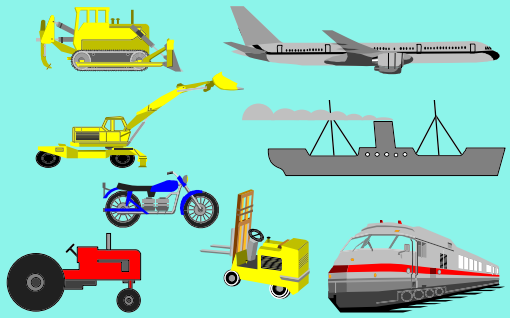
Nonroad Modeling



EPA National Nonroad Emissions Inventory Model (NONROAD)

"Early Feedback" Meeting
September 11, 1997
Chicago

Today's Focus

- Ensure User Needs Met
- Explain Draft Nonroad Model
- Feedback
  - » Model features, function, and inputs
- Identify Information Sources

Agenda

- Part I
  - » Introduction
  - » Inventory News
  - » Model Description
  - » Demonstration
  - » Stakeholder Review
- Part II
  - » Detailed Methodology
  - » Commercial Marine
  - » Default and User Inputs
  - » Wrap Up

Introduction: NONROAD Team

- EPA's Office of Mobile Sources
  - » Assessment and Modeling Divison
    - – Megan Beardsley
    - – Craig Harvey
    - – Greg Janssen
    - – Chris Lindhjem
    - – Rich Wilcox

Introduction: Model Overview

- SIP Tool Principal Focus
- EPA Regulatory Development
- EPA Strategic Planning

Introduction: Model Overview (cont'd)

- Stand Alone *(No User Data Necessary)*
- All Nonroad Sources (*except locomotives and aircraft*)
- Differentiated by Equipment Type and Other Characteristics
- HC, CO, NO_x, PM, SO_x, CO_2

Introduction: Model Overview (cont'd)

- Past, Present and Future Year Inventories
- Temporal Allocation
- Geographic Allocation

Introduction: Schedule

Aug.--Sept. 1997	Early Feedback Complete Model (Alpha version) Continue Gathering Input Data
Oct.--Dec. 1997	In-house Model Testing Prepare and Document Inputs Complete User's Guide
Jan.–Mar. 1998	Beta Testing/Peer Review Comment Period
Apr.–Jul. 1998	Finalize Model
Aug. 1998	Model Release

Questions???

Inventory News

- Nonroad Diesel Inventories Rising
  - » National inventories may substantially increase (*preliminary*)
- Why?
  - » Updated database has more equipment
  - » Added generator sets, pumps, compressors, and welders 50-500 hp (*stationary/mobile split issues*)

Inventory News (cont'd)

- » Methodology improved for agricultural tractors
- » Added new equipment categories
  - – AC/refrigeration, irrigation sets, underground mining, oil field equipment and railway maintenance
- » Added CNG and LPG engines

Questions???

General Description: Equipment Types:

- Airport service
- Agricultural
- Construction
- Industrial
- Recreational
- Lawn & garden
- Light commercial
- Logging
- Recreational marine
- Commercial marine

(*more than 80 basic and 260 specific categories*)

General Description: Pollutants Reported

- HC *(THC, TOG, NMOG, NMHC, VOC)*
- Non-exhaust HC by Mode *(hot soak, diurnal, refueling, running loss, resting loss, crankcase)*
- NO_x
- CO
- CO_2
- SO_x
- PM *(PM_{tot} , PM_{10}, $PM_{2.5}$)*

General Description: Geographic Coverage

- State
- County
- Option to add sub-county data for nonattainment area analysis.

General Description Temporal Coverage

- Estimates of past, present and future year emissions
- Annual, seasonal, monthly, or daily emissions.
- Daily emissions distinguished by season and weekday/weekend.

General Description: Model Structure

- User Interface (Visual Basic)
  - » Scenario definition
- Core Model (Fortran)
  - » Calculations
- Reporting Utility (Microsoft Access)
  - » Output content selection

General Description: Hardware / Software

- Minimum: 486 with 16MB RAM
  (core model will run separately with 8MB)
- DOS, Win 3.1 or Win 95
- MS ACCESS not required

General Description: Inputs

- User Selected:
  - » Year
  - » Temporal Period
  - » Geographic Area
  - » Equipment Types
  - » Fuel Characteristics
  - » Altitude

General Description: Defaults Provided

- » Equipment Populations
- » Temporal Allocation
- » Geographic Allocation
- » Load Factors
- » Equipment Useage
- » Emission Factor
- » Growth Factors
- » Scrappage Factors
- » Emission Deterioration Factors

Questions???

Demonstration: Output Options

- ASCII File
- Pre-formatted ACCESS Reports
  - » Access not required
- ACCESS database
- Excel Spreadsheet

Demonstration: Report Options

- By County
- By Source Category
- By Equipment type/code
- By Horsepower

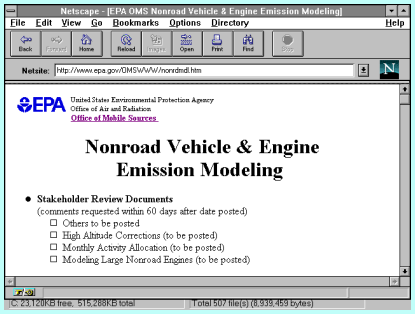
NONROAD Demonstration

(Note: Emissions based on preliminary inputs)

Stakeholder Review

- Electronic Information Sources
  - » Listserver
    - – Technical Memos
    - – Meeting Announcements
  - » Web Site: http://www.epa.gov/omswww/nonrdmdl.htm
  - » Email: nonroad-group@epamail.epa.gov

Stakeholder Review



Stakeholder Review

- MOBILE Workshop
  - » October 1 & 2, Ann Arbor
- NONROAD Workshop
  - » Mid-January 1998, Ann Arbor
- Beta Testing/Comment Period
  - » January-March 1998

Questions???

Step-by-step Methodology: General Calculation

Multiply Various Estimates

- Base year equipment population (distributed by age, power, fuel type, and application)
- Grow base year population to future years
- Average load factor in % of available power on average
- Activity in hours of use per year
- Emission factor with deterioration or new standards
- Geographic and temporal allocation

Step-by-step Methodology: Specific Calculation

- Statewide Calculation
  - » Grams/year = # * Power * LF * Activity * EF
    - – # - Engine Population
    - – Power - Average maximum power
    - – LF - Load Factor (fraction of max. power)
    - – Activity - Hours/year
    - – EF - Emission factor in grams per work unit

Step-by-step Methodology: Example

Example:

1995 Annual Emissions from Concrete\Pavement Saws in Suffolk CO., MA

Step-by-step Methodology : Population

- Population given as statewide by application and by power level
  - » Total 11-25 hp 4-stroke concrete\pavement saws in Mass. in 1995

Step-by-step Methodology : Allocation

- Geographic allocation to county
  - » Several options which will be discussed later (i.e. human pop. and land area)
  - » Saws, like other construction equipment, use human population in the current data file

Step-by-step Methodology: Activity

- Activity by power level and fuel type (2-stroke gas, 4-stroke gas, diesel, CNG, LPG)
  - » Saws have one activity for all regions and power levels but activity differs by fuel type

Step-by-step Methodology: Load

- Load factor by power level and fuel type
  - » Saws have one load factor for all regions and power levels though different for fuel types

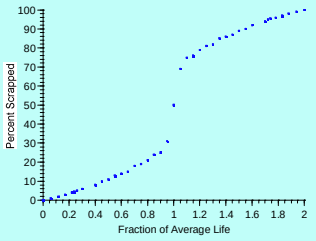
Step-by-step Methodology : Average Life

- Expected average life
  - » Average Life is given as hours at full load and calculated to determine years
    - – Average life (years) = AL (hrs)/ (LF * Hrs/year)

Step-by-step Methodology : Age Distribution

- Age distribution & scrappage
  - » Distribution and scrappage are functions of expected average life

Step-by-step Methodology : Scrappage Function



Step-by-step Methodology : Growth Methodology

- Growth is estimated by multiplying the current year engine population by the ratio of the growth indicator for the subsequent and current year
- Current indicator for saws is human population. Future indicator will be BEA's $Gross State Product for construction

Step-by-step Methodology : Growth Methodology

- Previous year's engines are scrapped by one additional year
- Next year's sales is the sum of that year's scrapped engines plus that needed to bring the engine population to the total calculated previously

Step-by-step Methodology : Growth Methodology (sample)

1995 In-Use Population

Model Year	*Pop.*
1995	*10*
1994	*9*
1993	*8*
1992	*5*
1991	*2*
1990	*1*
Total	*35*

1 One year Scrapped

2 3% Growth

1996 In-Use Population

Model Year	*Pop.*
1996	*11*
1995	*9*
1994	*8*
1993	*5*
1992	*2*
1991	*1*
Total	*36*

3 Calculate New Sales

Step-by-step Methodology : Technology Types

- Technology types define fraction of a model year's engines of a certain style (i.e. 4-strokes with and without catalyst)
  - » One technology type for pavement saws (still have 2 & 4-stroke gas and diesel separate)
- For future standards, technology types are predicted to be important

Step-by-step Methodology : Technology Types

Hypothetical Example

Equipment	Fuel/Cycle	Horsepower	Year	Tech1	Tech2
Pavement Saw	Gasoline 4-Stroke	11-25 HP	1995	100%	0
Pavement Saw	Gasoline 4-Stroke	11-25 HP	2010	50%	50%

Step-by-step Methodology: Emissions Factors

- Emission factors can be differentiated by technology type, power level, and model year
  - » Pavement saws have one emission factor
- Deterioration, if it exists, is calculated as a function of average life and is a multiple of the zero-hour emission rate

Step-by-step Methodology: Corrections

- Variety of Corrections
  - » Fuel corrections (oxygen, sulfur (PM and SOx only), RVP)
  - » Altitude
  - » Temperature

Questions???

Special Case Methodolgies: Marine Module

- 13 well-characterized ports
  - » 5 large ocean ports
  - » 2 typical international ocean ports
  - » 2 typical domestic ocean ports
  - » 2 river ports
  - » 2 lake ports

Special Case Methodolgies: Marine Module

- Detailed Ship Activity
  - » Vessel Power and Type
  - » Number of Trips
  - » Time in Mode
    - – Mode = Cruising, Maneuvering, and Hoteling

Special Case Methodolgies: Marine Module

- Model calculates emissions/port
- User specifies a port
- Model matches a given port with a well-characterized port of a similar vessel mix and scales the size by total tonnage

Special Case Methodolgies: Marine Module

- For vessel categories and load by mode, model will calculate by mode:
  - » Emissions by Vessel Category and Mode = Emission Rate$_{(ship\ type,\ mode)}$ * Hours$_{(mode)}$ * Load$_{(mode)}$ * # Ship Type * # Trips

Questions???

Potential User-Supplied Data Files

- Baseline Population
  - » Geographic Allocation
- Temporal Allocation
- Equipment Population Growth Factors
- Interdependent Inputs
  - » Equipment Populations
  - » Activity in Hours/year
  - » Load Factor
  - » Average Lifetime
- Emission Factors (with deterioration)

Geographic Allocation

- Planned default allocation to county by county/state ratio of appropriate business indicator. (Though the current version uses land area and human population)
- Option for user specified inputs.

Geographic Allocation
(page one of two)

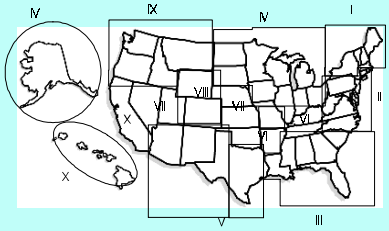
Nonroad Equipment Category	One Planned County Allocation Indicator (All SIC indicators from US Census County Business Patterns.)
Lawn and Garden	Single family housing units (SFHU) for residential. Landscape and horticultural services (SIC 78) employees for commercial.
Construction	Construction (SIC 15) employees
Recreational	Motorcycle Dealer establishments (SIC 557), or Automotive Dealers and Service Station employees (SIC 55) if SIC 557 data not available.
Agricultural	Agricultural Services (SIC 07) employees, adjusted to exclude Landscape and Horticultural Services (SIC 78).

Geographic Allocation
(page two of two)

Nonroad Equipment Category	One Planned County Allocation Indicator (All SIC indicators from US Census County Business Patterns.)
Industrial	Manufacturing (SIC 20) employees
Light Commercial	Wholesale (SIC 50) establishments.
Logging	Lumber and Wood Products (SIC 24) employees.
Recreational Marine	Ratio of county water surface area to total state water surface area. U.S. Census data used for water surface area. Recreational boat usage assumed to be no more than 1 mile offshore for emission allocation. Contract work being done to fine tune this method or find a better one.

Temporal Allocation (Month)

- From NEVES and CARB; Peculiar to the given region and given as a fraction of yearly use



Temporal Allocation (Day)

- From NEVES and CARB
  - » fraction of weekly emissions
  - » specific to the application
  - » either average weekday or weekend day

Growth Indicator

Engine Application	BEA Growth Indicator
Recreational, Lawn & Garden	Human Population
Agricultural	$GSP Farm
Construction	$GSP Construction
Industrial, Commercial	$GSP Manufacturing
Logging	$GSP Lumber & Wood
Airport Service Equipment	$GSP Transportation by Air
Railway Maintenance	$GSP Transportation by Rail
Mining	$GSP Mining
Oil Field Equipment	$GSP Oil & Gas

Other indicators, such as fuel consumption for the construction and agricultural sectors, show much higher growth rates.

Equipment Population

- Power Systems Research (PSR) estimates statewide equipment population on the basis of sales, average use, and manufacturer's estimated engine life
  - » Estimates are verified with selected surveys of equipment populations

Activity and Load Factor

- Power Systems Research (PSR) estimates hours/year and load factor based on surveys of equipment operators

Average Life of Engine

- For CARB, Energy and Environment Analysis (EEA) estimated average life of the engines by power and fuel type

Emission Factors

- Mostly from 1991 NEVES
- Currently conducting measurements and reviewing emission factor studies to modify as appropriate
- Will provide emission factors for newly regulated equipment

Questions???

Wrap Up

- Questions?
- Suggestions?