

MOVES Design & Implementation Plan

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**EPA Mobile Source Present
and Future Models Workshop
- November 6, 2002 -**



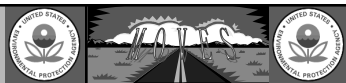
Document Publicly Available

- **“Draft Design and Implementation Plan for EPA’s Multi-scale Motor Vehicle & Equipment Emission System (MOVES)”**
- **Posted on MOVES Web Page**
 - <http://www.epa.gov/otaq/ngm.htm>
- **Requesting comments by December 20th**
- **Send to newgen@epa.gov**



MOVES Use Cases

- **Developed from NRC recommendations, external and internal user consultation**
- **Primary use cases:**
 - Inventories at national and local levels
 - Multi-scale analysis
 - Model integration (air quality, transportation)
 - Policy evaluation
 - Flexible and easy updates



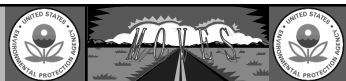
Desired User Interaction Features

- **GUI and batch (command-line) interface**
- **Flexibility of input/output formats**
- **Multiple options for output processing**
- **Ease of comparison for multiple model runs**
- **Ease of transition from MOBILE/NONROAD**



Design Objectives

- **Generic framework which can be applied across scale, source, pollutant**
- **Database-driven, modular design to allow easy updates**
- **High performance**



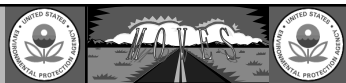
Design Concepts

- **Emission Process**
- **Fleet**
 - Source Use Type
 - Source Bin
- **Activity**
 - Total Activity
 - Operating Mode Bin
- **Emissions**
 - Emission Rate & Emission Factor
- **Scale**
 - Macroscale, Mesoscale, Microscale
 - Domain, Link, Zone



MOVES Emission “Processes”

- **Emission process = emission pathway with unique activity and emission characteristics**
- **Combustion Products**
 - Running exhaust, Start exhaust, Extended idle, Crankcase
- **Hydrocarbon Evaporation**
 - Diurnal, Hot Soak, Running Loss, Resting Loss, Refueling
- **Other**
 - Brake Wear, Tire Wear



Fleet Concepts: Source Use Type

- **a specific class of vehicles or equipment defined by unique activity patterns**
- **Mapped to HPMS Vehicle Types for on-road**
- **Off-road equivalent is SCC**

Proposed on-road use types

HPMS Vehicle Type	MOVES Use Type
Passenger car	Passenger car
Other 4-tire / 2-axle	Passenger truck Light work truck
Single Unit Trucks	Service truck Local delivery truck Short-haul delivery truck Motorhomes
Combination Trucks	Long-haul delivery truck
Buses	Urban buses School buses Interstate buses
Motorcycles	Motorcycles



Fleet Concepts: Source Bin

- Subcategories of use type that differentiate emission levels
- Examples: weight class, fuel type, technology, standard, horsepower range, etc.



Activity Concepts: Total Activity

- Population * per-source activity for a given time, location, use type, age
- Proposing a time basis – more broadly applicable than g/mi

Emission Process	Total Activity Basis
Running Exhaust, Brake Wear, Tire Wear, Running Loss, Crankcase	Source Hours Operating (SHO)
Start Exhaust	Number of Starts
Diurnal, Hot Soak	Source Hours Parked (SHP)
Resting Loss	Source Hours (SH)
Refueling	Gallons of Fuel Used



Activity Concepts: Operating Mode Bin

- Division of total activity into categories that differentiate emissions

Emission Process	Operating Mode Parameter(s)
Running Exhaust, Brake Wear, Tire Wear	Aggregate Operating Statistic and Vehicle Specific Power (VSP)
Start Exhaust, Hot Soak	Soak Time
Diurnal	Tank Pressure
Running Loss	Time Since Start

Intersection of Source Bin & Operating Mode Bin = “Source & Operating Mode Bin”

Example:

Use Type	Type of Bin	Bin Parameters	Example
Passenger Car	Source Bin	Fuel Type Mileage Technology Standard Emitter Category	Gasoline High Fuel Injection/3-Way Catalyst Tier 1 Normal
	Operating Mode Bin	Power Bin	Vehicle Specific Power =13 to 16 kW/ton



Emission Concepts: Emission Rate & Emission Factor

- **Emission Rate**

- the most disaggregated rates the model produces internally by source and operating mode bins

- **Emission Factor**

- emission rates aggregated and normalized by some activity basis, e.g. grams/miles or grams/hour



Scale Concepts: Macro, Meso, Micro

- **Macroscale**
 - Large-scale inventories (e.g. U.S. at county level)
 - 1 hour resolution
- **Mesoscale**
 - More refined inventories, generally at regional level
 - Based on Link-level Travel Demand Model framework
 - 1 hour resolution
- **Microscale**
 - Emission analysis for intersection or group of links
 - Based on project-level CAL3QHC framework
 - 15 minute time resolution



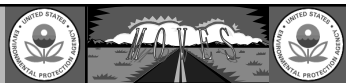
Scale Concepts: Domain, Zone, Link

- **Domain: the area being modeled**
 - Fleet makeup is assumed constant over domain
 - Treated as a “closed box”
 - Default is nation
- **Zone: a subdivision of domain**
 - Default is county
 - Can be defined at sub-county level, must belong to a county
- **Link: a representation of roadways**
 - Definition depends on scale
 - Macroscale: HPMS roadway types
 - Mesoscale/Microscale: Specific links
 - Can belong to either a domain or a zone



MOVES Components (1)

- **Core Model**
 - Generic structure provides flexibility across sources, analysis scales, pollutants
- **“Implementations”**
 - Drive core model to meet use cases
 - **Generators** and **Control Strategies**



MOVES Components (2)

- **Databases**
 - National default fleet & activity database
 - County default weather, fuel, control program database
 - User-input database
 - Emission rate database
 - Output database
- **User Interface**



Core Model: Inputs

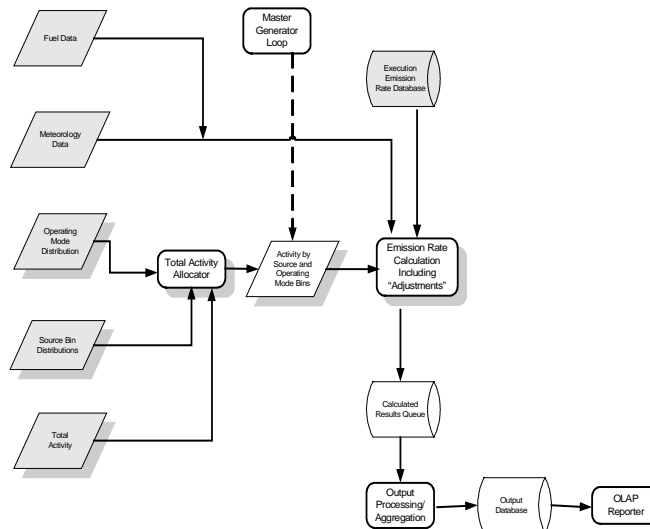
- For a given time, location:
 - **Total Activity**
 - By use type, age, process
 - **Operating Mode Distribution**
 - By process, pollutant
 - **Source Mode Distribution**
 - By use type, process, pollutant
 - **Meteorology**
 - **Fuel Parameters**



Core Model Steps

- Allocate total activity to source & operating mode bins
- “Lookup” emission rates by source & operating mode bin
- Aggregate emission factors across source & operating mode bin
- Apply emission adjustments
 - e.g. **Fuel, Meteorology, Air Conditioning**
- Produce output

Core Model



Generators

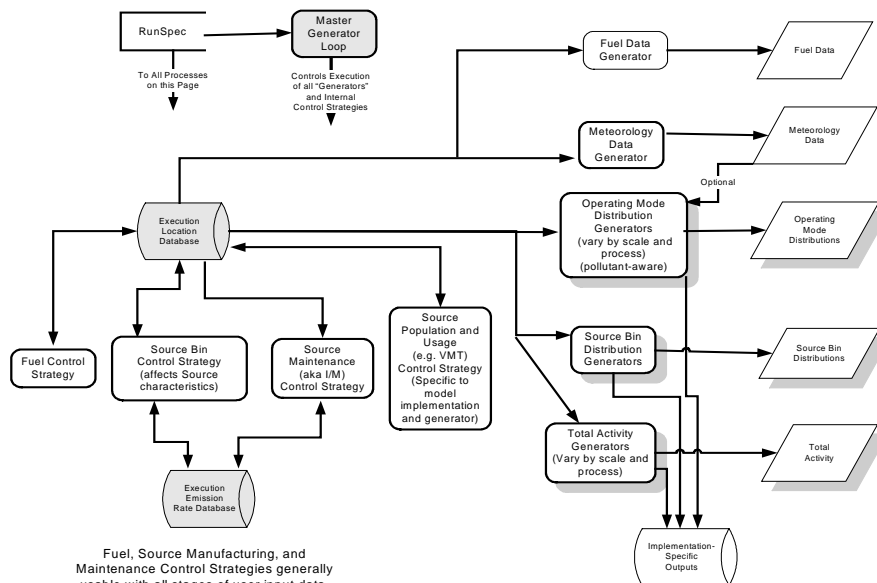
- Produce core model inputs from readily available data
 - **5 generators provide 5 input data types**
- Implementation-specific
 - **Provides link between generic core model and specific implementations**
 - **Total Activity and Operating Mode Distribution generators are where most of the implementation-specific math will happen**



Internal (built-in) Control Strategies

- Fuel Control
 - Alters fuel parameters, e.g. sulfur, oxygenate
- Source Bin
 - Alters distribution of source bins, e.g. new standards, fuel penetration,
- Source Maintenance
 - I/M
- Source Population and Usage
 - Alters total activity and/or operating mode distribution, e.g. reduced VMT, traffic smoothing

Generators and Control Strategies

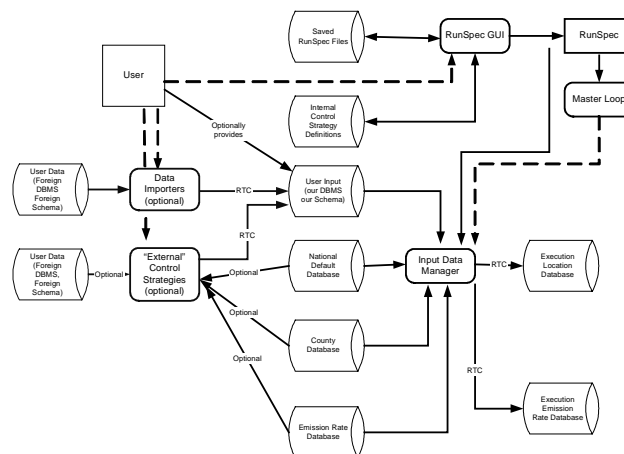




User Interface and Input Databases

- Input Databases
 - National default: fleet, activity
 - County default: weather, fuel, control programs
 - User-supplied data can override these
 - “Data Manager” sorts out which data to use
- User Interface
 - Run Specification GUI (Run Spec)

User Interface and Input Databases





MOVES Design: Specific Implementations

- **On-Road Macroscale Inventory**
 - Default inventory for U.S
 - Local inventory development with user-supplied inputs
- **On-Road Mesoscale Inventory**
 - Link-level based on output from travel demand model
- **On-Road Microscale Analysis**
 - Intersection modeling in conjunction with CAL3QHC
- **Off-Road**
- **TRANSIMS**
 - Would assist DOT in developing this implementation



Macroscale Total Activity Generation

- **Grow and Allocate VMT at Domain Level**
 - Accounts for sales, scrappage, annual miles by use type, age
 - Based on HPMS VMT
 - Allocate by use type, age, HPMS roadway type, time
- **Convert to Total Activity Basis**
 - SHO, Starts, SHP, SH, Gallons Refueled
- **Allocate to Zone Location**
 - Geographic allocation factors by process, use type



Input to Core Model

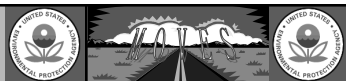


Microscale/Mesoscale Total Activity Generation

- **Running exhaust, tire/brake wear:**
 - Calculate link-level VMT
 - Based on travel demand model (meso) or CAL3QHC (micro)
 - Allocate by use type, age, time
 - Convert to Source Hours Operating
- **Start exhaust:**
 - Determine number of starts by Zone Location
 - Allocate by use type, age, time
- **Other processes, off-network travel handled same as macroscale**



Input to Core Model



Operating Mode Distribution Generation (running exhaust)

- **Determine distribution of driving cycles**
 - From average speed, HPMS roadway type
- **Calculate second-by-second Vehicle Specific Power (VSP)**
- **Determine bin distribution**
 - 14 VSP Bins developed by NC State
 - Aggregate Operating Statistic
 - e.g. average speed, fraction of time > 3 mph/s

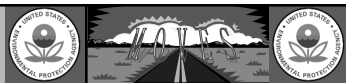


Input to Core Model



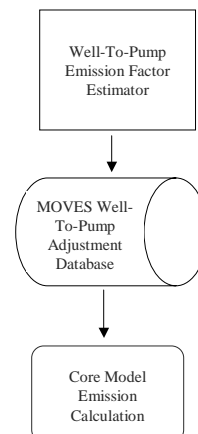
MOVES Implementation Plan

- **MOVES GHG (on-road): 2003-2004**
 - Inventory release (GHG.1): September 2003
 - Fuel consumption, CO₂, N₂O, CH₄
 - Policy evaluation release (GHG.2): December 2003
 - One-stop-shopping for technology and travel policy evaluation
 - Could incorporate well-to-pump emissions
 - Mesoscale release (GHG.3): Mid 2004
 - Add link-level modeling for local-level transportation policies
- **Full on-road implementation: Fall 2005**
 - Add HC, CO, NO_x, Toxics, PM, NH₃, SO₂
 - Microscale analysis capability
 - Will replace MOBILE6
- **Off-Road: 2006**



Well-To-Pump Emissions

- **Considering for MOVES GHG.2**
- **Separate utility would estimate well-to-pump emission adjustments for different technology pathways**
 - User could alter assumptions and run to completion for use in MOVES
- **Core model would treat as an emission adjustment**





Summary

- **MOVES design provides flexibility**
 - Multiple scales, pollutants, processes, sources
 - Single design can be applied to many use cases
- **Bin framework provides multi-scale capability**
- **Modular approach will allow easier updates**
 - New implementations will focus on a subset of components
 - Database-driven approach will allow for easier incorporation of new data
- **Iterative development approach will produce useful products on the way to full implementation**