MOVES - NONROAD Model Development :

Overview

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MOVES

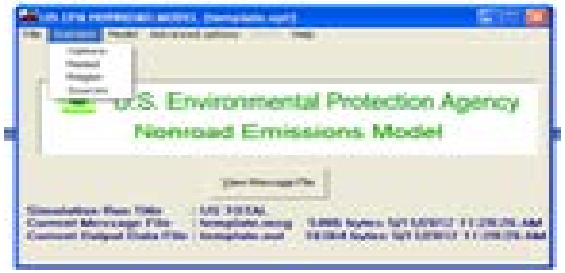
EPA

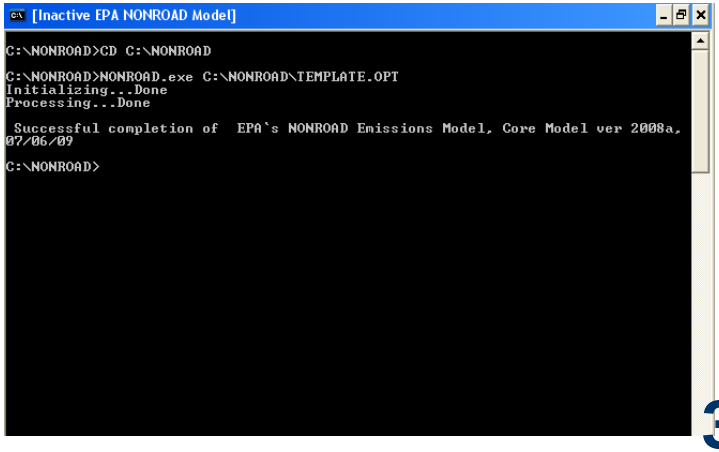
Overview

- NONROAD Model Summary
- Model Outputs
- Software Update

NONROAD2008a Model Summary

- **Used to estimate NONROAD equipment emission inventories in the USA.**
  - EPA Rulemaking Inventories
  - State and Local Usage
- **Geographical scale from county to national**
- **Models major pollutants and processes (exh & evap)**
- **Calendar year coverage 1970 through 2050**
- **Models most equipment types except locomotive, commercial marine and aircraft**





NONROAD Summary (cont'd 1)

- **Equipment Categories / Sectors**
  - Recreational
  - Construction
  - Industrial
  - Lawn/Garden
  - Agriculture
  - Commercial
  - Logging
  - Airport Service
  - Underground Mining
  - Oil Field
  - Pleasure Craft
  - Railroad Service
- **Fuels**
  - Gasoline
  - Diesel
  - LPG
  - CNG

NONROAD Summary (cont'd 2)

- **Development began with the 1991 NEVES Study**
- **Core code and algorithm developed in 1995**
  - Population and activity inputs based on PSR
- **First public version released in 1998**
- **Updated incrementally in 2000, 2002, 2005 and 2008**
- **Coded in FORTRAN95 with a reporting utility coded in Visual Basic 2003**
- **Utilized in EPA National Mobile Inventory Model (NMIM) package**
  - NMIM released in 2005
  - Runs MOBILE6 and NONROAD with a JAVA/MySQL GUI interface
  - Generates county, state and national emission inventories

NONROAD Model

- **NONROAD Emission/Fuel Equation**

- **Emissions = Population * Activity * EmissionFactor * LoadFactor * RatedPower**
  - **Where**
- **Population** >>>> Engine population
- **Activity** >>>> Annual activity (hrs/yr)
- **EmissionFactor** >>>> Emission rate (g/hp-hr)
- **LoadFactor** >>>> Fraction of available power
- **RatedPower** >>>> Average power (hp)

NONROAD Model (cont'd 1)

- **Population**
  - **>>>> Derived from CY 2003 PSR sales/pop data**
    - >>>>> Base Year Population: 1996, 1998, 1999, or 2000
    - >>>>> growth assumptions
    - >>>>> scrappage assumptions
    - >>>>> Snowmobile registration data, Motorcycle Industry Council
- **Activity**
  - **>>>> 1998 PSR database**
    - >>>>> Based on surveys of equipment owners
    - >>>>> Not a function of age
- **LoadFactor**
  - **>>>> Limited transient testing + PSR**
    - >>>> Combines ALL operating modes together
    - >>>> Computed using actual vs maximum fuel consumption
- **Rated Power**
  - **>>>> PSR data**
    - >>>> Categories separated by horsepower bin

NONROAD Model (cont'd 2)

Geographic Allocation >>>> Variety of category specific surrogates

Emission Factors >>>> 1991 NEVES study
California ARB testing
EPA Small Engine Model (1995, 96, 99, 02, 08)
Steady-state testing
Emission standards with compliance margin

Deterioration Factor >>>> $EF * Ef_{new} * DF$

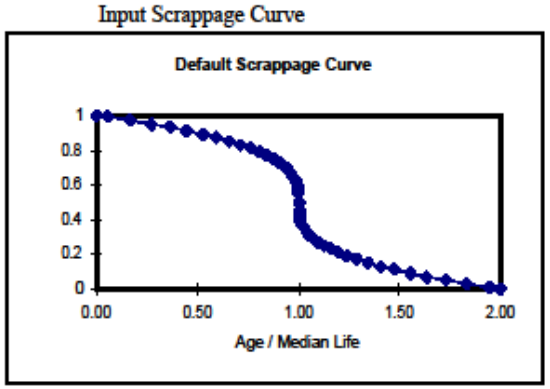
>>>> $DF = 1 + k * (AgeFactor)^{b}$

>>>> AgeFactor = (Activity*LF)/(medlife@full hours)

WEB SITE >>>> http://www.epa.gov/oms/nonrdmdl.htm

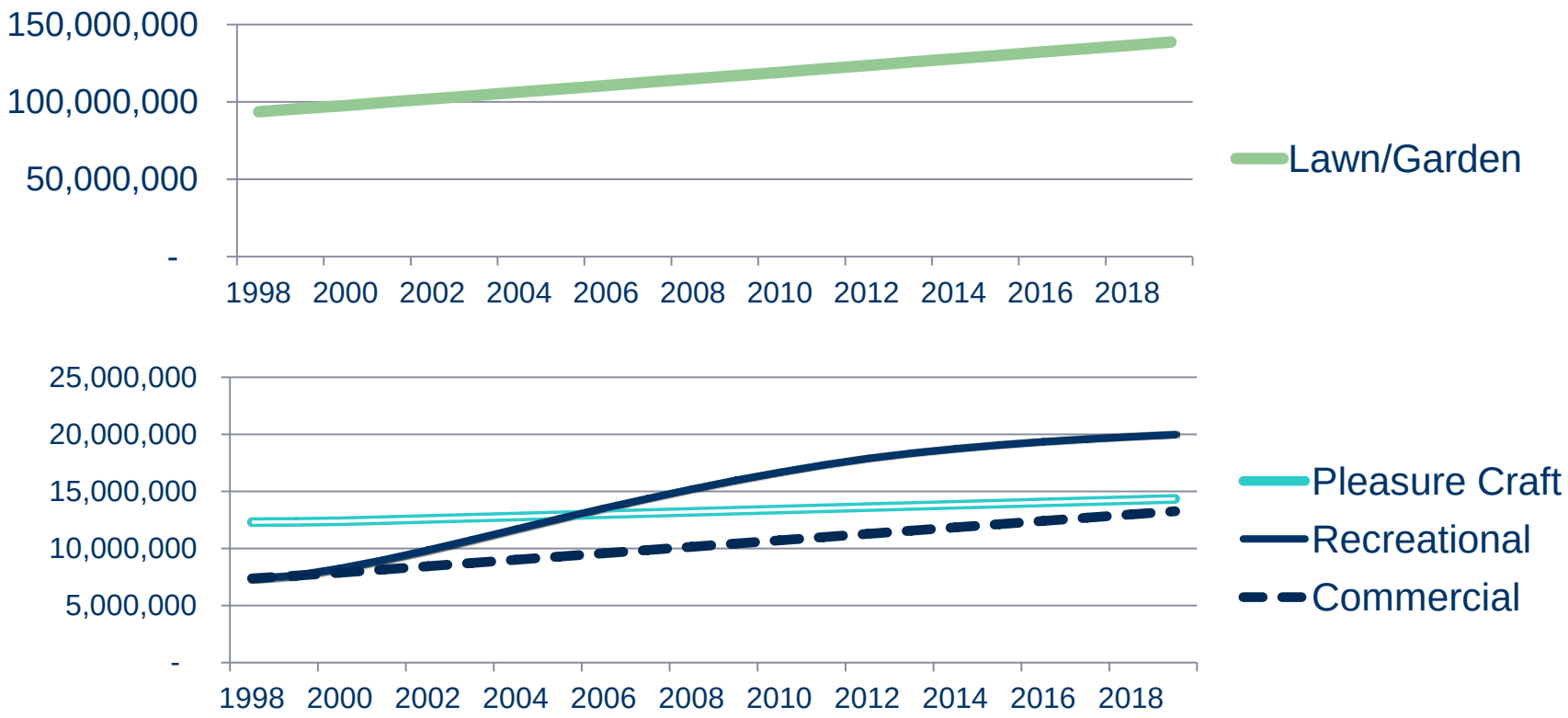
NONROAD Model (cont'd 3)

- **Growth / Scrappage >>>> reverse cumulative normal distribution scrappage curve**

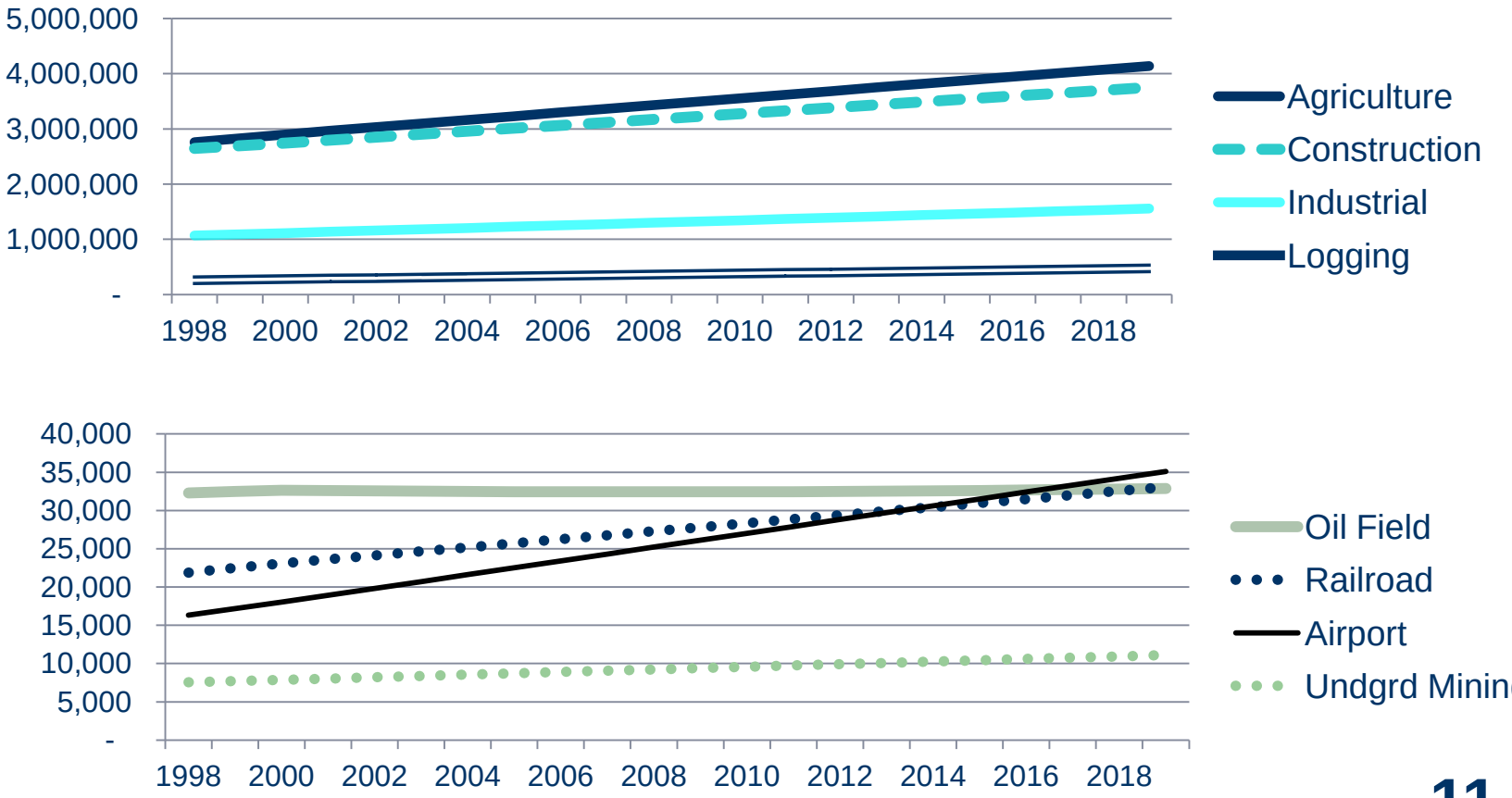


- **Median Lifetime (years) >>>> Median Life (hrs) /(Activity * LF)**
  - >>>> 200 hrs for small gas
  - >>>> 7000 hrs for large diesel
- **Growth: SalesGrw = PopGrw / { [(-1.4306 x PopGrw) x MedLifeYrs] + (-0.24 x PopGrw) + 1.0 }**
- **Growth Factors – Function of equipment type and calendar year – not linear**

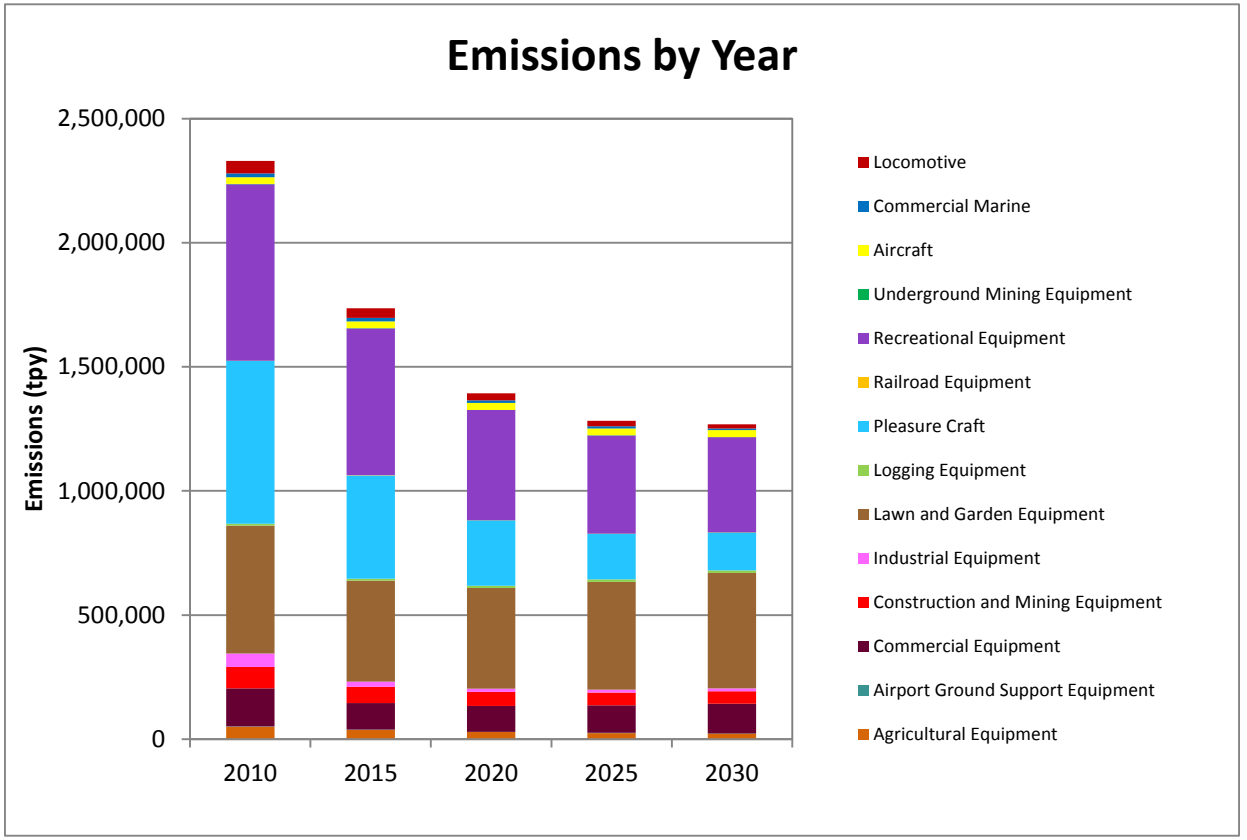
NONROAD Equipment Population by Sector



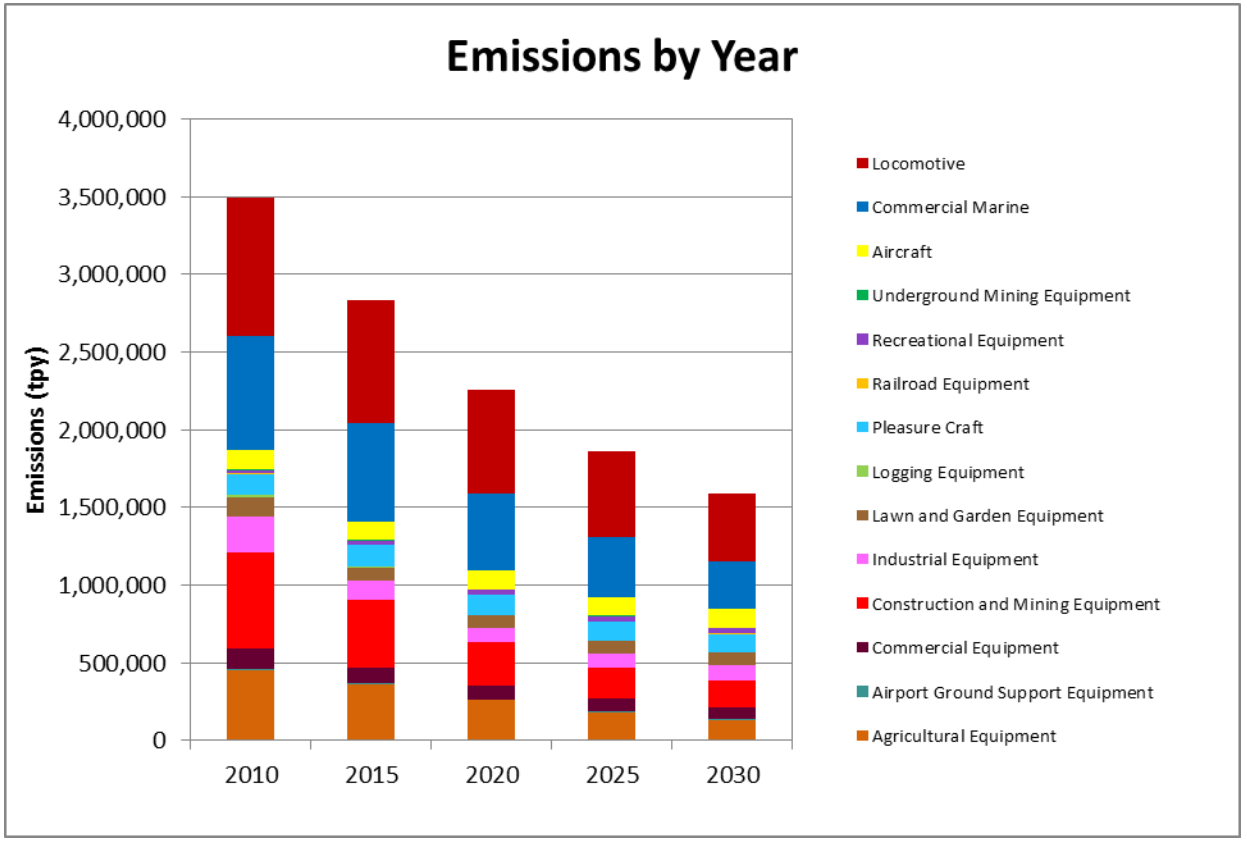
NONROAD Equipment Population by Sector (cont'd)



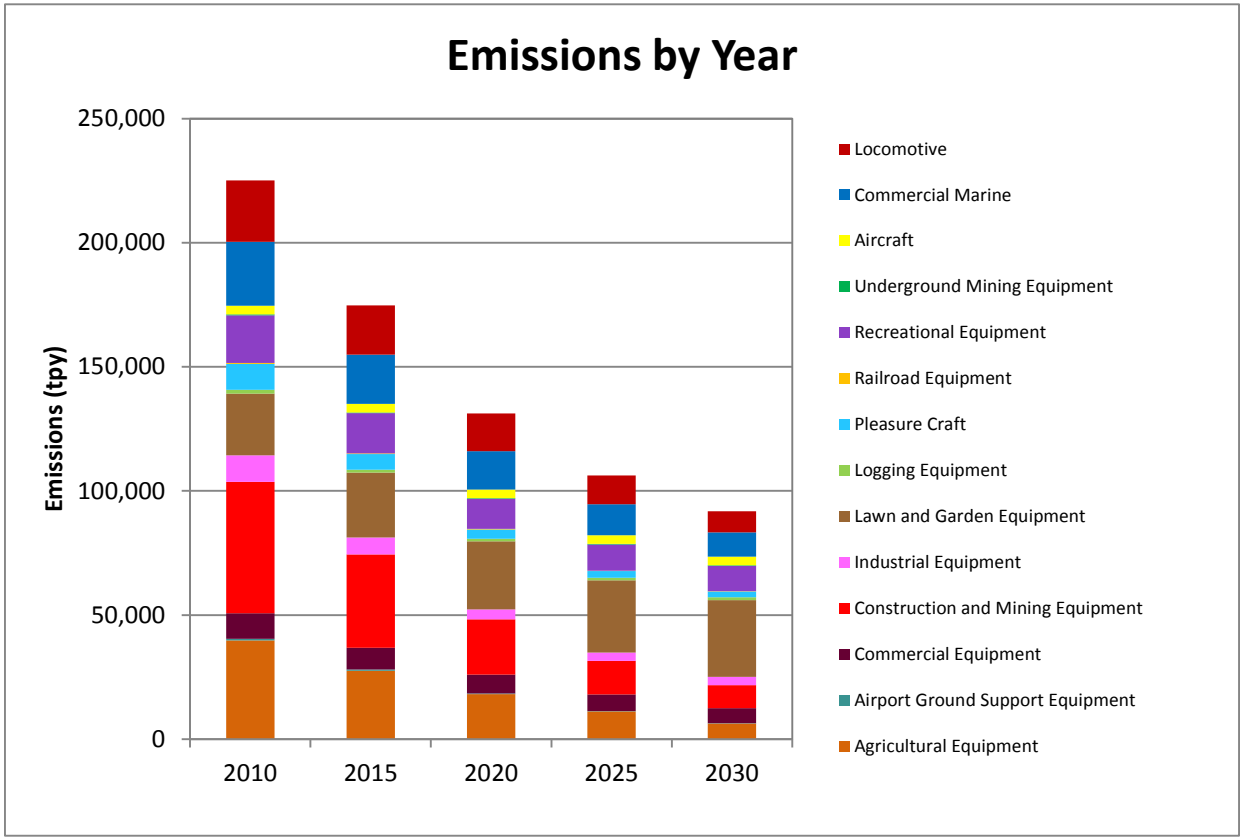
National NONROAD Sector VOC Emissions by Category



National NONROAD Sector NOx Emissions by Category



National NONROAD Sector PM2.5 Emissions by Category



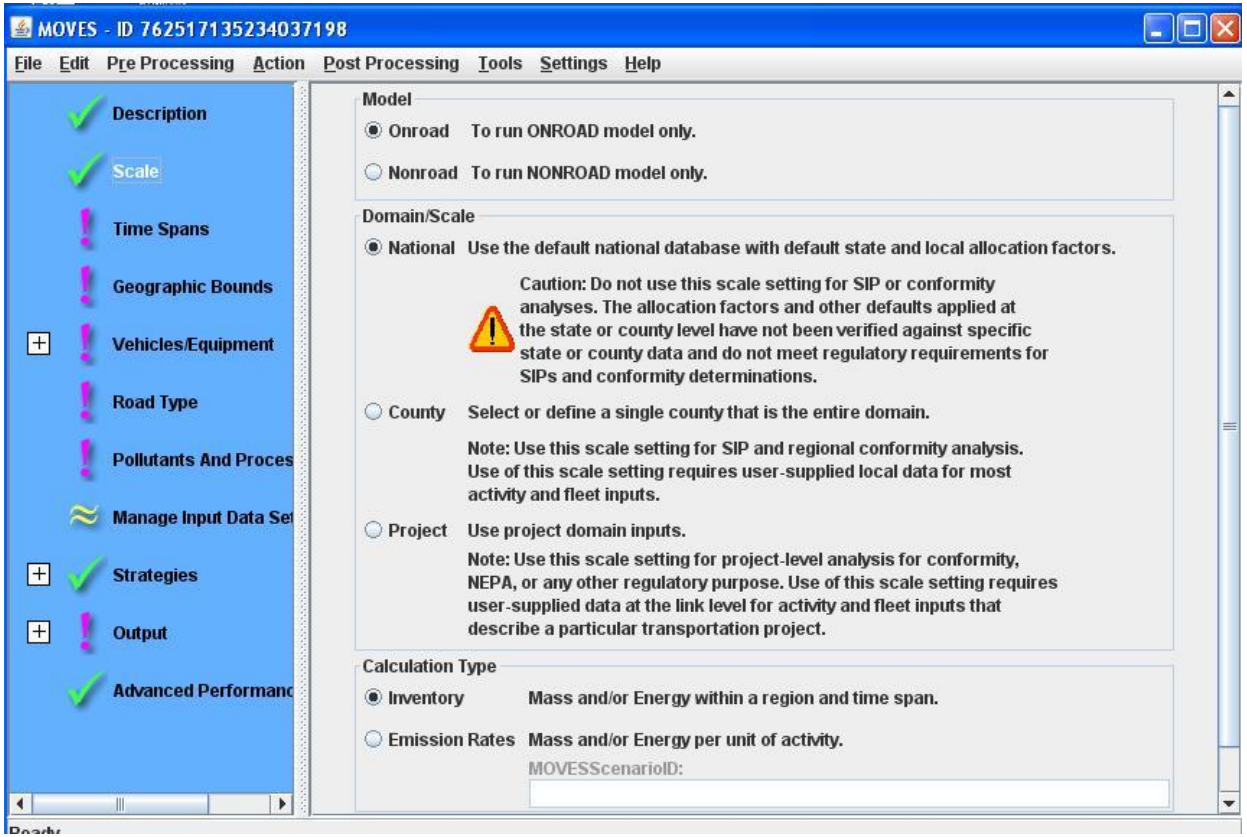
Why Add NONROAD to MOVES?

- **Ease of use**
  - Produce same user interface for on-road and non-road
  - Allow easier input of user data
  - Create consistent highway vehicle and non-road equipment inventories
- **NONROAD software platform is outdated**
  - Doesn't work with current Windows/Linux platforms
  - GUI Interface is limited and inflexible
  - Block data is difficult to edit
  - Programming is highly rigid and difficult to modify

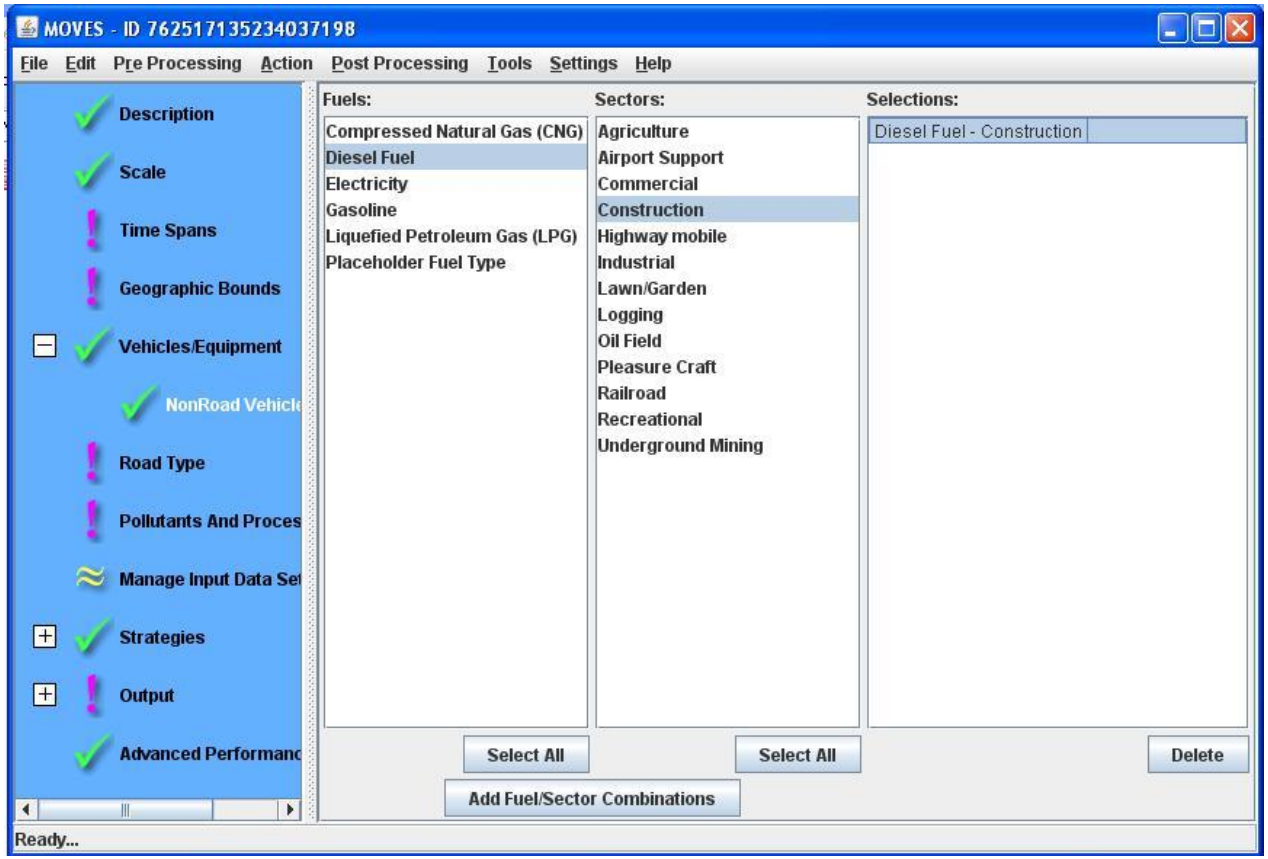
MOVES – NONROAD Software

- **Fully database driven**
  - Emission rates
  - Population / Allocation data
  - Activity
- **User friendly data input**
  - Spreadsheet based
  - Analogous to on-road MOVES input
- **Convenient output of results**
  - Range of disaggregation / aggregation
  - Customized scripts
- **Performance**
  - Similar to current NONROAD model
  - Interactive GUI or batch operation

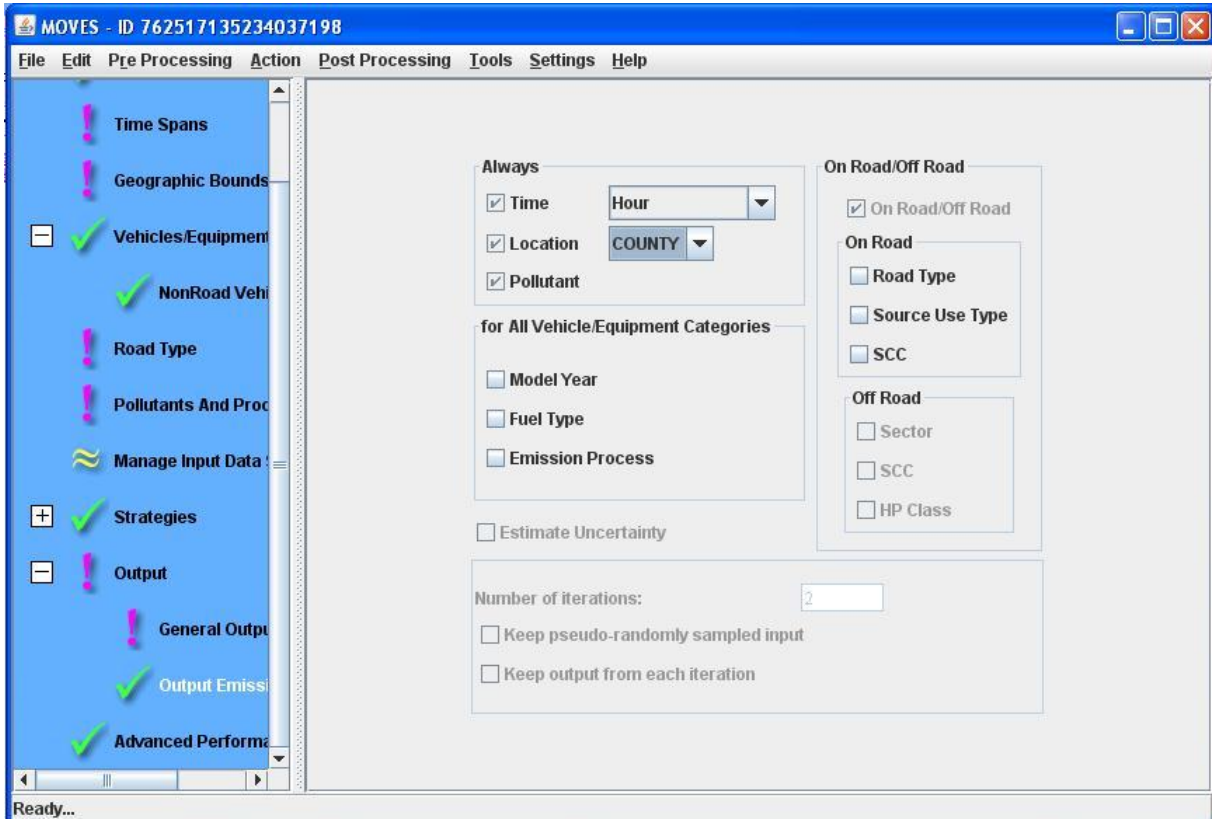
MOVES – NONROAD Scale/Model Screen



MOVES – NONROAD Equipment Screen



MOVES – NONROAD Output Screen



MOVES 2013 Schedule *(for NONROAD)*

- **Insertion of NONROAD Fortran code into the MOVES model**
  - Mostly complete
  - Final debugging and testing
- **Release of NONROAD2008a in MOVES2013 as "draft"**
- **Continue to develop MOVES – NONROAD after release of MOVES2013**