

# Module 6

## Modeling Nonroad Emissions



# Module Overview

- Options for modeling nonroad emissions
- Overview of nonroad in MOVES2014
- Hands-on demonstration of nonroad in MOVES

# Options for Modeling Nonroad Emissions

- NONROAD2008
  - Last revision of the NONROAD model
  - Can still be used for SIPs and other regulatory purposes
  - May not be fully compatible with latest operating systems
- NMIM2008
  - Last revision of NMIM, an inventory modeling “shell” for MOBILE6.2 and NONROAD2008
    - Includes some features that may make it easier to use than NONROAD2008
  - Nonroad portion only can still be used for SIPs and other regulatory purposes
  - Can model air toxics
  - May not be fully compatible with latest operating systems

# Options for Modeling Nonroad Emissions

- MOVES2014
  - Incorporates existing NONROAD2008 into MOVES framework
    - No changes to basic model design or data
    - Same results as NONROAD2008 and NMIM2008
  - More limited output options than other two models
    - But post-processing scripts may help
  - May be more difficult to enter local inputs in some cases
  - Compatible with latest operating systems
  - May be used for SIPs and other regulatory purposes

# Nonroad Guidance

Which model should I use?

- Use either NONROAD2008, NMIM2008, or MOVES2014 for nonroad inventory development
- Users should carefully weigh options before deciding

What data should I use?

- It is acceptable to use default nonroad fleet and activity data for SIPs and other regulatory submissions
- You can use local fleet and activity data for any of these models
  - Contact us at [mobile@epa.gov](mailto:mobile@epa.gov) with questions about how to do this in MOVES2014

# Future of Nonroad Modeling

- Adding nonroad to MOVES2014 is the first step toward major revisions to the nonroad modeling process
- Those revisions may include:
  - New emissions, activity, and fleet data
  - New algorithms for calculating emissions
  - New design
  - New coding language
- Still in the early planning stages
  - Timetable is not yet determined
- Goal is for MOVES to be a comprehensive model that covers most types of mobile sources in a consistent way

# Overview of Nonroad in MOVES

- Heavy reliance on national defaults applied at the county level
  - Local activity and fleet data can be hard to develop
  - MOVES uses surrogates (construction activity, acreage farmed, etc.) to allocate national data to the county level
- MOVES produces inventory output
  - Emission rates can be derived using post-processing scripts
- MOVES does not account for hourly activity patterns or aggregate emissions for more than 1 day

# Overview of Nonroad in MOVES

- Nonroad equipment divided into 12 sectors with 91 equipment types
  - Not included are locomotives, commercial marine, and aircraft
- Pollutants and Processes detail more limited than for onroad
- Produces huge output files
  - A run for all nonroad source types and multiple pollutants can give several hundred thousand lines of output
  - Use post-processing scripts to trim



# Hands-On Demonstration: Estimating Nonroad Emissions



# Scale

- Nonroad sectors can be modeled by selecting “Nonroad” in the Scale panel
- “National” is only option for scale
  - Refers to national default database
  - Individual counties can be selected in Geographic Bounds panel
- “Inventory” is only option for Calculation Type
  - Several scripts are available in the Post Processing menu to calculate emission factors from inventory results

# Scale

The screenshot shows the MOVES software interface with the 'Scale' panel selected in the left-hand navigation menu. The main window displays the following configuration options:

- Model:**
  - Onroad
  - Nonroad
- Domain/Scale:**
  - National
  - County
  - Project
- Calculation Type:**
  - Inventory **Mass and/or Energy within a region and time span.**
  - Emission Rates **Mass and/or Energy per unit of activity.**

Below the Calculation Type options is a text input field labeled 'MOVESScenarioID:'.

**Caution:** Changing these selections changes the contents of other input panels. These changes may include losing previous data contents.

The status bar at the bottom left of the window displays 'Ready...'.

# Time Spans

- Nonroad emissions in MOVES are calculated on a daily basis
- No options for specifying Time Aggregation Level or Hours
- Select:
  - 2015
  - July
  - Weekdays

# Time Spans

The screenshot displays the MOVES software interface with the 'Time Spans' configuration panel highlighted in yellow. The interface includes a menu bar (File, Edit, Pre Processing, Action, Post Processing, Tools, Settings, Help) and a left sidebar with various configuration categories. The 'Time Spans' panel is currently active, showing options for Time Aggregation Level (Year, Month, Day, Hour), Years (2015 selected), Months (July selected), Days (Weekdays selected), and Hours (Start and End Hour fields).

**MOVES - ID 2214896263202995615**

File Edit Pre Processing Action Post Processing Tools Settings Help

**Time Spans**

**Time Aggregation Level**

Year  Month  Day  Hour

**Years**

Select Year: 2015 Add

Years:

Remove

**Months**

January  July

February  August

March  September

April  October

May  November

June  December

Select All Clear All

**Days**

Weekend

Weekdays

Select All Clear All

**Hours**

Start Hour: [ ]

End Hour: [ ]

Select All Clear All

Ready...

# Geographic Bounds

- Can select Nation or County
- Can run multiple counties in a single run
- Select:
  - Indiana
  - Lake County

# Geographic Bounds

The screenshot shows the MOVES software interface with the following components:

- Window Title:** MOVES - ID 2214896263202995615
- Menu Bar:** File, Edit, Pre Processing, Action, Post Processing, Tools, Settings, Help
- Left Panel (Navigation):**
  - Description
  - Scale
  - Time Spans
  - Geographic Bounds** (highlighted with a yellow box)
  - Vehicles/Equipment
  - Road Type
  - Pollutants And Processes
  - Manage Input Data Sets
  - Strategies
  - Output
  - Advanced Performance Features
- Main Panel (Configuration):**
  - Region:**  Nation,  State,  County,  Zone & Link,  Custom Domain
  - States:** GEORGIA, HAWAII, IDAHO, ILLINOIS, **INDIANA** (highlighted with a yellow box), IOWA, KANSAS, KENTUCKY, LOUISIANA
  - Counties:** INDIANA - Kosciusko County, INDIANA - La Porte County, INDIANA - Laarange County, **INDIANA - Lake County** (highlighted with a yellow box), INDIANA - Lawrence County, INDIANA - Madison County, INDIANA - Marion County, INDIANA - Marshall County
  - Selections:** INDIANA - Lake County
  - Buttons:** Select All, **Add** (highlighted with a yellow box), Delete
- Geographic Bounds Requirements:** A large empty text area at the bottom of the main panel.
- Status Bar:** Ready...

# Nonroad Vehicle Equipment

- Select these fuel types:
  - Compressed Natural Gas (CNG)
  - Diesel
  - Gasoline
  - Liquefied Petroleum Gas (LPG)
- Best to select all 12 sectors
  - MOVES allocates activity to each sector in a county based on various surrogates:
    - Farmed acreage for agriculture, construction starts for construction, etc.



# Nonroad Vehicle Equipment

MOVES - ID 2214896263202995615

File Edit Pre Processing Action Post Processing Tools Settings Help

**Description**

- ✓ Scale
- ✓ Time Spans
- ✓ Geographic Bounds
- [-] ✓ Vehicles/Equipment
  - ✓ **NonRoad Vehicle Equipment**
- ! Road Type
- ! Pollutants And Processes
- Manage Input Data Sets
- [+] ✓ Strategies
- [+] ! Output
- ✓ Advanced Performance Features

**Fuels:**

- Compressed Natural Gas (CNG)
- Diesel Fuel
- Electricity
- Ethanol (E-85)
- Gasoline
- Liquefied Petroleum Gas (LPG)

**Sectors:**

- Agriculture
- Airport Support
- Commercial
- Construction
- Industrial
- Lawn/Garden
- Logging
- Oil Field
- Pleasure Craft
- Railroad
- Recreational
- Underground Mining

**Selections:**

- Compressed Natural Gas (CNG) - Agriculture
- Compressed Natural Gas (CNG) - Airport Support
- Compressed Natural Gas (CNG) - Commercial
- Compressed Natural Gas (CNG) - Construction
- Compressed Natural Gas (CNG) - Industrial
- Compressed Natural Gas (CNG) - Lawn/Garden
- Compressed Natural Gas (CNG) - Logging
- Compressed Natural Gas (CNG) - Oil Field
- Compressed Natural Gas (CNG) - Pleasure Craft
- Compressed Natural Gas (CNG) - Railroad
- Compressed Natural Gas (CNG) - Recreational
- Compressed Natural Gas (CNG) - Underground Mining
- Diesel Fuel - Agriculture
- Diesel Fuel - Airport Support
- Diesel Fuel - Commercial
- Diesel Fuel - Construction
- Diesel Fuel - Industrial
- Diesel Fuel - Lawn/Garden
- Diesel Fuel - Logging
- Diesel Fuel - Oil Field
- Diesel Fuel - Pleasure Craft
- Diesel Fuel - Railroad
- Diesel Fuel - Recreational
- Diesel Fuel - Underground Mining
- Gasoline - Agriculture

Select All Select All Delete

Add Fuel/Sector Combinations

**NonRoad Vehicle Equipment Requirements**

- Compressed Natural Gas (CNG)/Airport Support combination is not in the database.
- Compressed Natural Gas (CNG)/Lawn/Garden combination is not in the database.
- Compressed Natural Gas (CNG)/Logging combination is not in the database.
- Compressed Natural Gas (CNG)/Pleasure Craft combination is not in the database.
- Compressed Natural Gas (CNG)/Railroad combination is not in the database.

Ready...

# Road Type

- Doesn't apply to nonroad
- Click on Road Type in navigation panel to get green check

# Pollutants and Processes

- All needed criteria pollutants are included
  - Limited speciation detail
  - Less differentiation by process than for onroad
- Planning to add toxics next year
  - NMIM can be used for nonroad toxics until then
- Select:
  - Total Gaseous HC
  - Oxides of Nitrogen
  - Primary Exhaust PM<sub>2.5</sub>

# Pollutants and Processes

MOVES - ID 2214896263202995615

File Edit Pre Processing Action Post Processing Tools Settings Help

Description

Scale

Time Spans

Geographic Bounds

Vehicles/Equipment

NonRoad Vehicle Equipment

Road Type

**Pollutants And Processes**

Manage Input Data Sets

Strategies

Output

Advanced Performance Features

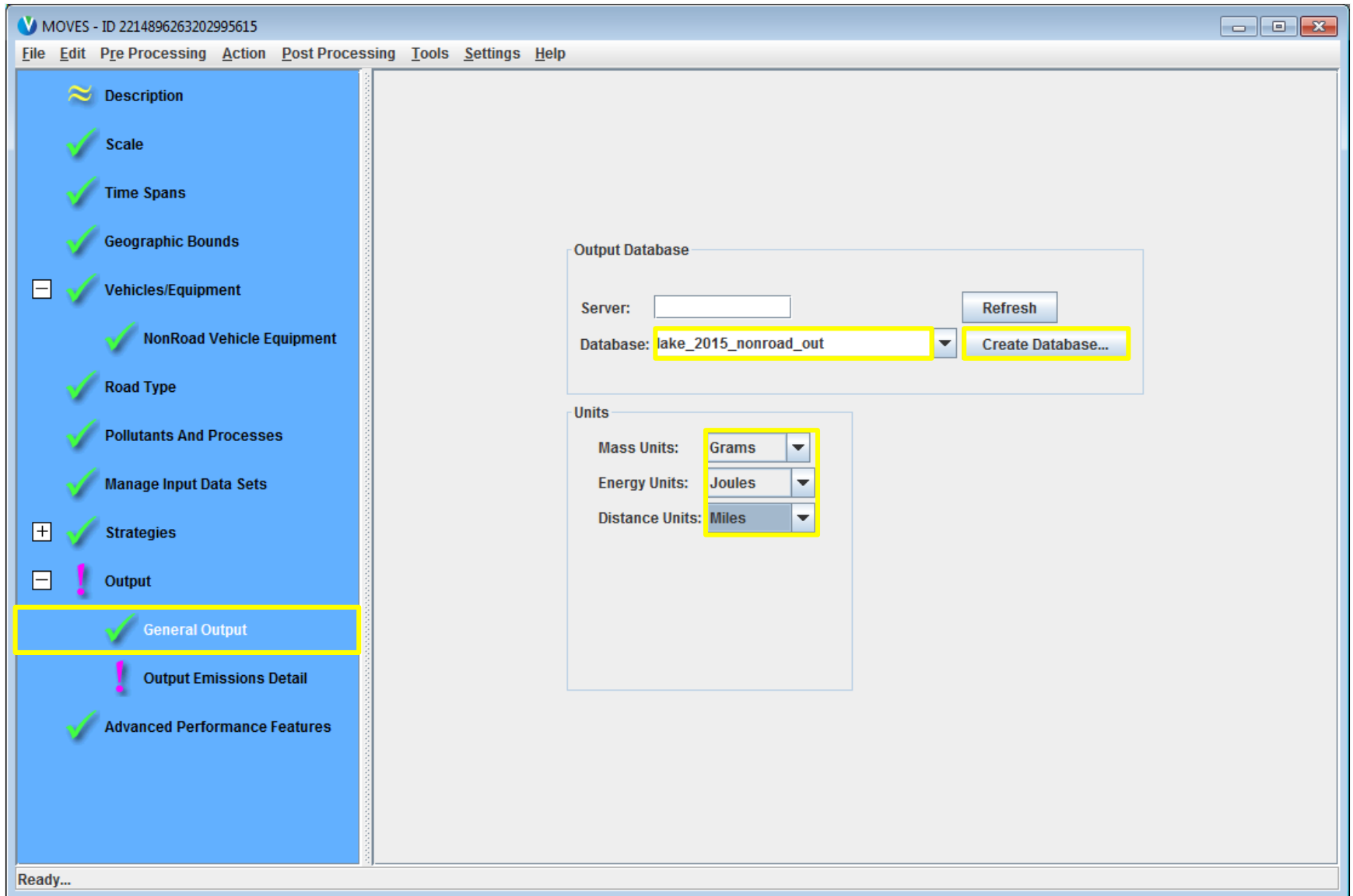
	Running Exhaust	Crankcase Running Exhaust	Refueling Displacement Vapor Loss	Refuel
<input checked="" type="checkbox"/> Total Gaseous Hydrocarbons	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
<input type="checkbox"/> Carbon Monoxide (CO)	<input type="checkbox"/>			
<input checked="" type="checkbox"/> Oxides of Nitrogen (NOx)	<input checked="" type="checkbox"/>			
<input type="checkbox"/> Ammonia (NH3)	<input type="checkbox"/>			
<input checked="" type="checkbox"/> Primary Exhaust PM2.5 - Total	<input checked="" type="checkbox"/>			
<input type="checkbox"/> Primary Exhaust PM10 - Total	<input type="checkbox"/>			
<input type="checkbox"/> Sulfur Dioxide (SO2)	<input type="checkbox"/>			
<input type="checkbox"/> Brake Specific Fuel Consumption (BSFC)	<input type="checkbox"/>			
<input type="checkbox"/> Atmospheric CO2	<input type="checkbox"/>			

Select Prerequisites

Clear All

Ready...

# Output – General Output



# Output – Output Emissions Detail

- All output will be for a 24-hour day
- Currently, all MOVES nonroad output is broken down by:
  - Model year
  - Fuel Type
  - Emission process
  - Engine Technology
  - Horsepower class
- As a result, output tables are very large
  - Output for this example run (one county, three pollutants, all source types) has 312,642 lines
- We will look at using post-processing scripts to manage these files later

# Output – Output Emissions Detail

The screenshot displays the MOVES software interface for configuring output emissions details. The window title is "MOVES - ID 2214896263202995615". The menu bar includes "File", "Edit", "Pre Processing", "Action", "Post Processing", "Tools", "Settings", and "Help".

The left sidebar contains a tree view of configuration categories, with "Output Emissions Detail" highlighted in yellow. The categories are:

- Description
- Scale
- Time Spans
- Geographic Bounds
- Vehicles/Equipment
  - NonRoad Vehicle Equipment
- Road Type
- Pollutants And Processes
- Manage Input Data Sets
- Strategies
- Output
  - General Output
  - Output Emissions Detail**
  - Advanced Performance Features

The main configuration area is divided into several sections:

- Always:** Includes checkboxes for "Time" (set to "24-Hour Day" in a dropdown), "Location" (set to "COUNTY" in a dropdown), and "Pollutant".
- for All Vehicle/Equipment Categories:** Includes checkboxes for "Model Year", "Fuel Type", and "Emission Process".
- Estimate Uncertainty:** A checkbox that is currently unchecked.
- On Road/Off Road:** Includes a checked checkbox for "On Road/Off Road".
- On and Off Road:** Includes checkboxes for "Road Type", "Source Use Type", "SCC", and "Regulatory Class".
- Off Road:** Includes checked checkboxes for "Sector", "Engine Tech.", and "HP Class".
- Number of iterations:** A text input field containing the value "2".
- Keep pseudo-randomly sampled input:** An unchecked checkbox.
- Keep output from each iteration:** An unchecked checkbox.

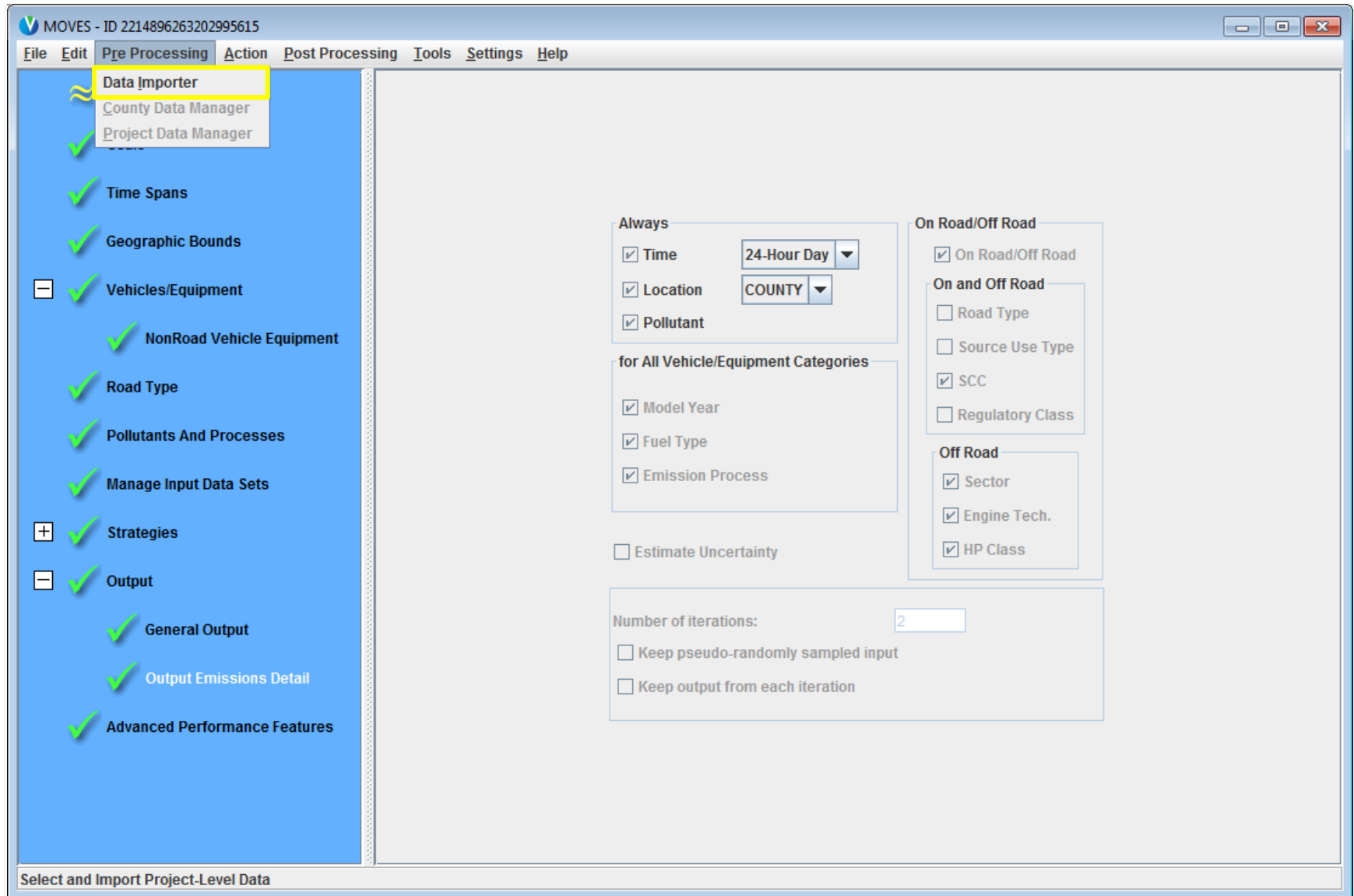
The status bar at the bottom left shows "Ready..."

# Using the Data Importer

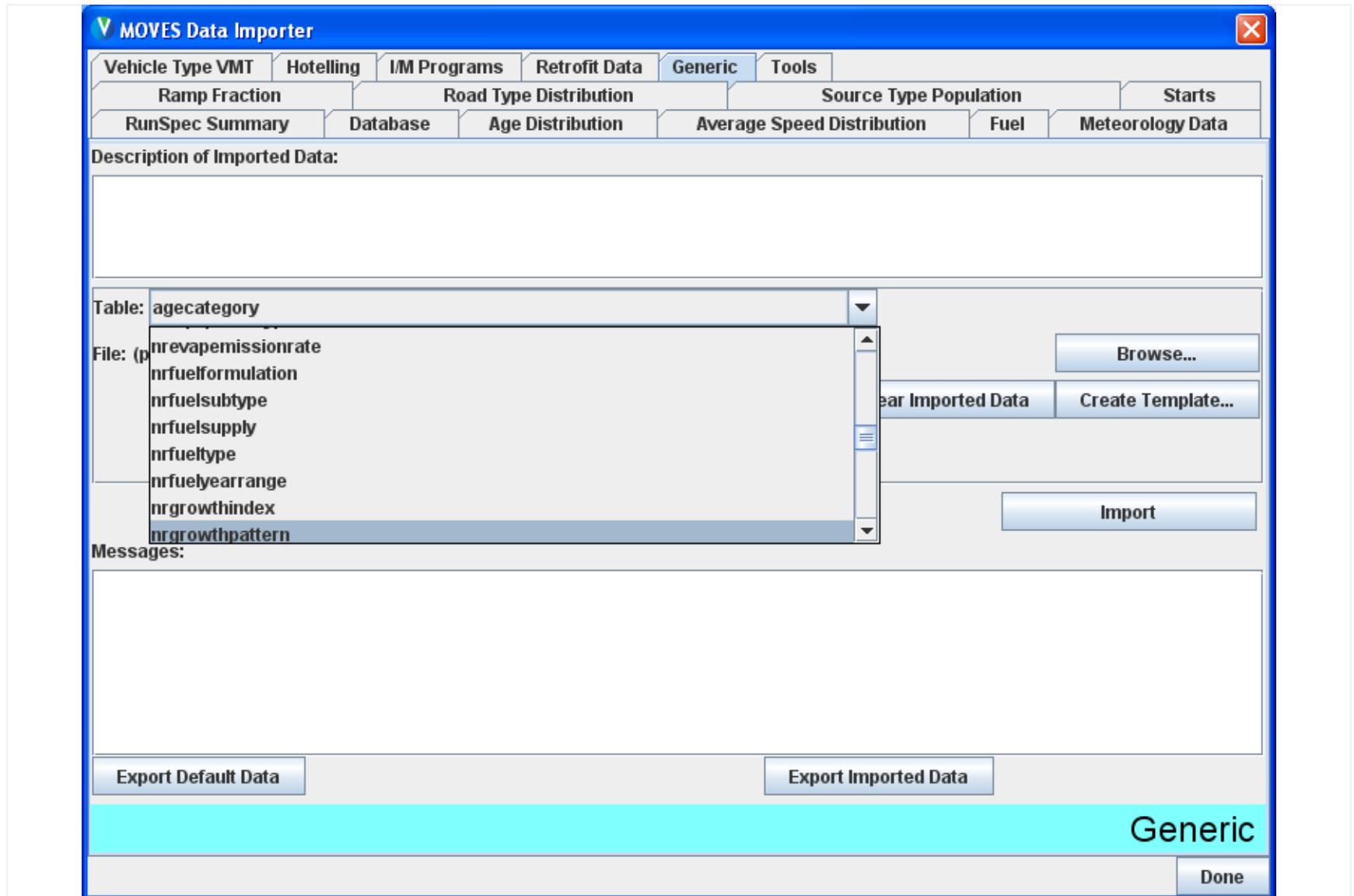
- Access from Pre-Processing menu
- Meteorology Data
  - Nonroad in MOVES uses the same met data table as onroad
    - ZoneMonthHour
    - Use same local temperature data for nonroad and onroad
- None of the other tabs in the data importer work for nonroad except Generic tab
- Generic
  - Provides access to nonroad tables
    - All begin with “nr” (e.g. nrfuelformulation)
  - Consult with EPA before changing nonroad tables



# Using the Data Importer



# Data Importer – Generic Tab



# Using Post Processing Scripts

- Post-processing menu contains scripts to process nonroad output into more manageable forms
- 10 Emission factor scripts
  - Per horsepower/hour, per operating hour, per vehicle
  - Use these to produce emission factors that can be multiplied by locally derived hours of operation or equipment population
- 6 Inventory scripts
  - By county, by equipment type, by sector
  - Use these to consolidate inventory output
- 1 Population script
  - By sector and SCC

# Using Post Processing Scripts

The screenshot displays the MOVES software interface. The title bar reads "MOVES - ID 2214896263202995615". The menu bar includes "File", "Edit", "Pre Processing", "Action", "Post Processing", "Tools", "Settings", and "Help". The "Post Processing" menu is open, showing options: "Run MySQL Script on Output Database", "Run MySQL Script on Nonroad Output Database" (highlighted in yellow), "Produce Summary Report", and "Produce State/County Map".

The left sidebar contains a tree view of settings, all marked with a green checkmark:

- Description
- Scale
- Time Spans
- Geographic Bounds
- Vehicles/Equipment
  - NonRoad Vehicle Equipment
- Road Type
- Pollutants And Processes
- Manage Input Data Sets
- Strategies
- Output
  - General Output
  - Output Emissions Detail
  - Advanced Performance Features

The main configuration area is divided into several sections:

- Always:**  Time (24-Hour Day),  Location (COUNTY),  Pollutant
- for All Vehicle/Equipment Categories:**  Model Year,  Fuel Type,  Emission Process
- Estimate Uncertainty
- On Road/Off Road:**  On Road/Off Road
- On and Off Road:**  Road Type,  Source Use Type,  SCC,  Regulatory Class
- Off Road:**  Sector,  Engine Tech.,  HP Class

At the bottom, there is a section for "Number of iterations:" with a text box containing "2". Below this are two unchecked checkboxes: "Keep pseudo-randomly sampled input" and "Keep output from each iteration".

The status bar at the bottom of the window reads "Run MySQL Script on MOVES Output Database".

# Using Post Processing Scripts

- Run “Inventory by Equipment Type Pollutant”
  - Converts 312,642 line output table to 2047 line file that provides as much emission detail as typically needed
- Emission factor scripts can have very long run times depending on the size of the output database
- If you need emission factors:
  - Only select sectors for which you have appropriate activity data
  - Run MOVES multiple times to get smaller output files
    - One sector, one fuel type, one pollutant at a time
  - Delete source types for which you don’t have activity information from the output file before running the script

# Questions?

