” directory of the MOVES MySQL database folder**
- **Documents include:**
  - Table and field descriptions with units
  - Table relationship charts
  - Database quality checks

## Technical Reports

- **MOVES technical reports describe the development of:**
  - Activity algorithms and default data
  - Meteorological algorithms and default data
  - Emission rate algorithms and default data
- **These reports address the sources of the data used by MOVES**
- **New reports are written when the algorithms or the default data are updated**

## MOVES Presentations

- Presentations (such as this one) are made available on the MOVES web site
- Presentations can provide a summarized version of the information in the more detailed documentation
- Presentations often contain examples that were not included in the original detailed documentation

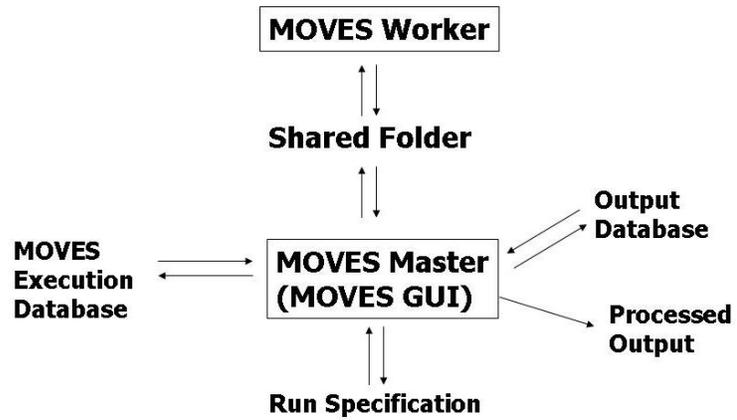
## Other MOVES Documents

- **The MOVES web site contains other documents that may be of interest to MOVES users:**
  - Physical Emission Rate Estimator (PERE)
  - MOVES Design and Emissions Analysis Plans
  - Federal Advisory Committee Act (FACA) Modeling Workgroup materials
  - MOVES Training materials
  - Validation results

# How Does MOVES Work?



## Master – Worker Structure



## Geography and Time in MOVES

- ✓ **Modeling domain is the entire U.S.**
  - 50 States plus (DC, Puerto Rico, & Virgin Islands)
  - 3222 Political subdivisions (counties as of CY 1999)
- ✓ **Calendar years (1990, 1999-2050)**
  - ✓ 12 months of the year
  - ✓ Week days and weekend days
  - ✓ 24 hours of the day

## Emission Processes

- ✓ **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 Source Types (vs. HPMS Vehicle Types)

HPMS Vehicle Type	MOVES2004 & HVI Demo SourceType
Motorcycle	Motorcycle
Passenger Car	Passenger Car
Other 4-tire, 2 axle	Passenger Truck Light Commercial Truck
Bus	Intercity Bus Transit Bus School Bus
Single Unit Truck	Refuse Trucks Short-haul Single Unit Long-haul Single Unit Motorhomes
Combination Truck	Short-haul Combination Long-haul Combination

**Sub-categories (like refuse trucks and motorhomes) will be addressed in guidance; EPA does not expect areas to have local data for all subcategories.**

## Road Types

- ✓ **For running emissions, county-level VMT is distributed to four road types:**
  - Rural Restricted Access (freeways and Interstates),
  - Rural Unrestricted Access,
  - Urban Restricted Access (freeways and Interstates),
  - Urban Unrestricted Access
- **A fifth road type, “off-network”, is included to capture start, evaporative and extended idle emissions**
  - This is not the same as “off-network” vehicle activity in the travel modeling world.

## Vehicle Ages

- ✓ Emission rates can vary by age as well as model year; activity also varies by age
- ✓ Vehicles 0-29 & 30+ years old modeled
- ✓ Age groups used for emissions calculations
  - 0 to 3 years old
  - 4 or 5 years old
  - 6 or 7 years old
  - 8 or 9 years old
  - 10 to 14 years old
  - 15 to 19 years old
  - 20 or more years old

## Emissions by Source, Age, Mode

✓ MOVES uses a different rate for each combination of:

- Source,

- Age group, and

- Operating mode

Gas-LDV-MY1998

8-9 years

"low-speed" coast

Gas-LDT-MY2002

4-5 years

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

## How MOVES handles vehicle activity - Definitions

- **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

## MOVES: Operating Mode Bins

- ✓ Division of total activity into categories that differentiate emissions
- ✓ Defined by speed and **Vehicle Specific Power (VSP)** for running emissions
- ✓ There will be additional operating mode distributions for start and evaporative emissions in MOVES2009

## Modal “Binning” Approach

- ✓ Any driving pattern can be modeled
  - Adds major flexibility compared to MOBILE
- ✓ Allows direct use of data from many sources
- ✓ Provides common emission rates for all scales
- ✓ Independent validation has shown good results even for macroscale application

## Running Operating Modes in MOVES

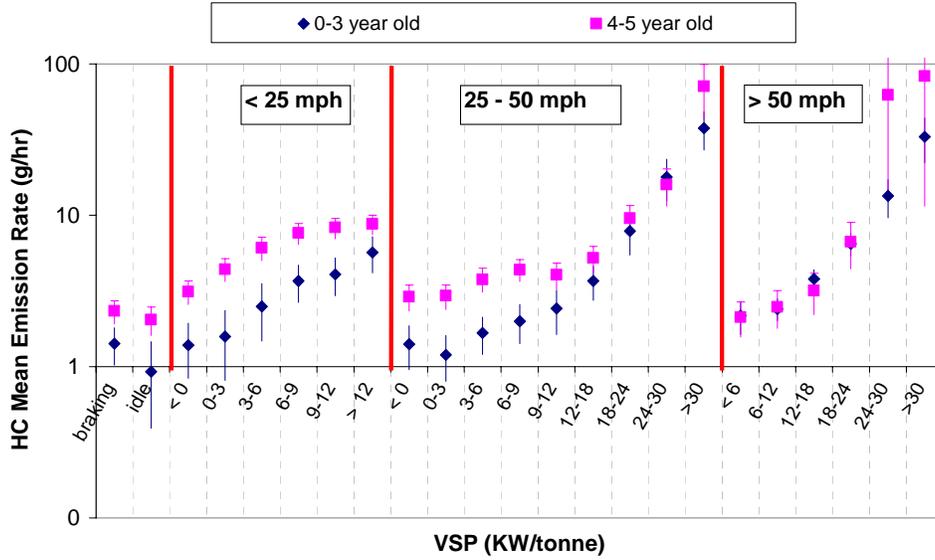
- **MOVES uses second-by-second emissions data categorized in operating mode bins based on combination of speed and VSP**
- **MOVES includes default operating mode distributions based on typical driving cycles**
  - Different road types in MOVES have different default operating mode distributions
- **Users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

## Operating Mode Bins

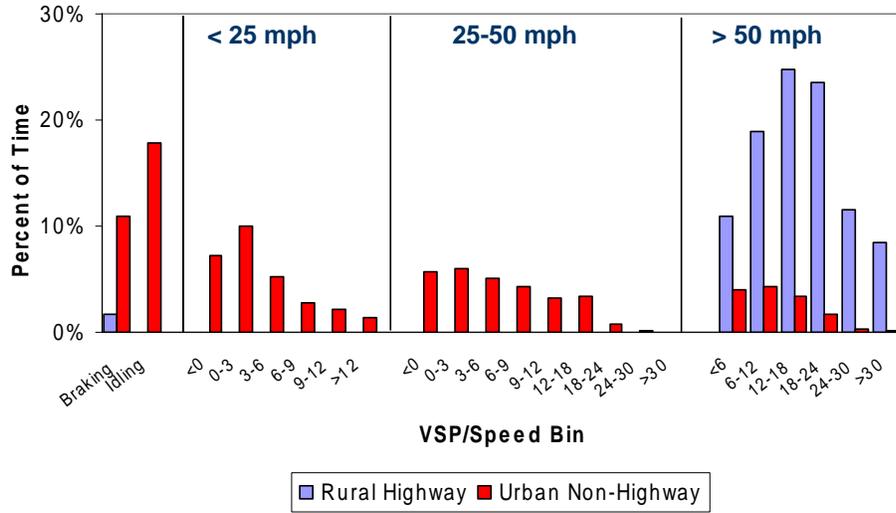
	Speed Class (mph)			
	1-25	25-50	50 +	
30 +	16	30	40	<i>PLUS</i> One mode each for idle (Bin 0), and deceleration/braking (Bin 1) ----- Gives a total of 23 opModes
27-30				
24-27		29	39	
21-24		28	38	
18-21				
15-18			37	
12-15		27		
9-12	15	25		
6-9	14	24	35	
3-6	13	23		
0-3	12	22	33	
< 0	11	21		

### HC Emission Rates By Bin

Source Bin: LDV Gasoline / 1996 MY



### Distribution of Time by Mode



## New Analysis Opportunities

- **Modal emission structure allows calculation of “Project-level” emission changes**
  - Changes in operating mode distribution → changes in emissions
- **Includes an “importer” to help users input project-specific information on driving activity**
  - Users can enter operating mode distribution or driving pattern by link
- **Areas will want tools to estimate how changing road design affects operating modes**
  - Adding lanes?
  - Synchronizing signals?
  - Replacing stop signs with rotaries?
- **Creates need to better characterize driving patterns -**  
MOVES defaults may not characterize local patterns, esp project level

## MOVES Databases

- **MOVES stores information in MySQL databases**
- **The Draft MOVES2009 default database has 119 different tables that store**
  - Lookup/reference information
  - Conversion/adjustment factors
  - Emissions data
  - Activity data
- **MOVES also uses databases to store intermediate results and final output**

## MOVES Databases

- ✓ **Input Databases (default or user-created)**
  - Default Input Database
  - User Input Database(s) (optional-MOVES will run with just defaults for the National Scale)
- ✓ **Execution Database (created by MOVES)**
  - Resolves differences between the user input and default data
  - Contain information needed for a particular run
  - Temporary storage for intermediate results
  - Resources for new modeling applications
- ✓ **Output Database (created by user)**
  - ✓ Run results
  - ✓ Run diagnostics and documentation

## Output

- Post-processing scripts
- MOVES Summary Reports
- Exporting MOVES output to EXCEL
- MySQL can also be used to summarize output

## Errata Sheet

- Default vehicle miles traveled (VMT) projections may not match the VMT projections used in other EPA models (such as the National Mobile Inventory Model, NMIM).
- There will be no output of Benzene, Ethanol, MTBE, Naphthalene or Methane for the Refueling Vapor or Refueling Spillage loss processes, even though there are check boxes for these pollutants in the Pollutants and Processes panel.
- **When you execute MOVES, you get the pop-up window that allows you to cancel. However, if you instead hit the X in the top corner of the box, the program will execute. The normal response should be to cancel the run.**
- There will be no output of Methane for Evaporative Vapor, Evaporative Permeation or Evaporative Leak losses, even though there are check boxes for these processes for Methane in the Pollutants and Processes panel.

## Errata Sheet

- There are no options to get non-methane hydrocarbon, non-methane organic gases, total organic gases or volatile organic compound speciation of total gaseous hydrocarbons or options for methane, nitrous oxide, benzene, ethanol, MTBE, naphthalene, 1,3-butadiene, formaldehyde, acetaldehyde or acrolein for the crankcase running, crankcase start or crankcase extended idle processes.
- There are no options to get non-methane hydrocarbon, non-methane organic gases, total organic gases or volatile organic compound speciation of total gaseous hydrocarbons or options for methane or nitrous oxide for the extended idle process.
- **The sulfate particulate (PM10 and PM2.5) results from the Extended Idle Exhaust process are not correct. This will also cause the Primary Exhaust Particulate Total results (PM10 and PM2.5) for this process to be incorrect.**
- **When using the Project Level scale, the Extended Idle Exhaust process will only produce results for Total Energy Consumption.**

## Errata Sheet

- In the Time Spans panel, if you choose the Time Aggregation Level Year, the panel will still allow you to choose Months, Days and Hours. Of course, since you want a total year, selecting anything other than all months, days and hours will cause problems. If you choose the Time Aggregation Level Year, you must select all months, days and hours.
- Similarly, if you choose the Time Aggregation Level Month, you must select all days and hours. If you choose the Time Aggregation Level Day, you must select all hours.
- When making a retrofit parameter file for importing for the On Road Retrofit Strategies panel, you must not use the PollutantID, ProcessID, FuelTypeID or SourceTypeID numbers. You must use the text names for these parameters.

## Errata Sheet

- **This version of MOVES does not include criteria pollutant or air toxic emission factors for motorcycles.** Composite fleet emission rates of criteria pollutants or air toxics that are intended to include motorcycle emissions will not properly reflect their contribution.
- The Well-to-Pump emission process in this version of MOVES has not been updated and will not produce appropriate emission results. Users should not select Well-to-Pump process.
- The emission results for non-methane hydrocarbon, non-methane organic gases, total organic gases or volatile organic compound speciation of total gaseous hydrocarbons from Refueling Vapor and Refueling Spillage losses are not correct. Do not select these pollutants when including refueling emissions.

## Errata Sheet

- The option to Manage Input Datasets or the Pre-Processing Data Importer option does not work properly in some circumstances. We are scoping the problem.
- **The Calculation Type of Emission Rates on the Scale panel will produce emission rates only for the Exhaust Running process.**
- If you select only the brake wear and tire wear toggle boxes for PM, the Distance Traveled toggle box will be inaccessible. You will need to select another pollutant in the Running process in order to obtain vehicle miles traveled information along with brake wear and tire wear emissions

# Next Steps



## What Should You Do Now?

- **Update computer hardware**
  - Dual-core processor (faster is better)
  - At least 1 GB memory (more is better)
  - At least 40 GB storage (more is better, output files can be very large )
  - Consider setting up a distributive network (specs of “master” computer are key)
  - Windows XP or 32-bit Vista
    - Current version of MySQL does not work on 64-bit Vista

## What Should You Do Now?

- **Build staff expertise in relational databases and MYSQL**
  - Not needed for simple runs
  - Some basic knowledge gives users flexibility to customize outputs and view inputs
  - In-house expert would be helpful for more advanced analysis
- **Subscribe to MOBILENEWS email list for MOVES updates**

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

## After Draft MOVES2009

- **A lot will happen in the time between Draft MOVES2009 and Official MOVES 2009**
  - Give in-depth training
  - Gather feedback from users during comment period
  - Continue to improve usability and make any other necessary changes to MOVES
  - Prepare MOVES guidance documents
- **The more feedback you provide on Draft MOVES2009, the better Official MOVES2009 will be**
  - Please plan to begin testing and commenting on Draft MOVES2009 as soon as it is released

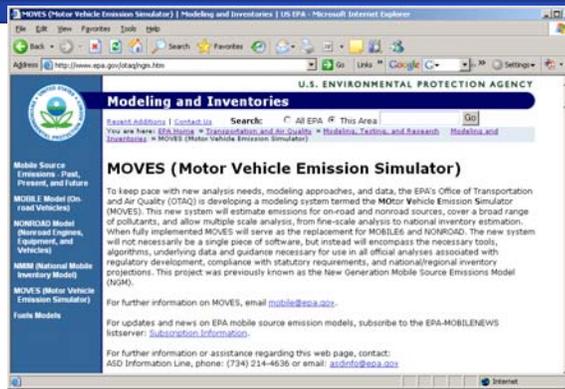
## Feedback

- **We need your comments and ideas**
  - Does MOVES meet your needs?
  - Did you find errors in MOVES?
- **Official Comment Period:**
  - Begins when Draft MOVES2009 is released
  - Comments are most effective when obtained early
- **We are interested in your ideas to make MOVES better meet your needs**
- **Best way to provide comments:**
  - Send an email to: [mobile@epa.gov](mailto:mobile@epa.gov)

# MOVES



Visit the MOVES website:  
<http://www.epa.gov/otaq/ngm.htm>



- Software, technical documentation, conference and meeting presentations, and other helpful background materials