MOVES Demo
Basic Orientation

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Outline

MOVES Design Concepts

Making the Transition to MOVES

Introduction to MySQL

MOVES Demonstration

What is MOVES?

MOtor

Vehicle

Emission

Simulator

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- **FORTRAN code used in MOBILE6.2 is obsolete and increasingly difficult to maintain**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**

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Why is EPA developing MOVES?

- **National Research Council 2000 review of EPA's mobile source modeling program included several recommendations that will be 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

Written In

✓ Java™

✓ MySQL

– Relational database management system

Future MOVES Modeling Applications

✓ National/Local On-road Emissions Inventory (THC, CO, NOx, and PM)

- SIP development, Conformity, Trading Programs

✓ Hot-Spot and Project Level Analysis

- PM and CO Conformity

- Mobile Source Air Toxics Analysis

✓ U.S. Greenhouse Gas Inventories

✓ Regulatory/Policy Analyses

What is MOVES Demo?

- **Posted May 2007**
- **Replaces MOVES2004 for on-road energy consumption, CO2, CH4, N2O, Well-To-Pump**
- **Has placeholder (not real) values for HC, CO, NOx, PM, SO4**
- **Has basic MOVES structure but not all functionality planned for later versions**

Uses of MOVES Demo

- Allow users to become familiar with basic operation of MOVES including database structure, input options, etc.

- Get early feedback from users on ease-of-use, additional features needed, etc.

- Can be used for GHG and energy analysis, but should be considered draft

- MOBILE6.2 is still the official model for emissions analysis in all states but CA

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Limitations of MOVES Demo

- **Criteria pollutant (HC, CO, NOx, PM, SO4) results are meaningless**
- **GUI focuses on use for developing national inventories**
  - County level analysis in MOVES Demo is based on mix of national defaults with some EPA-developed county-level inputs
  - Hard to enter many county level inputs
  - E.g., county-level VMT is based on national VMT disaggregated to county level using county fractions, users can't easily enter county VMT
- **Many features still incomplete**
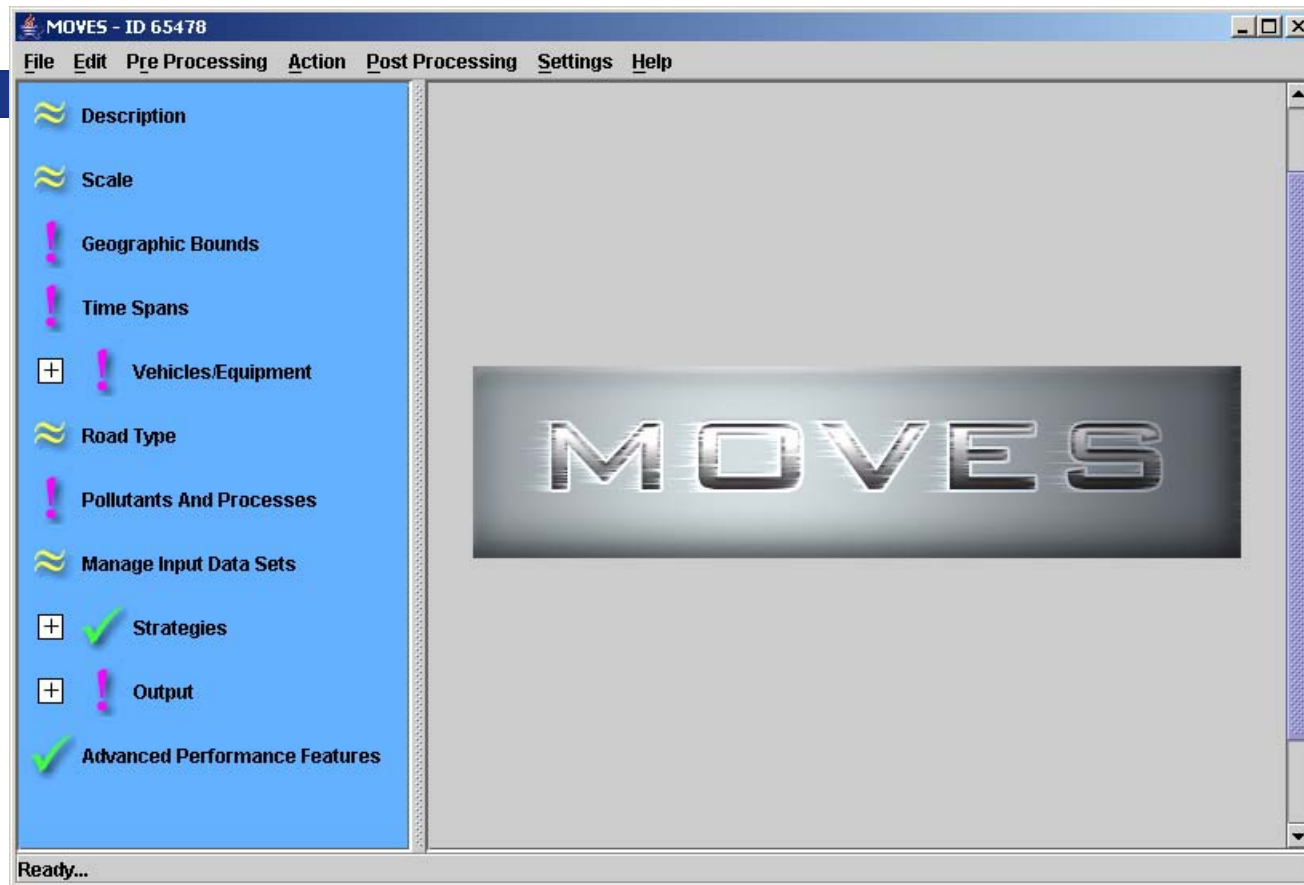 - E.g., I/M program inputs

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How is MOVES different from MOBILE6.2?

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)

MOBILE6.2 Uses Text Input and Output Files

MOVES

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)

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Multiple Geographic Scales

- **MOBILE6.2**
  - Emissions rates based on regional-scale trip patterns (no specific geographic area)

- **MOVES Demo**
  - Emissions inventories from national level to county level
  - Mesoscale speed lookup tables
  - Future versions will have additional geographic scales

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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)

More Data Supplied by MOVES

- ● **MOBILE6.2**
  - – Some data must be supplied for model to run
  - – Local data needed for area-specific runs
- ● **MOVES**
  - – Default data provided for the entire US (down to the county level in some cases)
    - ● Some county level inputs are disaggregations of national data and may not be appropriate for SIP or conformity analysis

MOVES

MOVES will be largely shaped by data collected since release of MOBILE6

- ✓ **Activity**
  - – In-use vehicle trip patterns
  - – Rural area activity data
- ✓ **Light-duty vehicles**
  - – Thousands of in-use vehicles from I/M programs
  - – Kansas City gasoline PM study
  - – Remote Sensing Data
- ✓ **Heavy-duty vehicles**
  - – More than 100 in-use vehicles from WVU (E-55 plus)
  - – New on-board real-world driving data from over 300 vehicles

How Does MOVES Work? (High-level Overview)

Master – Worker Structure

MOVES Worker
↕
Shared Folder
↕
MOVES Master (MOVES GUI)

MOVES Execution Database ↔ MOVES Master (MOVES GUI)

MOVES Master → Output Database

MOVES Master → Processed Output

Run Specification ↕ MOVES Master
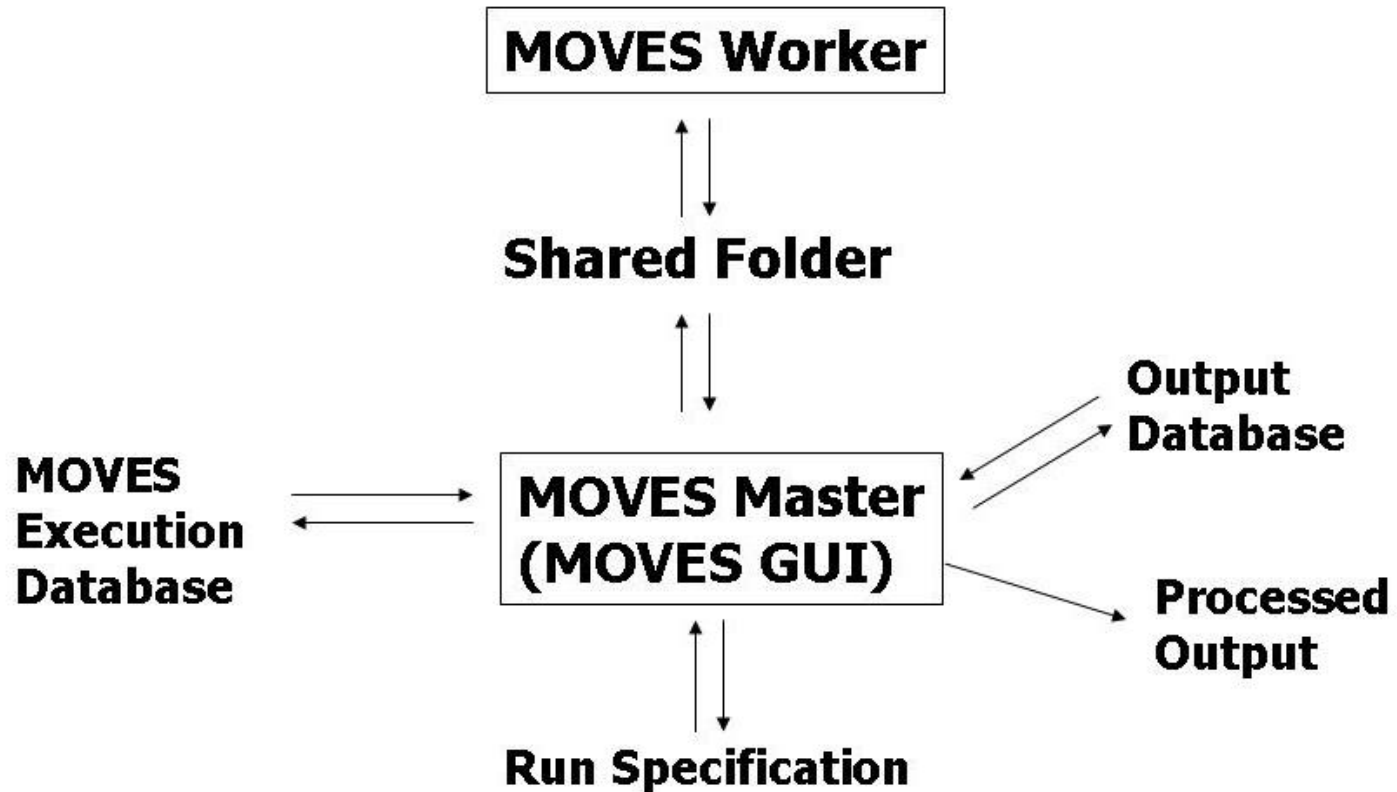
Geographic Coverage

✓ **Modeling domain is the entire U.S.**
  - 50 States plus (DC, Puerto Rico, & Virgin Islands)
  - 3222 Political subdivisions (counties as of CY 1999)

Time Periods

✓ **Calendar years (1990, 1999-2050)**

✓ **12 months of the year**

✓ **Week days and weekend days**

✓ **24 hours of the day**

✓ **Specific months or days are generic examples**

  – 5 week days, 2 weekend days

  – MOVES does account for

    ● Different number of days in months

    ● Leap years

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.

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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

Road Types

- A fifth road type, "off-network", is included to capture emissions that are not produced by vehicles operating on roadways (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,

-

-

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)

Age group, and

Operating mode
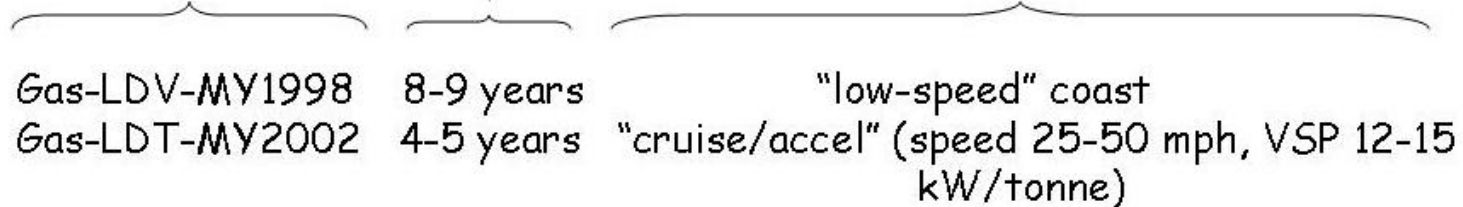
MOVES: Operating Mode Bins

✓ **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 MOVES 2008**

Operating Mode Bins for Running Energy Consumption

Braking (Bin 0)			
Idle (Bin 1)			
VSP \ Speed	0-25mph	25-50	>50
< 0 kW/tonne	Bin 11	Bin 21	-
0 to 3	Bin 12	Bin 22	-
3 to 6	Bin 13	Bin 23	-
6 to 9	Bin 14	Bin 24	-
9 to 12	Bin 15	Bin 25	-
12 and greater	Bin 16	Bin 26	Bin 36
6 to 12	-	-	Bin 35
< 6	-	-	Bin 33

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Distribution of Operating Time by Operating Mode
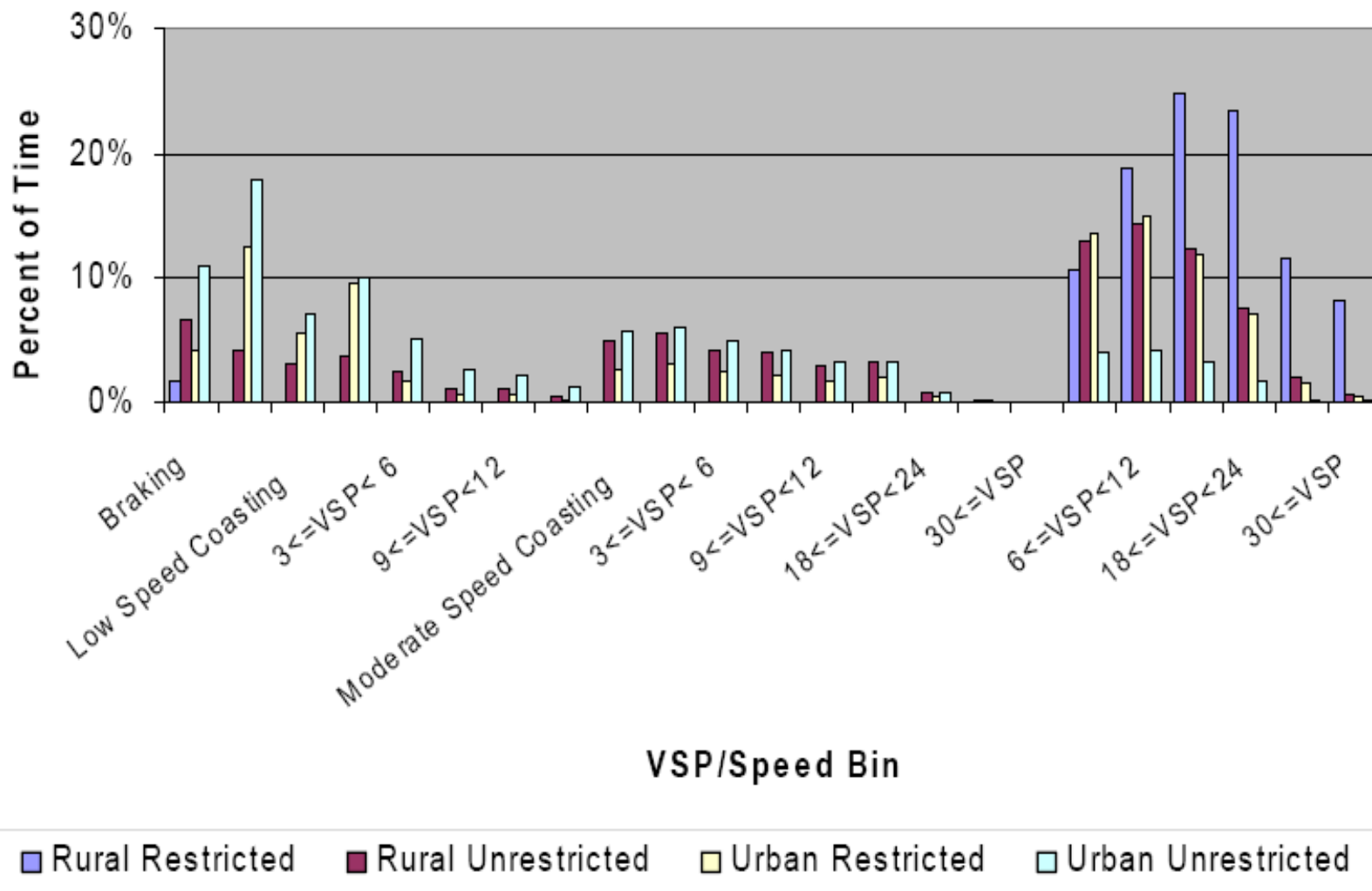
Modal "Binning" Approach

✓ **Group activity and emissions into "bins"**
- **Vehicle Specific Power (VSP) & Speed**
  - **Accounts for speed, acceleration, road load**

✓ **Any driving pattern can be modeled**
- **Adds major flexibility compared to MOBILE**

✓ **Allows direct use of data from many sources**
- **Laboratory, I/M programs, RSD**

✓ **Provides common emission rates for all scales**

✓ **Independent validation has shown good results even for macroscale application**

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MOVES Databases

✓ **Input Databases (default or user-created)**
- Default Input Database
- User Input Database(s) (optional-MOVES will run with just defaults)

✓ **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

User Input - Databases

Default Database → MOVES Execution Database → MOVES Application

User Input Database → MOVES Execution Database

User Input Database → MOVES Execution Database

MOVES Application ⇅ Intermediate Result Tables

User Input Database → Intermediate Result Tables

(Advanced Feature)
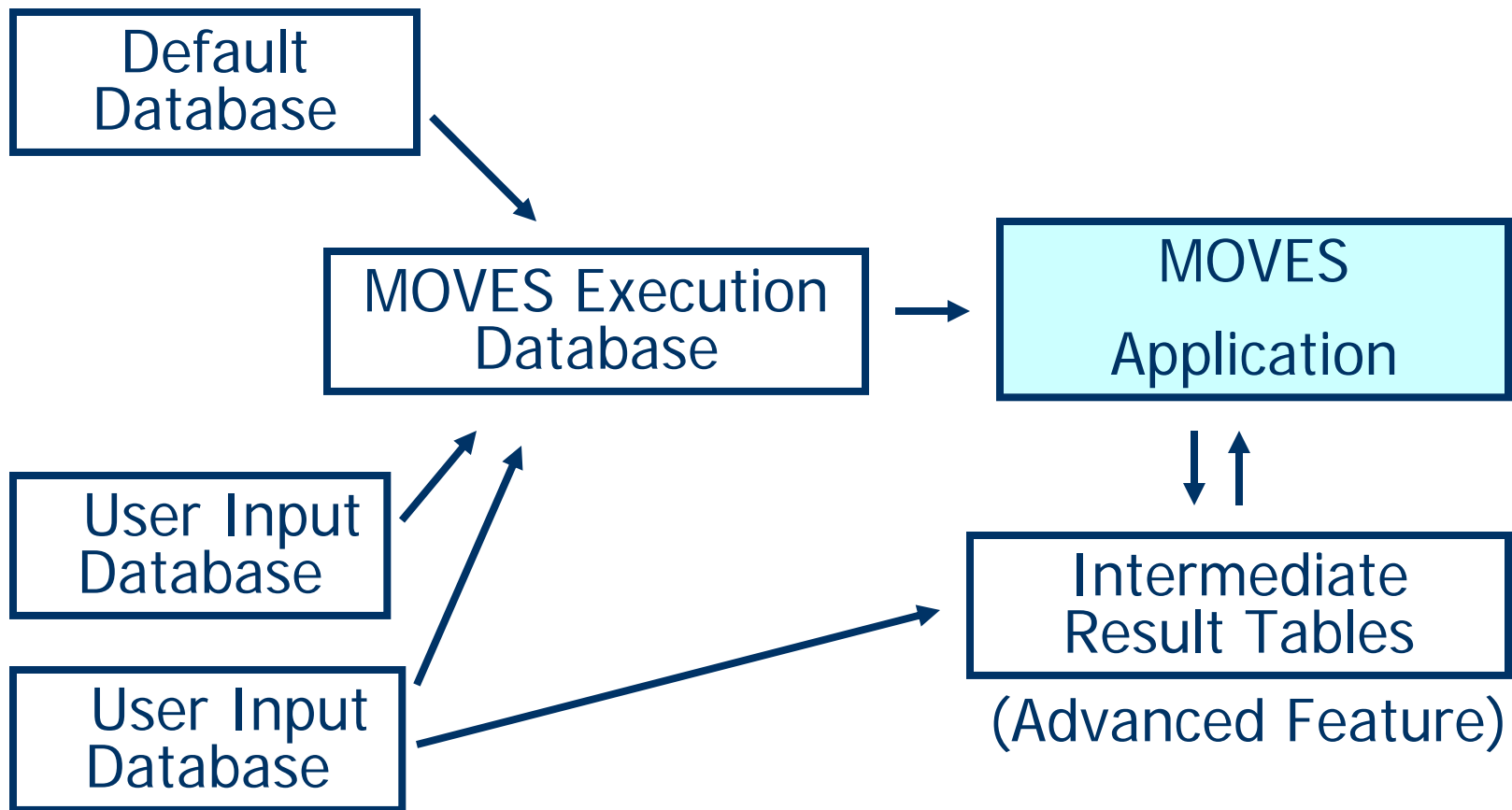
Output

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

Making the Transition to MOVES

Outline

- **MOVES schedule and MOVES versions**
- **Stages to learning and using MOVES**
- **Easing the transition**
  - Improvements in handling different geographic domains
  - Data importers
  - Guidance documents
  - Training
- **What you can do to prepare**
- **Next steps**

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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**
- **Late 2008**
  - **Planned release of draft MOVES2008**
    - **Add draft criteria pollutant emission factors**
- **Late 2009**
  - **Planned release of MOVES2009**
    - **Final onroad criteria pollutant model**
- **2009+**
  - **Add nonroad emissions to MOVES**

MOVES2008

- **Developing draft MOVES2008 for release in late 2008**
  - Adding criteria pollutant emission factor databases
  - Adding more features to simplify regional and project-level analysis for SIPs and conformity
    - **Data importers**
    - **Improved domain handling capabilities**
- **MOVES2008 will be a draft model**
  - No official use requiring MOVES2008
  - Followed by public review, training, and EPA guidance development
  - May not include all data or features planned for MOVES2009

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MOVES2009

- **MOVES2009 planned for release in late 2009**
- **MOVES2009 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 which could be shorter than regional conformity grace period
  - NEPA analysis (e.g., air toxics)

Stages to Learning and Using MOVES

- **Use MOVES with national defaults**
    - Learning step only - Not appropriate for SIPs or conformity
- **Running MOVES with converted MOBILE6 inputs**
- **Running MOVES with inputs developed specifically for MOVES**
    - This may be simpler in some cases than what users currently do to get data in terms MOBILE requires
- **Using MOVES advanced features with customized inputs**
    - Will allow users to take full advantage of MOVES features

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Using MOBILE6 Input Data in MOVES

- **During MOBILE5 to MOBILE6 transition, EPA provided tables in Technical Guidance to convert certain inputs to new MOBILE6 formats**

  - Example: default conversion factors to change from MOBILE5 vehicle classes to MOBILE6 classes

- **For MOVES, EPA will take a similar approach with a combination of:**

  - Conversion tables

  - Data importers that will automate this process

Developing Input Data Specifically for MOVES

- **In the long-term, users will want to collect data specifically for MOVES**

- **Will allow users to take better advantage of MOVES design and features**

- **In some cases this may simplify data collection**

  – Example: MOVES uses HPMS vehicle types, no need to convert HPMS-type vehicle counts to MOBILE vehicle types

Taking Full Advantage of Advanced Features in MOVES

- **In some cases, users may want to customize data inputs to take full advantage of MOVES features**
    - Example: MOVES allows users to input customized drive cycles or VSP distributions for specific links, which could be useful for some project-level analysis
- **EPA still needs to develop guidance on the use of these features, but current view is that these will be optional in regional and project level analysis**

Easing the Transition to MOVES

- **Improving handling of different domain sizes**
  - Adding GUI for nonattainment area and project level analysis to allow users to specify local inputs

- **Developing data importers which will:**
  - Ease conversion of MOBILE inputs to MOVES inputs
  - Allow input of data as text files

- **Writing future guidance documents**
  - Technical guidance will address when and what type of local input is needed

- **Planning outreach and training**
  - FHWA & EPA planning MOVES training for 2008 and beyond

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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

- **Adding GUI to MOVES2008 for local inputs for nonattainment area and project level analysis**

Domains

- Some MOVES inputs are applied identically to all locations being modeled (i.e., the domain).

- All analysis levels, other than National, will require the entry of some user supplied data.

- The analysis level chosen by the user will determine which inputs are required.

- The MOVES interface will guide the user to the appropriate importers necessary for modeling at that analysis level.

Domains in MOVES
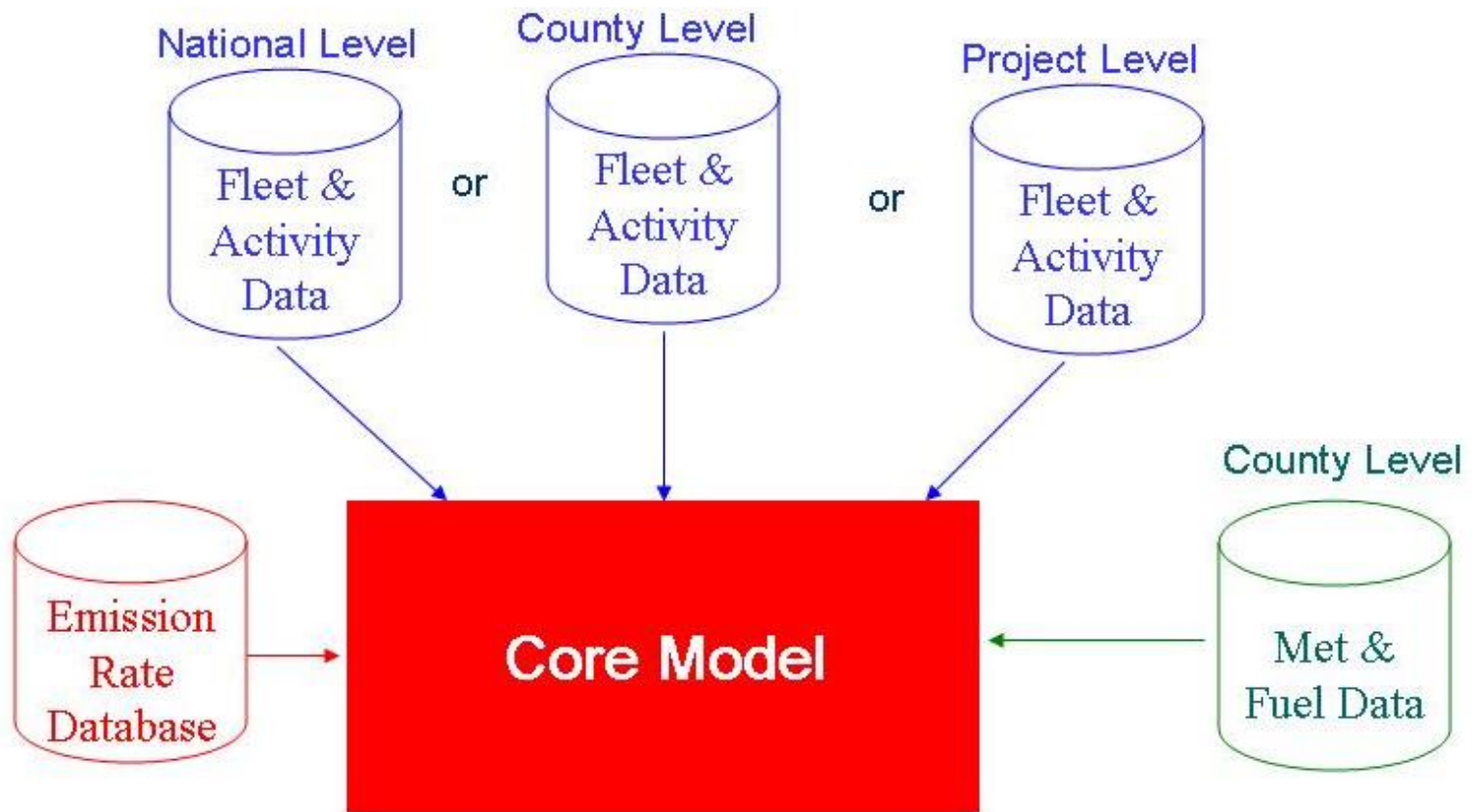
National Level

- **Uses national default data with allocation to county level**
- **Primary use is broad-scale national analysis**
  - e.g. EPA rulemakings for vehicle standards
  - Not appropriate for use in SIPs or conformity
- **Users can change inputs, but not easily at the county level**
- **Output for nation, states, or counties**
- **MOVES Demo works best for this level of analysis**

Nonattainment Area or County Level

- **Define a "domain" as a single county or group of counties**
- **Users input local environmental, fleet, and activity data similar to that required in MOBILE**
- **May be able to define subareas**
  - individual counties within a group of counties
  - zones within a single county
- **Output is at the county level by road type**
- **This level of analysis will be appropriate for SIPs and regional conformity analyses**

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Project Level

- **Users will be able to define inputs at the project level as individual links in the project**

    - Enter fleet and activity data specific to each link

    - Could enter detailed driving behavior by link

    - Multiple links could be modeled in a single run

- **Users will also be able to input idle and start information if applicable for the type of project**

- **This level of analysis will be appropriate for project level conformity analyses**

Look-up Table Output Option

- **MOVES is an inventory model**
  - designed to produce total emissions incorporating VMT by road and vehicle type

- **A look-up table output option allows users to produce running emission rates in grams per mile in order to post-process results, as some agencies currently do with MOBILE**
  - This output option will work at all levels – national, nonattainment area, and project
  - EPA is considering g/hour output for non-running emissions

What Are MOVES Data Importers?

- **Software interfaces that can create alternate databases, tables, and data records for use by MOVES**

  – Replace default database

  – Substitute updated tables, or

  – Change individual records

- **EPA is currently developing data importers to simplify creation of local input files in draft MOVES2008**

  – Enhancements to these planned importers and additional importers may be developed after release of MOVES2008

Advantages of Importers

- **User input tables can be created without using importers, however importers:**
  - 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 check user-supplied information for obvious errors and inappropriate values.
- **Importers can also be designed to apply appropriate guidance to convert existing information (MOBILE6) to the MOVES format.**

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Importer Limitations

- **Substantial effort is needed to create importers**
  - Some may not be completed in time for draft MOVES2008
- **Importers can include some data checking capabilities but cannot guarantee that all errors in the data supplied by users will be identified**

Exporting Data Formats

- **In some cases, importers will be able to export empty tables in the appropriate format to files that can be read by other applications, such as spreadsheets.**

- **Users can then populate these exported files with data using spreadsheet (or other) applications.**

- **The resulting populated files can then be submitted to MOVES using the importer.**

Adding Importers to MOVES

- **Ideally all required data supplied to MOVES will be provided through data importers**

- **However, EPA will not be able to provide importers for all data elements used by MOVES**

- **Addition of importers to the MOVES model will need to be prioritized**
  - **The most important.**
  - **The easiest to develop.**
  - **The best understood and defined**.

- **Data needed without an available importer will need to be provided using other methods**
  - **For example, using MySQL to directly modify data tables**

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Proposed First Priority Importers

- Fraction of each model year by fuel type/technology
- Vehicle populations
- Annual vehicle miles traveled (VMT)
- Age distributions
- Temperature and humidity
- I/M and Stage 2 program descriptions
- Average speed distributions
- Fuel parameters

Additional Proposed Importers

- Allocation of annual VMT to months of the year.
- Allocation of VMT to each road type by source type, day and hour.
- User specification of fuel parameters (gasoline, diesel, etc.).
- Sample trip start and end times (used to calculate vehicle non-driving activity)
- Driving schedule speed/sec by source type and road type.
- Hours of extended idling by heavy duty diesel vehicles at truck stops.
- Barometric pressure.
- Mapping of MOBILE6 vehicle and roadway types to MOVES

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Example:
Importing Age Distributions

- Starting with raw fleet information, determine the count of vehicles in each model year by source type classification.

- Determine the age distribution for each source type.

- From the MOVES GUI, export the SourceTypeAgeDistribution table format using the relevant importer.

- Open the exported file using a spreadsheet application and populate the appropriate cells with the distribution values.

- From the MOVES GUI pre-processing menu, import the populated table into your user input database.

- Designate your user input database in the run specifications for any runs where you wish to use this set of age distributions.

Example:
MOBILE6 Age Distributions

- **From the MOVES GUI pre-processing menu, choose to import MOBILE6 registration data.**
- **Select the MOBILE6 external data file that contains the registration data.**
- **Convert the MOBILE6 data to MOVES format and import the data into your user input database.**
  - **MOVES will map the MOBILE6 vehicle classes to the appropriate MOVES source types.**
  - **Separate importers can be used to adjust the M6 to MOVES mapping.**
- **Designate your user input database in the run specifications for any runs where you wish to use this set of age distributions.**

Future Guidance Documents

- **EPA expects to release several guidance documents that will help with the transition to final MOVES**
  - MOVES Technical Guidance for SIPs and Conformity
  - Project Level Conformity Guidance for PM
  - MOVES SIP and Conformity Policy Guidance

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
        - **Use local information**
    - Mileage accumulation
        - **Use national defaults**

Local Inputs vs. Defaults – Key Factors

- **Does the input vary by location?**
  - Some inputs are more likely to vary than others
- **How sensitive is MOVES to changes in the input?**
  - Take into account results of MOVES sensitivity analysis
- **Is local information available?**
  - Ease or difficulty of developing local information
  - Quality of local information

Local Inputs vs. Defaults – Balancing Two Goals

- **Need to make sure that areas with less resources can use MOVES**
  - May be too difficult for some areas to develop good local data for some inputs
- **Want to encourage development of new local data if it will result in better inventories**
- **As with MOBILE6, some local inputs will be required, some will be recommended, some will be optional, and some may be discouraged if local data are unreliable**
  - Your feedback on availability and quality of local data is helpful

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Project Level Guidance for PM

- How to do project level analysis for PM2.5 and PM10 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 dispersion 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**

Guidance Schedule

- **EPA will work with DOT on development of MOVES guidance**
- **Plan to release draft guidance for comment by stakeholders sometime after release of MOVES2008**
- **Final guidance documents will be available when MOVES is finalized**

MOVES Outreach and Training

- **EPA developing a joint training plan with FHWA**
- **Near-term outreach prior to release of draft MOVES2008**
  - Focus on basic information to prepare users for transition
- **More detailed training after release of draft MOVES2008 focusing on use of MOVES for SIPs and conformity**
- **We welcome comments on training needs and priorities**

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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**
- **Provide feedback on MOVES Demo**
  - Still time to let EPA know about possible bugs, other concerns

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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
- **Plan to attend MOVES training events after release of MOVES2008**
- **Subscribe to MOBILENEWS email list for MOVES updates**

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

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Summary of Planned MOVES2008 Features

- Improved run-time
- Draft exhaust and non-exhaust emissions for criteria pollutants and toxics
- Updated energy rates and GHG emissions (more responsive to speed changes)
- Importer for key county-level domain inputs
- Basic project level data importer
- Basic fuels and I/M importers

After MOVES2008

- **A lot will happen in the year between MOVES2008 and MOVES 2009**
  - Begin 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 MOVES2008, the better MOVES2009 will be**
  - Please plan to begin testing and commenting on MOVES2008 as soon as it is released

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Feedback

- **We need your comments and ideas**
  - Does MOVES meet your needs?
  - Is MOVES too hard to use?

- **Official Comment Period:**
  - Begins when MOVES2008 is released
  - Comments are most effective when obtained early

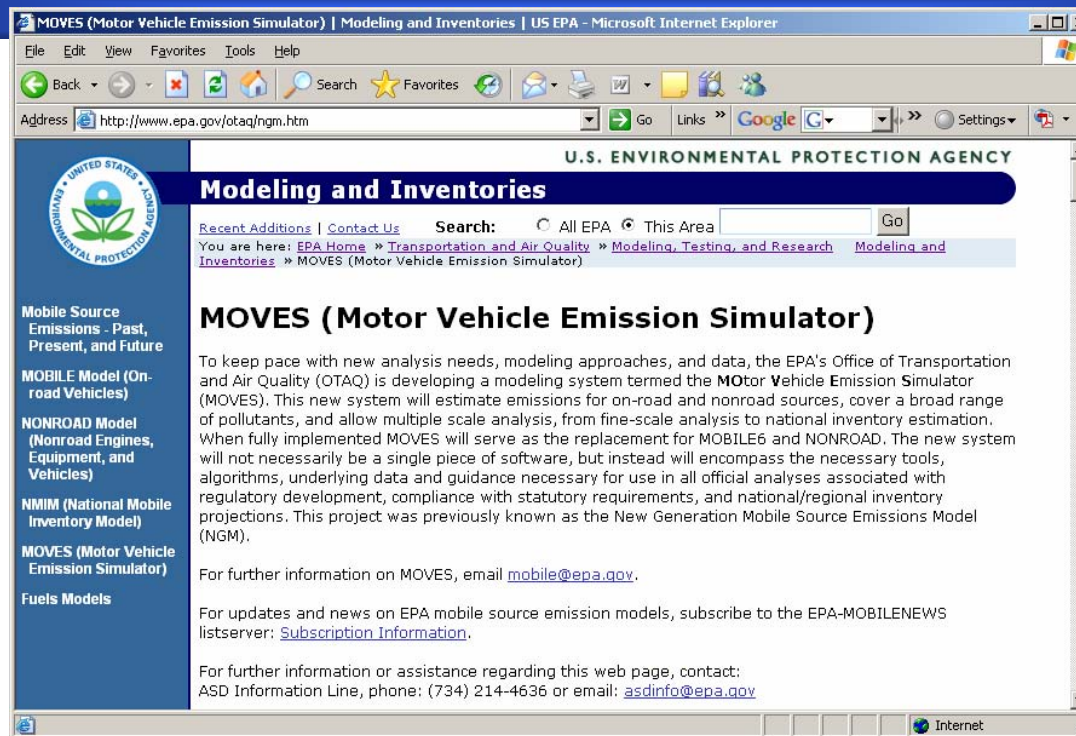- **We are interested in your ideas to make MOVES better meet your needs**

How Can I Provide Comments?

- **Send an email to mobile@epa.gov.**
- **Send a letter to:**

  MOVES Model Comments

  US EPA NVFEL ASD

  2000 Traverwood Dr.

  Ann Arbor, MI 48105
- **Attend a workshop (like this one).**
- **Through your stakeholder group:**
  - STAPPA/ALAPCO
  - NESCAUM
  - Etc.

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

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

Introduction to MySQL

MOVES Databases

- **MOVES stores information in MySQL databases**
- **The MOVES Demo default database has 101 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**

MySQL Query Browser

- **Windows tool for viewing databases, executing queries, and editing tables—supplied with MOVES**
- **Query results can be exported as csv or Excel files**
- **Built-in Help files**
- **Record query history to repeat queries without retyping them**
- **Tables can be edited directly, rather than using MySQL commands**

Exploring MOVES Default Database with Query Browser

- **Demonstration of MySQL commands for exploring the default database**

MOVES Demonstration

- **Demonstration of MOVES input screens and some features**

MOVES Documentation

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

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

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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