Chapter 1   ***Introduction***

Air pollution in the United States results from the emission of a wide variety of manmade and natural pollutants such as volatile organic compounds (VOC) , nitrogen oxides (NO$_X$), air toxics, and particulate matter (PM). Under the Clean Air Act, the U.S. Environmental Protection Agency (EPA) is given specific responsibilities to reduce the emissions of pollutants from a range of sources in order to provide clean and healthy air in the United States.

Generally speaking, the EPA classifies anthropogenic (manmade) emissions into three broad categories, mobile, stationary (point), and area sources. Mobile source emissions are further disaggregated into on-road (e.g., cars, trucks, and motorcycles) and nonroad emission categories. Because of the significant contribution of nonroad emission sources to the total mobile source emission inventory, it has become critical over the past several years for the EPA to provide state and local pollution control agencies with the ability to easily create and project accurate, reproducible inventories of nonroad emissions to satisfy the specific requirements of the Clean Air Act Amendments of 1990.

Nonroad emissions result from the use of fuel in a diverse collection of vehicles and equipment, including vehicles and equipment in the following categories:

- recreational vehicles, such as all-terrain vehicles and off-road motorcycles;
- logging equipment, such as chain saws;
- agricultural equipment, such as tractors;
- construction equipment, such as graders and back hoes;
- industrial equipment, such as fork lifts and sweepers;
- residential and commercial lawn and garden equipment, such as leaf and snow blowers;
- recreational and commercial marine vessels, such as power boats and oil tankers;
- locomotive equipment, such as train engines; and
- aircraft, such as jets and prop planes.

With the exception of aircraft, all categories of nonroad vehicles and equipment were unregulated by the EPA prior to the mid-1990s.

In a report issued by the EPA in 1991[1], the agency reported that nonroad vehicles and equipment were a significant source of VOC, NO_x , and PM emissions. The report showed that in some areas of the country, nonroad emissions contributed to as much as a third of the total mobile source NO_x and VOC inventory and over two-thirds of the mobile source PM inventory.

To assist states and local regulatory agencies in the creation of accurate nonroad emission inventories, the EPA has developed a national nonroad emissions model. This document describes the draft version of the model now available.

OVERVIEW OF THE NATIONAL NONROAD EMISSIONS MODEL

Equipment Types

The draft version of the nonroad emissions model predicts emissions for all nonroad equipment categories listed above with the exception of commercial marine, locomotive, and aircraft emissions; future model updates will include modules for estimating emissions from those sources. The model includes more than 80 basic and 260 specific types of nonroad equipment, and further stratifies equipment types by horsepower rating. Fuel types include gasoline, diesel, compressed natural gas (CNG), and liquefied petroleum gas (LPG).

Pollutants Reported

The NONROAD model estimates emissions for six exhaust pollutants: hydrocarbons (HC), NO_X, carbon monoxide (CO), carbon dioxide (CO_2), sulfur oxides (SO_X), and PM. The user selects among five different types for reporting HC — as total hydrocarbons (THC), total organic gases (TOG), non-methane organic gases (NMOG), non-methane hydrocarbons (NMHC), or volatile organic compounds (VOC). Particulate matter can be reported as total PM, PM of 10µ or less (PM_{10}), or PM of 2.5µ or less ($PM_{2.5}$). The model also estimates emissions of non-exhaust HC for six modes — hot soak, diurnal, refueling, resting loss, running loss, and crankcase emissions. All emissions are reported as short tons (i.e., 2000 lbs).

Geographic and Temporal Coverage

In each run of the model, the user selects what geographic area(s) are to be included. At the broadest level, the model estimates national total emissions. More commonly users will specify emissions by state, or for one or more counties within a state. At the most detailed level, the user can estimate sub-county emissions; however, this is an advanced feature and the user must

---

[1]EPA, *Nonroad Engine and Vehicle Emission Study*, EPA-21A-2001, November 1991.

supply sub-county input data. Thus the model is capable of estimating emissions for nonattainment areas which may consist of multiple counties or sub-counties in one or more states.

The NONROAD model can estimate current year emissions for the specified geographic area as well as project future year emissions and backcast past year emissions. In estimating future year projections and in backcasting, the model includes growth and scrappage rates for equipment in addition to a variety of control program options. The model can calculate emissions for a variety of time periods — an entire year, one of four seasons, or any particular month. Emissions for the period selected are estimated either for the total period or for a typical day (weekday or weekend) in that period.

Model Components

As shown in Figure 1-1, the NONROAD model consists of three separate components: a graphical user interface written in Visual Basic, the core model written in Fortran, and a reporting utility written in Microsoft ACCESS. The install utility supplied easily installs all three components of the model onto a personal computer.

The primary purpose of the user interface is to provide the user with an easy method to specify the options for a model run. With simple Windows-type menus and pull-down screens, the user can quickly set up, execute, and view a modeling scenario. Once the model options are specified, the user can then run the Fortran core model from within the interface, and then can move directly to the reporting utility to view and summarize the modeling results.

The core model of NONROAD, written in Fortran, contains all of the algorithms used by the model for calculating emissions estimates. The core model can be operated as a stand-alone application; however, as a stand-alone application it requires some basic knowledge of the DOS operating system. Also, note that while the user interface runs the core model for one specified set of conditions, it cannot run multiple runs in batch mode. Multiple runs can be performed by creating and running a batch file in DOS or in a DOS window in a Windows 3.1 or 95 environment.

The reporting utility, written using Microsoft's ACCESS database software, is used to create standardized reports using output data generated in the core model. Like the graphical user interface, the reporting utility is a fully operational Windows program, with pull-down menus, designed as a separate module in order to take advantage of the many reporting and formatting options available when using a database application. Although the reporting utility is written in ACCESS, it is a stand-alone application, and you do not need to know how to use ACCESS to generate reports.

Figure 1-1. NONROAD MODEL FLOWCHART
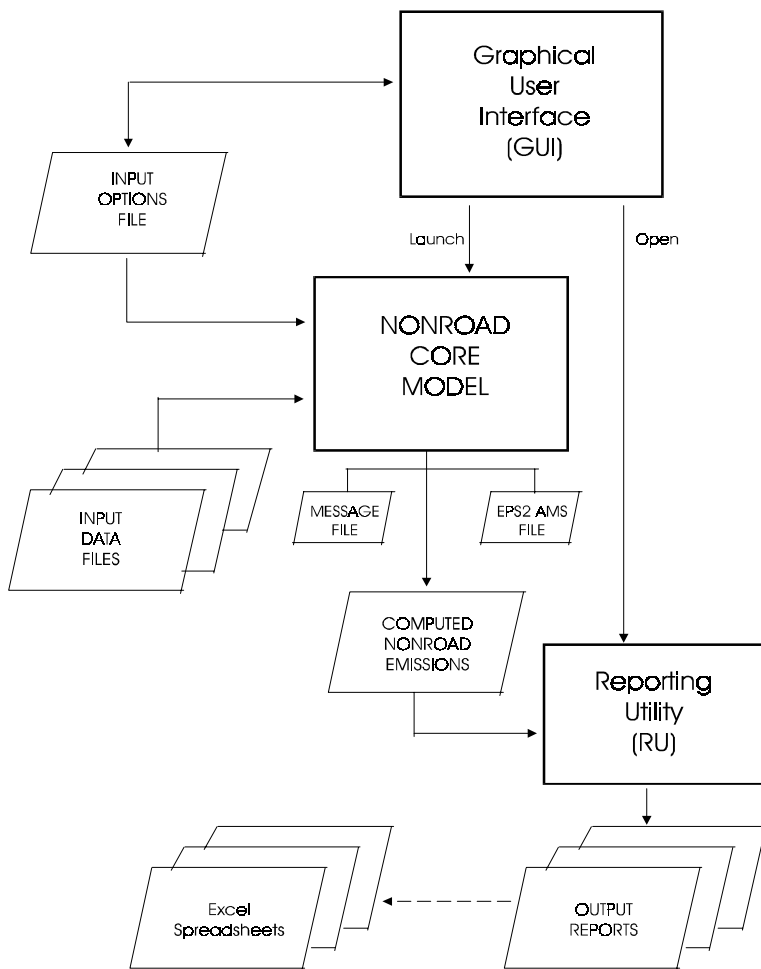
GUI: Visual Basic program used to easily modify core model input options file, launch the core model, and open the reporting utility.

Core Model: Fortran program which computes nonroad emissions. Reads numerous data files and writes ASCII output files.

RU: Microsoft ACCESS program with pull down menus to allow easy reporting of core model results.

The reporting utility provides the user with eight types of standard reports:

- Emissions Totals by County
- Emissions Totals by Equipment Type
- Emissions Totals by Horsepower
- Emissions Totals by SCC (source category code)
- Emissions Totals by SCC and Horsepower
- Emissions Totals by Source Classification
- Population and Fuel Consumption by SCC
- Population and Fuel Consumption by SCC and Horsepower

For most reports, emissions can be reported for either all counties or for a single, user-specified county. Reports that include emissions estimates by equipment types or by SCC are separated by major source classification (e.g., agricultural, lawn and garden), with subtotals provided for each classification. For those reports, equipment type descriptions are also included (e.g., "2-wheel tractors", "asphalt pavers", etc.). Where appropriate, reports also include a grand total by pollutant.

In addition to generating and viewing standardized reports from single model runs, the reporting utility provides the user the ability to compare the results of two separate model runs. The current version of the reporting utility has standardized reports for comparing two model runs by

- Emissions Totals by SCC,
- Emissions Totals by Source Classification,
- Emissions Totals by Horsepower and Source Classification, and
- Population and Fuel Consumption by SCC.

For the emissions totals comparisons, the report displays the results of the two model runs, and the absolute and percent difference between the two model runs. For the population and fuel comparisons, the report displays only the results of the two model runs side by side. The comparison reports are useful, for example, to compare emissions from present and future year projections, or to compare emissions with two different future year control programs.

Model Inputs

The NONROAD model estimates emissions for each specific type on nonroad equipment by multiplying the following input data estimates:

- Equipment population for base year (or base year population grown to a future year), distributed by age, power, fuel type, and application;

- Average load factor expressed as average fraction of available power ;

- Activity in hours of use per year; and

- Emission factor with deterioration and/or new standards.

The emissions are then temporally and geographically allocated using appropriate allocation factors.

There are several input files that provide necessary information to calculate and allocate emissions estimates. These input files correspond to the basic data needed to provide the calculations: emission factors, base year equipment population, activity, load factor, average lifetime, scrappage function, growth estimates, and geographic and temporal allocation. Default values are provided for all input files. The user can replace the default data files when better information becomes available, either from EPA for national defaults or from local sources for locality-specific data. The input files are also modified to test control strategies.

Output Options

Output from the core model is an ASCII file, which can be imported directly into the reporting utility by simply specifying the file name. The reporting utility can then be used to generate the standardized reports; users with ACCESS can generate their own reports or query the emissions estimates and other output from the model. The ASCII file can also easily be imported into an Excel or Lotus spreadsheet for those users who prefer spreadsheet applications, or wish to generate graphs of model output. In addition, the reporting utility has a feature that allows users to easily output an Excel file of data in a tabulated report; Excel can then be used to graph the tabled results.

Lastly, the user also has the option to generate an Emission Pre-Processor System 2 (EPS-2) input file. EPS-2 is a program, available on EPA's Web site or bulletin board, that can take the county-level output from the NONROAD core model and create gridded emissions files ready for input to the Urban Airshed Model (UAM), a photochemical grid model.

TECHNICAL DOCUMENTATION

Technical documentation of the default model inputs may be found at the EPA's Office of Mobile Sources (OMS) web site for nonroad modeling:

> **http://www.epa.gov/omswww/nonrdmdl.htm**

The documents can be downloaded as either Adobe Acrobat PDF files or as WordPerfect files. If you obtained the model from a CD-ROM rather than downloading it from the web site, the technical documents are included on the CD-ROM.

As of the release date for the draft version of the model, the following technical documents are available:

- Nonroad Engine Growth Estimates (NR-008)
- Exhaust Emission Factors -- Spark-Ignition (NR-010)
- Calculation of Age Distributions -- Growth and Scrappage (NR-007)
- Basic Evaporative and Crankcase Emission Rates (NR-012)
- Exhaust Emission Factors -- Compression-Ignition (NR-009)
- Nonroad Engine Population Estimates (NR-006)
- Average Life, Annual Activity, and Load Factor Values (NR-005)
- Seasonal and Monthly Activity Allocation Fractions (NR-004)
- HC Conversion Factors: VOC/TOG/ROG/etc (NR-002)
- Exhaust Emission Effects of Fuel Sulfur and Oxygen on Gasoline Nonroad Engines (NR-003)
- RVP and Temperature Corrections (NR-001)

Four additional technical documents will be posted on the web site when available:

- Geographic allocation factors
- Emissions deterioration factors
- Refueling emissions
- Weekday/weekend allocation factors

Also currently available on the web site are numerous review documents, papers, and presentation materials.

For answers to specific questions on the nonroad model and model inputs, or to make comments or suggestions, email the nonroad inventory model team at:

nonroad@epamail.epa.gov

FUTURE MODEL UPDATES

The current version of the NONROAD model does not include the following categories of equipment:

- commercial marine vessels, such as power boats and oil tankers;
- locomotive equipment, such as train engines; and
- aircraft, such as jets and prop planes.

Emissions for commercial marine vessels are anticipated to be included in the final model release in late 1998. Emissions for locomotive equipment and aircraft are anticipated for later updates of the model.

An additional feature that is expected to be included in the final release in late 1998 is graphical output in the reporting utility for display of output from a single run and comparisons from two runs.

Note: The EPA NONROAD modeling team is very interested in receiving comments on the draft version of the model and suggestions for future model revisions and enhancements. Email your comments and suggestions to the team at   nonroad@epamail.epa.gov

All updates to the model will be announced on and available from the OMS nonroad modeling web site.

TO STAY INFORMED

For the latest news on the NONROAD inventory model, subscribe to EPA-MOBILENEWS. EPA will use this listserver as the primary means of communication on the NONROAD model to distribute technical memos for review, to answer commonly asked questions, and to announce future model updates. The list is also used for EPA's other mobile source inventory models, so if you use the MOBILE series of models, you may already be a subscriber.

To subscribe to the EPA-MOBILENEWS listserver, send the following message to the EPA Listserver address:

        subscribe EPA-MOBILENEWS FIRSTNAME LASTNAME

where FIRSTNAME and LASTNAME is your name (for example: subscribe epa-mobilenews
George Jetson). The listserver email address is:

        listserver@unixmail.rtpnc.epa.gov

Your email address will then be added to the list of subscribers and a confirmation message will
be sent to your email address. Whenever EPA posts a message to the listserver, a copy of that
message will be sent to all subscribers.

ORGANIZATION OF THE USER'S GUIDE

To assist you in the set-up and operation of the
nonroad emissions model, this document
guides you in the process of installing the
model, provides information on system
requirements to operate the model, and
provides detailed information on each
component of the model. In addition, a chapter
is provided to assist you on more advanced
topics.

Note: For reference, each section begins with
a "Quick Start" that summarizes the steps
explained in the chapter. The chapters then
continue with a more detailed guide to the
model. As the detailed descriptions include
some important notes on the proper use of the
model, we recommend that you read the
sections completely before using the model
for any official purposes.

The user's guide is organized in the following
manner:

   Chapter 2 - Getting Started: This chapter provides information on model hardware and
   software requirements. In addition, instructions are provided on installing the model on the
   your computer. Finally, conventions for the User's Manual are provided.

   Chapter 3 - Graphical User Interface: This chapter discusses the graphical user interface
   in detail, and how to specify and change model inputs for most model runs.

   Chapter 4 - The Core Model: This chapter describes how to edit options using a text editor
   and how to run the core model. Step by step examples are provided.

   Chapter 5 - Reporting Utility: This chapter describes the reporting utility and provides you
   with information on how to import data from a model run and generate standardized reports.

Chapter 6 - Advanced Topics - This chapter provides detailed information to assist more advanced users of the model. This detailed information includes:

- a description of the core model inputs;
- a description of required and optional input file packets;
- how to incorporate local data by editing input tables;
- how to perform additional model runs by editing input tables;
- a description of core model output options, such as the generation of EPS-2 input files and the creation of spreadsheet files; and
- how to model more advanced scenarios.

Chapter 7 - Trouble Shooting - This chapter describes possible solutions to troubles you may have running the model.

Several appendices are individual that document FIPS and SCC codes used by the NONROAD model and provide examples of reporting utility standardized reports.