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User's Guide for the Final NONROAD2005 Model

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Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

Prepared with assistance from
Cimulus, Inc.
and
ENVIRON International Corp.

NOTICE

This technical report does not necessarily represent final EPA decisions or positions. It is intended to present technical analysis of issues using data that are currently available. The purpose in the release of such reports is to facilitate the exchange of technical information and to inform the public of technical developments which may form the basis for a final EPA decision, position, or regulatory action.

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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

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

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 nonroad emissions model which covers all areas of the nation. This document describes the 2002 limited release version of the model.

OVERVIEW OF THE EPA NONROAD EMISSIONS MODEL

Equipment Types

This 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. 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 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 several modes — diurnal, refueling spillage, vapor displacement, hot soak, running loss, tank permeation, hose permeation, 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 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 for calendar years 1970 through 2050. 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.

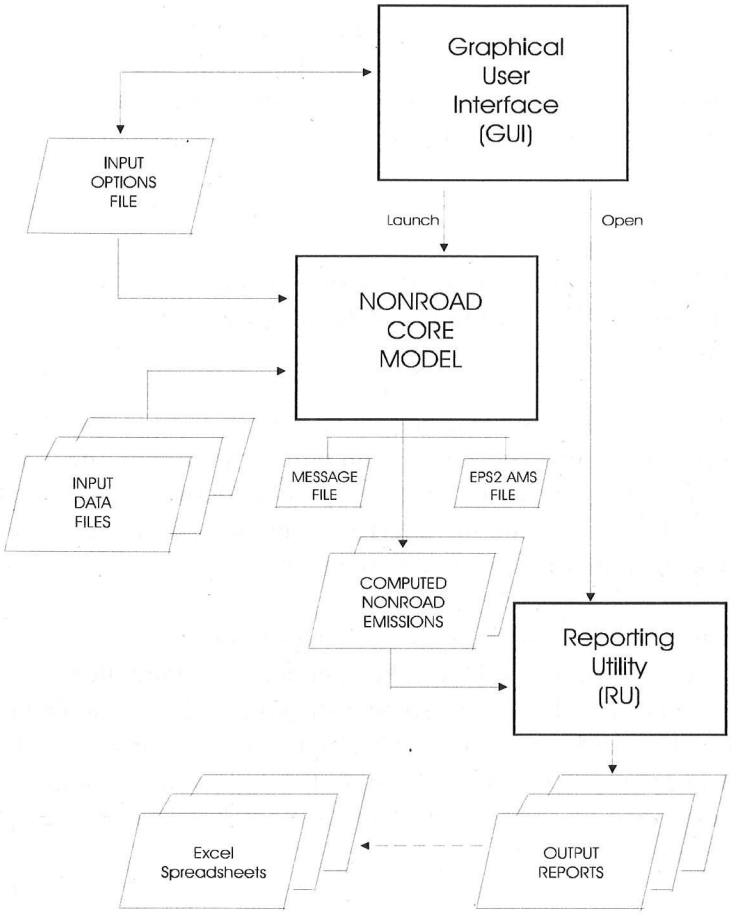
Model Components

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 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 screens and pull-down menus, 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, and there is no built-in capability to run multiple scenarios in a single model run. However, multiple runs can be performed by creating and running a batch file in DOS or in a DOS window in a Windows 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.



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.

Figure 1-1: NONROAD model flowchart.

The reporting utility provides the user with the following standard reports:

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

For most reports, emissions can be reported for either all counties or for a single, user-specified county and for all fuels or for a single user-specified fuel type. 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", "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

- Emission Totals by HP and Source Classification,
- Emission Totals by SCC,
- Emission Totals by Source Classification,
- Emission Totals by County,
- Emission Totals by HP,
- Emission Totals by Equipment Type,
- Emission Totals by HP and SCC,
- Population and Fuel Consumption by SCC,

For the emission 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.

Finally, the reporting utility provides the user with the following emission factor reports:

- Grams per Operating Hour by SCC

- Grams per Operating Hour by HP and SCC
- Grams per Day by SCC
- Grams per Day by HP and SCC
- Grams per HP-Hour by SCC
- Grams per HP-Hour by HP and SCC

Both the reports that include emission factor estimates by SCC and by HP and SCC are separated by fuel type, major source classification, and SCC. The reports that include estimates by HP and SCC display one more level of separation, breaking the information down to the horsepower category level. The emission factor reports do not provide subtotals or grand totals for each group of estimates. The HP-Hour reports are only provided for exhaust and crankcase pollutants.

Model Inputs

The NONROAD model estimates emissions for each specific type of 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 ;
- Available power in horsepower;
- 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 modifiable 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 Transportation and Air Quality (OTAQ) web site for nonroad modeling:

http://www.epa.gov/otaq/nonrdmdl.htm

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 this version of the model, the following technical documents are available:

- Temperature Corrections for Nonroad Exhaust Emissions (NR-001c)
- Conversion Factors for Hydrocarbon Emission Components (NR-002c)
- Exhaust Emission Effects of Fuel Sulfur and Oxygen on Gasoline Nonroad Engines (NR-003c)
- Seasonal and Monthly Activity Allocation Fractions for Nonroad Engine Emissions Modeling (NR-004c)
- Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling (NR-005c)
- Nonroad Engine Population Estimates (NR-006d)
- Calculation of Age Distributions in the Nonroad Model — Growth and Scrappage (NR-007c)

- Nonroad Engine Growth Estimates (NR-008c)
- Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling — Compression-Ignition (NR-009c)
- Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling — Spark-Ignition (NR-010e)
- Spark-Ignition Engine Emission Deterioration Factors for the Draft NONROAD2004 Emissions Model (NR-011b)
- Nonroad Evaporative Emission Rates (NR-012c)
- Refueling Emissions for Nonroad Engine Modeling (NR-013b)
- Geographic Allocation of Nonroad Engine Population Data to the State and County Level (NR-014d)
- Weekday and Weekend Day Temporal Allocation of Activity in the Draft NONROAD2004 Model (NR-015a)

Any additional technical documents will be posted on the web site when they are completed. 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@epa.gov

FUTURE MODEL UPDATES

The EPA NONROAD modeling team is very interested in receiving comments on this version of the model and suggestions for future model revisions and enhancements. E-mail your comments and suggestions to the team at nonroad@epa.gov

All updates to the model will be announced on and available from the OTAQ 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 a blank email to:

join-EPA-MOBILENEWS@lists.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. You can remove yourself from the list by sending a blank email to:

leave-EPA-MOBILENEWS@lists.epa.gov

CONVENTIONS USED IN THE USER'S GUIDE

The following conventions are used in this User's Guide:

- "Click" when used in reference to commands means to carry out the command by clicking it with the left button on the mouse or using keyboard equivalents -- for example, the **Enter** key used in place of the **Enter** command.

- "Enter OK" means to click the **OK** button with the mouse or press the **Enter** key to carry out the action.

- A dialog radio-button option is enabled when its button contains a black dot. The absence of a black dot means the option is disabled.

- Key strokes are printed in bold and bracketed. For example **<R>** means to press the R key on the keyboard.

- Carrying out commands or procedures with keys frequently involves pressing two or more keys together. For example, **<Alt-F>** means to hold down the **Alt** key while simultaneously pressing **F**.

- "Arrow keys" or "Cursor keys" are collective terms for the Up, Down, Left, and Right arrow keys.

- A selection from a Windows menu bar is illustrated by **bold type** and the full name of the pull-down menu. For example, **Reports** from the Reporting Utility menu bar. To demonstrate the selection of an item in a pull-down menu both the main menu selection and the submenu selection are in bold type connected with a "➤". For example, **Reports**

➤ **Emission Totals by SCC**, indicates you should pull-down the Reports submenu and select the Emission Totals by SCC report.

- Files names are italicized. For example, the default option file provided with the NONROAD model is *template.opt*.

Both the Graphical User Interface and the Reporting Utility are standard Windows applications. They use pull-down menus, dialog boxes, and message boxes. This document assumes that an individual setting up and running the NONROAD model has experience in a Windows environment. If you find yourself bogged down in either the graphical user interface or the reporting utility perhaps you would benefit from one of the many books available that discuss in great detail the Windows environment.

A very brief summary of pull-down menus follows using the example **Reports ➤ Emission Totals by SCC** from the Reporting Utility:

You can activate the Reports submenu using the mouse or with keyboard strokes. With the mouse, you move the mouse pointer over Reports and click with the left mouse button. This displays the reports submenu list. To select an item from the pull-down list click on the item with the left mouse button. You can also click on the Reports menu and then drag the mouse to the item of interest (Emission Totals by SCC) while holding down the left mouse button. When you release the button the item is selected.

Alternatively, using the keyboard you can activate the Reports submenu by typing **<Alt-R>**, where R is the underlined character of the menu selection (usually the first character of the word if there are no conflicts). You can also use the arrow keys to move to a different menu selection or within the submenu list. To select a pull-down menu option type the underlined letter in the item name. For the above example, **<S>** will select the Emissions Totals by SCC report.

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 chapter begins with a "Quick Start" section 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 chapters 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.

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 included that document FIPS and SCC codes used by the NONROAD model and provide examples of reporting utility standardized reports.

Chapter 2 Getting Started

In this chapter of the User's Guide, the following topics are discussed:

- the minimum system requirements for installing and running the model; and
- the steps involved in installing the NONROAD model on your computer.

Note: Please see the README file for installation instructions. The latest version of the model may not have the setup.exe installation utility described below, in which case you must carefully follow the step-by-step installation instructions referred to in the README file.

QUICK START

The process of installing the NONROAD model on your computer may be quite simple using the installation utility provided, which works for Windows 98, 2000, NT, and XP. It is named *setup.exe*, and it is included on the NONROAD CD-ROM or can be downloaded from the nonroad modeling web site. In addition, the CD includes electronic copies of this NONROAD User's Guide, all currently available technical reports, and the source code for the FORTRAN core model.

In brief, the steps involved in installing and setting up the NONROAD model are as follows (in this example drive D is used for the CD drive and you should substitute the appropriate letter for the CD drive on your system):

1. Insert the NONROAD CD-ROM in drive D.

   Windows 95, 98, 2000, NT, XP: **Start ➤ Run** and then type *d:\setup.exe*

2. The NONROAD model installation program will prompt you for information as required during the installation process. Once you have supplied the necessary information, the program will install the NONROAD model on your computer. When the process is complete, a message box will appear indicating that the installation was completed successfully.

SYSTEM REQUIREMENTS FOR RUNNING THE NONROAD MODEL

The following are the minimum system requirements for running the NONROAD model:

- **Processor** 486
- **RAM** 8 megabytes
- **Drive** CD-ROM (or access by network)
- **Operating System** Windows 98, NT, or XP (core model only needs DOS)
- **Mouse**

It is recommended that you have at least 200 megabytes of free disk space for installation and operation of the NONROAD model. Besides the files to be installed, disk space will also be needed for the output files generated when running the model. The installed files consist of approximately 20 megabytes for the core model and data files, 4 megabytes for the graphical user interface, 10 megabytes for the reporting utility and multi-year postprocessors, and for users without Microsoft Access 2000 or later already installed, the stand-alone Microsoft Access runtime package is installed for the Reporting Utility, requiring an additional 50-100 megabytes.

INSTALLING THE NONROAD MODEL

To install the NONROAD model, follow these steps:

1. Insert the NONROAD CD-ROM in drive D (substitute the appropriate letter for the CD drive on your system).

2. Begin the installation procedure.

   Windows 98, 2000, NT, XP: Specify **Start ➤ Run** and enter *d:\setup.exe*. Specify **OK**.

3. During the installation process, a number of dialog screens will appear that request information from you to assist in installing and setting up the program. Once you have provided all required information, the installation program will set-up a directory on your computer and copy the necessary files to that directory.

4. The installation program will create a program group on your computer called Nonroad. This program group will contain an icon for each component of the model -- the graphical user interface, the core model, and the reporting utility. For information on the operation of each of these components, see Chapter 3 (graphical user interface), Chapter 4 (core model), and Chapter 5 (reporting utility).

Attaching the Reporting Utility Databases

When the NONROAD model is installed, a subdirectory called Reports is created. Within this subdirectory are two databases, *Nrdata.mdb* and *Reports.mdb*, required to run the reporting utility. To operate the reporting utility, *Reports.mdb* must "know" the path of *NRdata.mdb* in order to properly connect to it. This connection is done automatically the first time the Reporting Utility is opened.

If the Reporting Utility cannot find *Nrdata.mdb* (for example, the file was moved to another directory) then a message is displayed. You must attach the tables in order to successfully generate reports. Refer to the section in Chapter 5 titled Attaching the Reporting Utility Databases.

REINSTALLING THE NONROAD MODEL

The NONROAD model can be completely reinstalled on your computer by following the normal steps outlined above. During reinstallation, the program will search for a current installation of the program. If any current NONROAD files are found, the program will ask you whether you want to overwrite the files. Indicate **Yes** or **No**.

Chapter 3 Graphical User Interface

In this chapter of the user's guide, the following topics are discussed after the Quick Start description:

- a general description of the graphical user interface,
- moving around in the user interface,
- creating an option file and specifying model parameters,
- running and viewing a model scenario, and
- some advanced options.

QUICK START

The process of setting up an option file that contains a scenario that you are interested in modeling, and running and viewing the modeling results, is quite simple with the graphical user interface. Each of the steps involved is discussed in detail in this chapter. In summary, the steps involved in setting up, running, and viewing a modeling scenario are as follows:

1. Start the Graphical User Interface using the icon created when the EPA NONROAD Emissions Model was installed on your computer. (For more information, see General Description below.)

2. Define the parameters that you are interested in modeling. When you first run the interface, the modeling parameters are contained in the default option file *TEMPLATE.OPT* which is automatically read by the interface. Select **Scenario** on the main menu. A submenu will appear that contains the various options that you can specify. These options include the title of your model run, fuel specifications, the period of time and geographical region over which you want to estimate emissions, and the source categories that you want to model. (For more information, see the section below on Creating an Option File.)

3. Save the modified option file, **File ➤ Save** (or **Save As**). (For more information, see the section below on Creating an Option File.) If you do not save the option file with the name you want, it will be saved automatically with its currren tname when you choose **Model ➤ Run** in the next step.

4. Submit your option file to the core model to run, **Model ➤ Run**. Once the run has been completed, a message will appear in a DOS screen notifying you that the run was successful. (For more information, see the section below on Running and Viewing a Modeling Scenario.)

5. To view the results of this model run, specify **Model ➤ Reports**. This will move you to the reporting utility. (For more information, see the section below on Running and Viewing a Modeling Scenario.)

6. Exit the interface when you are finished with **File ➤ Exit**. (For more information, see the section below Exiting the Graphical User Interface.)

GENERAL DESCRIPTION

The NONROAD user interface provides you with an easy method for designing the nonroad emissions simulations that you are interested in modeling. In addition, the interface provides you with an easy means for accessing the reporting utility to view the results of your modeling run. With simple Windows-type screens and pull-down menus, you can quickly set up, execute, and view a modeling scenario without any computer programming experience.

When the NONROAD emissions model is installed on your computer, an icon for each component of the model is created. While this allows you to access each component of the model individually, through the interface you can operate most of the functions of the EPA NONROAD Emissions Model -- from the creation of a scenario, to the running of the core model, to the development of reports -- without exiting one program and executing another.

Note: In this chapter of the user's guide, information is provided to assist you in setting up an emissions scenario to model using the default data provided in the model. If you are interested in modifying the data files to reflect alternatives to the default data, please see Chapter 6 on Advanced Topics.

MOVING AROUND IN THE GRAPHICAL USER INTERFACE

Figure 3-1: Graphical User Interface icon.

Begin the Graphical User Interface denoted by the icon displayed in Figure 3-1. If your computer operates with Windows 95 or above, the icon can be found in a program group called **Nonroad Model** accessed from the **Start** menu. If you are operating with Windows 3.1, the icon can be found through Program Manager.

When launched, the main menu screen of the interface appears (Figure 3-2). The title bar of the screen displays the NONROAD name followed by the currently opened option file in parentheses. The default is *template.opt*. Below the title bar is the main menu bar, followed by the EPA banner, and the model run title, message file name, and output file name which are extracted from the opened option file.

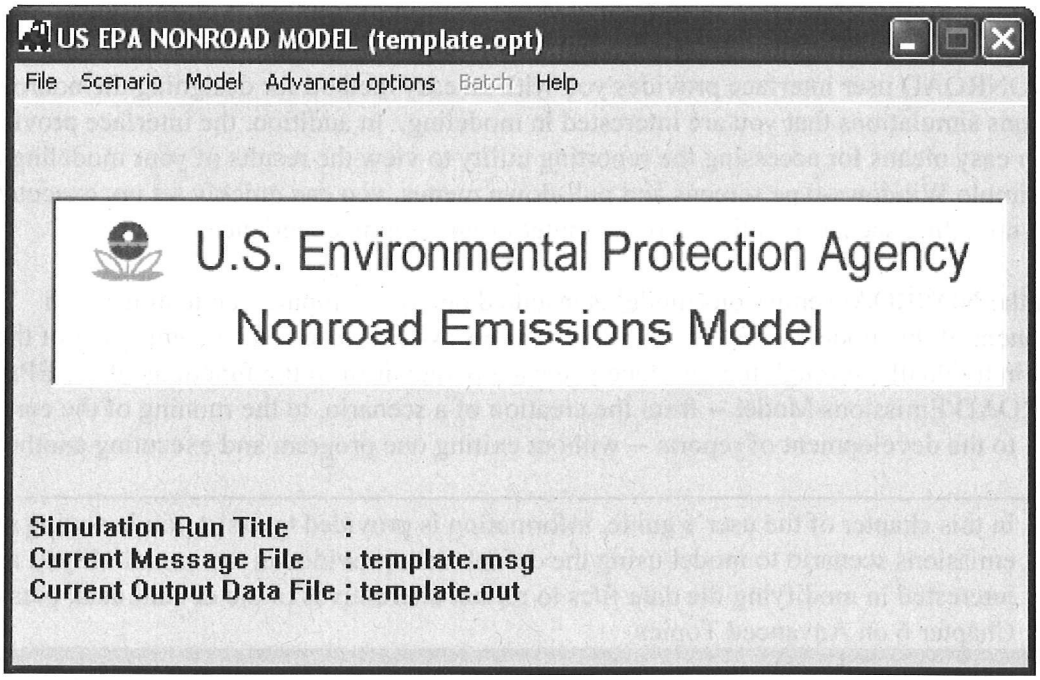


Figure 3-2: Initial graphical user interface screen

From this screen you can access submenus that make up the graphical interface module, as listed at the top of the window in the menu bar:

- **File** - open an existing option file, save a modified option file with the old or a new name, or exit the interface.

- **Scenario** - define the various parameters that you want in your modeling run.
- **Model** - run the core model and access the reporting utility.
- **Advanced Options** - select your own data files to replace the default files provided with the model and to specify optional output.
- **Batch** - this option is unavailable. Multiple runs must be done manually.
- **Help** - general information is provided on the version and status of the model.

Once a main menu item is selected, a list of submenu items will be displayed. The following shows the list of submenu items for each of the main menu choices:

File	Open Save Save As Exit
Scenario	Options Period Region Sources
Model	Run Reports
Advanced Options	Geographical Allocation Temporal Allocation Growth Equip. Population Phase In Emission Factors Deterioration Factors Activity U.S. Counties FIPS Optional Output
Help	Help About Current

In most instances, after selecting a submenu item a form is displayed for user inputs or selections. When an input error occurs, an appropriate message (dialog box) is displayed. If a dialog box appears, specify **OK**, make the corrections needed and continue.

CREATING AN OPTION FILE

The first step involved in operating the EPA NONROAD Emissions Model is to setup an option file which defines the parameters that you are interested in modeling. Once this file has been set up, it can be submitted directly to the core model from the interface, and then following the model run the estimated emissions output can be imported into the reporting utility and standard reports generated.

An option file (**.opt*) contains all of the parameters that specify your modeling run. This file is opened, read, and updated from the interface. To more easily explain the process of setting up an option file, the following example is provided:

> *You have been given an assignment to estimate the total emissions from all lawn and garden equipment in Travis County (Austin), Texas. You are interested in estimating these emissions for the summertime of 1998.*

Throughout this chapter, we will refer to the above example.

Opening and Naming an Option File

When you first run the interface, the default option file *TEMPLATE.OPT* is automatically opened and the file name is displayed on the title bar of the main screen. Also displayed in the main menu screen is the run title, the message file name, and the output file name extracted from the currently opened option file. You can modify the default option file to define a modeling scenario of interest. Alternatively, if you want to use or modify a different option file (**.opt*) that you have previously created, follow these steps:

1. From the Main Menu, select **File ➤ Open**.

2. An open file dialog box appears that requests you to select a new option file. Specify the option file you are interested in using. This loads the option file into the interface and updates the main screen.

Before beginning to modify the scenario options in the option file, you should save the option file with a different name to prevent yourself from accidentally overwriting data in a previously created option file or in *TEMPLATE.OPT*. To do this, select **File ➤ Save As** and indicate the new file name. For our example, you would specify the file *TRAVIS.OPT*. The main menu

screen title bar is updated with the new file name. In addition, when you specify a new file name the message file and output file names are set to the same name as the specified option file with the file name extensions *.msg* and *.out* respectively. For our example, you see the files *TRAVIS.MSG* and *TRAVIS.OUT*.

Note: The name of the option file must be no longer than eight characters as a result of DOS conventions. It is recommended that the extension *.OPT* be used for all option files.

If the message file specified in the opened option file exists then the button "View Message File" will appear in the middle of the main menu window. Click on this button to open Windows Notepad and review the indicated message file.

Defining a Report Title

The interface allows you to easily title your model run. This title will be used on any reports you might generate for this particular scenario.

To provide a descriptive title for your model run, follow these steps:

1. From the main menu select **Scenario ➤ Options**.

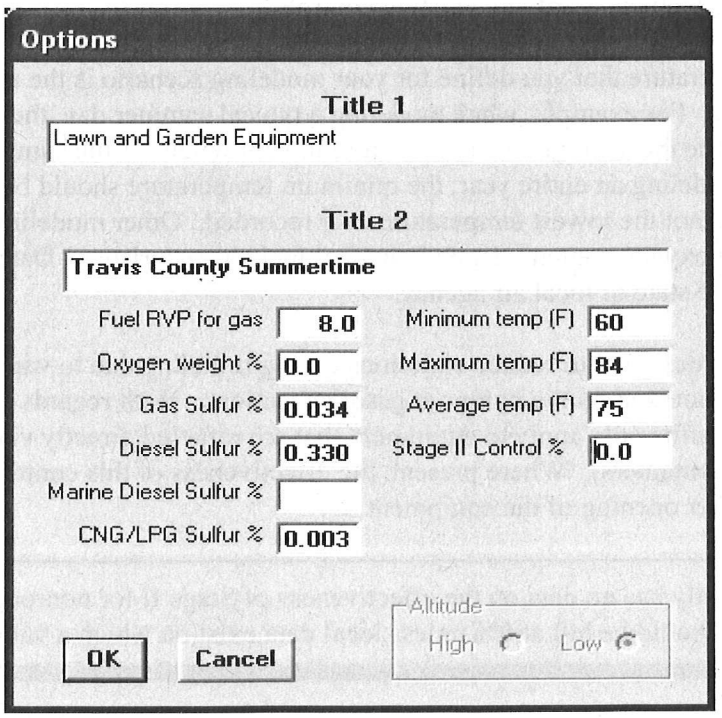


Figure 3-3: Options screen

2. Update the Options screen (Figure 3-3). When the Options screen first appears, it will contain the title and any options previously defined for this option file. Specify a descriptive title for your scenario in the field below Title 1. If you want to add a subtitle, you can do so in the field below Title 2.

Note: The two title lines of your modeling run must be no longer than 80 characters each. In addition, the titles should not include single or double quotation marks (i.e., " or '), or periods.

3. Specify **Done** or **OK** to return to the main menu.

Defining Fuel Specifications, Ambient Temperatures, and Stage II Control Effectiveness

Nonroad emissions result from the combustion, evaporation, and spillage of fuel in equipment and vehicles designed primarily for off-road use. The emissions that come from nonroad equipment and vehicles are dependent, in part, on the composition of the fuel used. Similarly, the ambient temperature will also affect the emissions from nonroad sources. Finally, implemented controls act to decrease emissions. As a result, it is important to define the composition of the fuel, the ambient temperature for the period of time that you are interested in modeling, and the effectiveness of any existing controls.

The minimum temperature that you define for your modeling scenario is the average low for the time period selected. For example, when modeling a typical summer day, the minimum temperature should be the average low temperature in Fahrenheit for the summer season. Moreover, when modeling an entire year, the minimum temperature should be the average daily low for the year and not the lowest temperature ever recorded. Other modeling parameters, such as RVP, sulfur, and oxygen content, depend on local fuel characteristics. Data for an area should be available from the state or local air agency.

Stage II controls are designed to reduce emissions during refueling due to vapor displacement. They are generally mounted on the pumps at gasoline stations. With regards to nonroad equipment, their benefits only apply to equipment that are refueled directly via the pumps (rather than with portable containers). Where present, the effectiveness of this control is also affected by the design of the filler opening of the equipment.

Note: EPA currently has no data on the effectiveness of Stage II for nonroad equipment. The value should be left at 0% unless local data exist on which a value can be based.

To specify fuel characteristics, temperature, and Stage II control effectiveness, follow these steps:

1. From the main menu select **Scenario ➤ Options**.

2. Modify the required parameters. For our example, indicate the gasoline specifications and ambient temperatures that will be in effect in Travis County during the summer of 1998. Next, identify whether the modeling region is at high or low altitude[1]. High should be specified where the average altitude is greater than 5000 feet; this is consistent with the MOBILE program.

3. Specify **Done** or **OK** to return to the main menu.

The acceptable range of values for each of the fuel specification and ambient temperature options are as follows:

Parameter	Minimum	Maximum
Fuel RVP (psi)	6	16
Oxygen (wt.%)	0	5
Fuel Sulfur (wt %)	0	0.5
Temperature (F)	-40	120
Stage II control effectiveness (%)	0	100

Note: The percent effectiveness value must be followed by a decimal point.

Defining the Modeling Period

The modeling period is simply the period of time for which you want to estimate emissions. To define the modeling period, follow these steps:

1. From the main menu select **Scenario ➤ Period**.

[1] Altitude adjustment is not in this version of the model. Hence, this selection is currently disabled in the user interface.

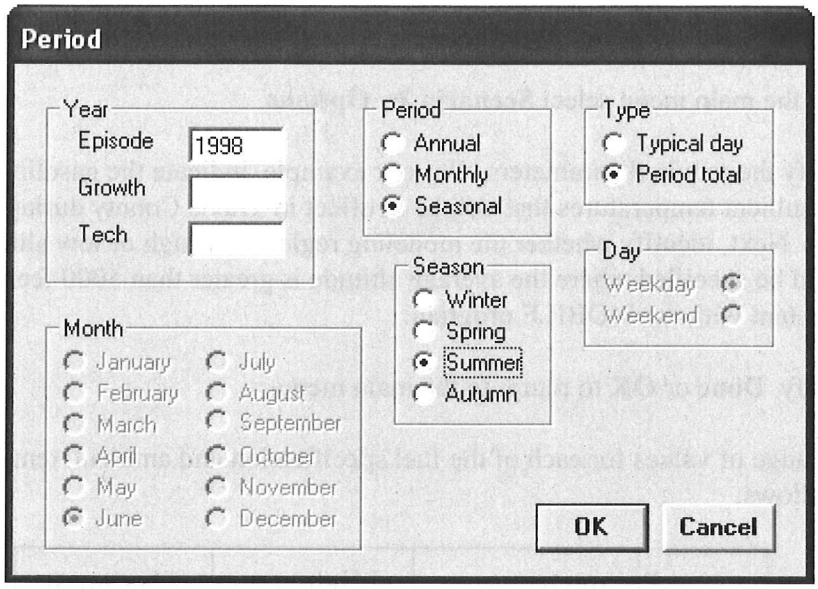


Figure 3-4: Period screen

2. Indicate the modeling period of interest in the displayed screen (Figure 3-4).

   The interface makes it easy to define the modeling period through a series of select buttons. The following options are available to you:

   - **Episode Year** - You can define any year between 1970 and 2050 that you are interested in modeling.

   - **Growth Year** - You can define any year between 1970 and 2050 to forecast or backcast engine populations. If this is left blank, the Episode Year will be used.

   - **Tech Year** - You can define any year between 1970 and 2050 as the maximum technology year. If this is left blank, the Episode Year will be used. Note that if a year is entered, it cannot be greater than the Episode Year.

   - **Period** - You can define the modeling period as annual, monthly, or seasonal.

- **Month** - If you select the modeling period to be monthly, the list of months will become active and you can select the appropriate month of the year.

- **Season** - If you select the modeling period to be seasonal, the list of seasons will become active and you can select the appropriate season of the year. Seasons are defined as follows in the model:

Winter:	Jan/Feb/Dec
Spring:	Mar/Apr/May
Summer:	Jun/Jul/Aug
Autumn:	Sep/Oct/Nov

- **Type** - For any period that you select, you can estimate the emissions as the total for a 24-hour period (typical day) within the period or for the total period.

- **Day** - If you select the type to be a typical day, days will become active and you can select a weekday or weekend day.

Note: While the model allows you to define any model year from 1970 to 2050, it actually forecasts and backcasts based on data from 1990-2002. For this reason, its estimates become less accurate as you move further into the past or the future.

Since we are interested in estimating the total emissions during the summertime of 1998 in our example, specify **Seasonal** (under Period), **Summer** (under Season), **Period Total** (under Type), and type in 1998 in the year field.

3. Specify **Done** or **OK** to return to the main menu.

Defining the Modeling Region

The interface makes it relatively easy to define the geographical region -- from one county to multiple counties to an entire state or the nation -- that you are interested in modeling. To do this, follow these steps:

1. Specify **Scenario ➤ Region**. The Region screen will appear (Figure 3-5).

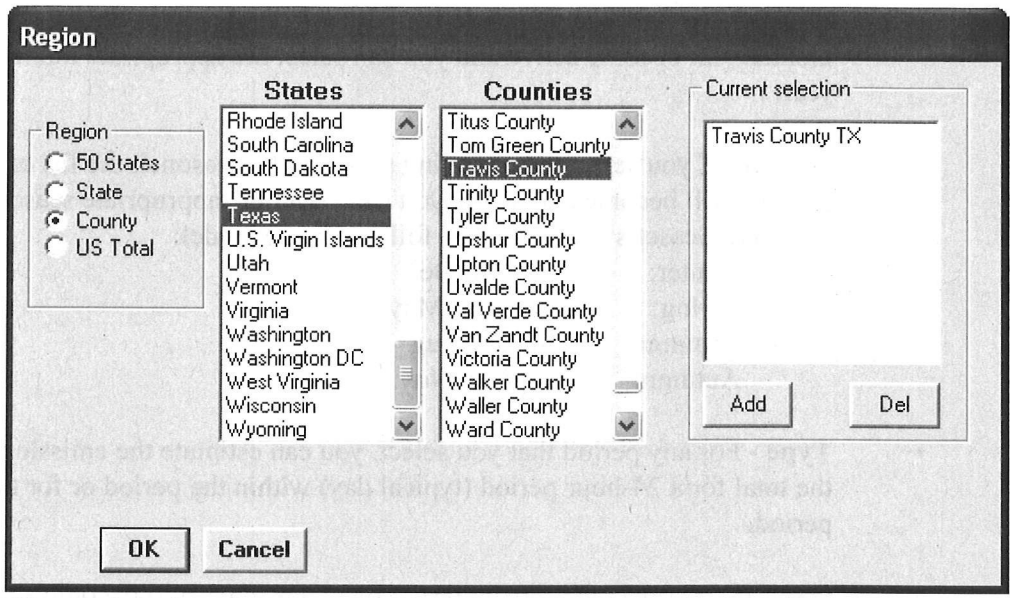


Figure 3-5: Region screen.

2. The first step in defining the modeling region is to remove any regions that have been specified in a previous scenario that are not applicable to the current scenario. To do this, highlight the regions in the Current selection list and click on **Del**.

3. Specify a region. Several options are available, the methods for selecting them are as follows:

   - **50 States** - This option selects all 50 states, you will obtain the state totals for all 50 states individually. When selected, the "Current selection" list is cleared, as no individual states or counties need be specified.

Tip:	Since selecting 50 States as a region clears the current selection list this is a quick and easy way to delete all previously specified states or counties before starting a new region definition.

   - **State** - This option allows you to select any one, or multiple, of the 50 states. When a state is selected, the model will compute total emissions for the entire state, but will not allocate emissions among counties in the state. Specify **State** (under region), scroll through the list of states or type the first letter to jump in the

list. Once found, highlight the state and then **Add**. The state will appear in the current selection field.

- **County** - This option allows you to select one or more counties. To select an individual county, specify County (under region) and highlight the state of interest. When you highlight the state a list of counties for that state will be displayed. Move through the list of counties until you find the one that you want, highlight the county, and then **Add**. The county name and state abbreviation are written to the Current selection list.

  To specify all counties within a state, indicate County (under region), highlight the state of interest, and then **Add**. The Current selection list will display the state name (e.g., Michigan) with "All of ..." (e.g., "All of Michigan"). The core model will compute emission estimates for every county, individually, in the named state.

Note: To create a modeling region that is larger than a single state or county, continue to add new regions to the list of currently selected regions by repeating the process for selecting states or counties. For example, if a metropolitan area covered four counties, simply select the first county and then each additional county one at a time.

- **US Total** - This option allows you to estimate national total emissions, no state detail is generated. When selected, the "Current selection" list is cleared, as no individual states or counties need be specified.

Note: The NONROAD model also allows you to define a sub-county region. However, this option requires that you provide a significant amount of data beyond that furnished with the model. For information on how to input this additional data, please see Chapter 6, Advanced Topics.

For our example scenario, indicate **County** (under Region), highlight Texas from the list of states, highlight Travis from the list of counties, and **Add**.

5. Specify **Done** or **OK** to return to the main menu.

Defining Source Categories

The EPA NONROAD Emissions Model allows you to estimate emissions from many different types of equipment and vehicles. Each source category in the NONROAD model is uniquely

identified with a source classification code (SCC), which is a ten-digit number. The first two digits, 22, represent mobile sources. For most categories, the next two digits represent the engine or fuel type (60, 65, 67, 68, and 70, represent 2-stroke gasoline, 4-stroke gasoline, LPG, CNG, and diesel respectively). The next three digits represent the segment type (for example, recreational or construction). And the last three digits represent the specific kind of equipment (for example, golf carts or snowmobiles). Refer to Appendix B for a complete list of NONROAD SCCs.

When selecting source categories to process in a NONROAD simulation you can specify 'global' source category codes instead of each individual SCC. For example, instead of listing all lawn and garden equipment types individually, when you specify **Add segment** the SCCs are listed with the last three digits (equipment type) as zero. It is implied that all equipment types within that segment will be processed.

To define the source categories that you want to model, follow these steps:

1. From the main menu specify **Scenario ➤ Sources**. The Sources screen will appear (Figure 3-6).

The following options are available:

- **Active** - Choose either 'Selected sources' to specify a subset of sources to model or 'All Sources' which will model all SCCs with valid equipment population data. If 'All Sources' is selected then the ability to select specific SCCs is removed (i.e. the Add buttons become deactivated).

- **Fuel** - Choose between 'All Fuels', 'Diesel', or 'SI' (spark ignition engines).

- **Segment** - Choose one of the segments listed.

- **List of selected sources** - Each selected SCC and a brief description is displayed in the lower portion of the window.

- **Add Segment** - The 'global' SCCs which represent the specified segment and fuel type will be added to the list of selected SCCs.

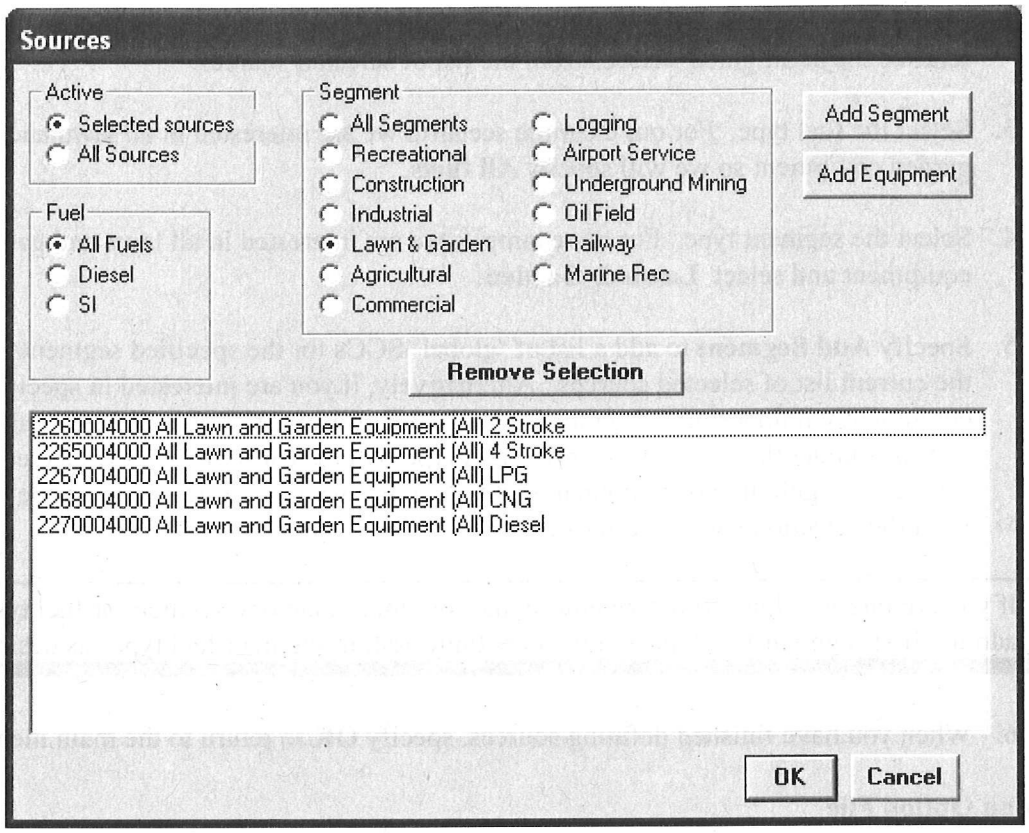


Figure 3-6: Sources screen

- **Add Equipment** - The individual SCCs which represent every type of equipment within a segment will be added to the list of selected SCCs. This allows you to select a subset of equipment types within a segment, by then removing the individual equipment types that you do not want.

- **OK** - Return to the main menu.

- **Remove Selection** - This will remove any highlighted SCCs from the list of selected sources.

2. Similar to defining a region, you must first remove any source segments or equipment that you do not want to model. Highlight the segments and/or equipment in the list of selected sources and specify **Remove Selection**. Multiple sources may be highlighted

by using the **<Shift>** or **<Control>** keys. The **<Delete>** key may also be used to remove the highlighted sources from the list of selected sources.

3. Select the fuel type. For our example scenario we are interested in all lawn and garden equipment so we will specify **All fuels**.

4. Select the segment type. For our example, we are interested in all lawn and garden equipment and select **Lawn & Garden**.

5. Specify **Add Segment** to add a list of 'global' SCCs for the specified segment/fuel to the current list of selected sources. Alternatively, if you are interested in specific equipment within a source segment then **Add Equipment**. Every type of equipment that falls under the specified segment/fuel type will appear in the list of selected sources. Highlight any equipment that you do not want to model, and remove them from the selection list (see 2 above).

Note: If you are interested in estimating emissions from more than one segment or fuel type, add the first segment/fuel type and then continue adding segment/fuel types as desired.

6. When you have finished defining sources, specify **OK** to return to the main menu.

Saving an Option File

Once you have created an option file by defining all of the parameters that you want, you should save this file. To do this, follow these steps:

1. From the main menu **File ➤ Save**.

Note: The option file is saved automatically when you specify **Model ➤ Run**, but it is good practice to save it manually using **File ➤ Save as...** to be sure the version you want is saved with your desired filename.

RUNNING AND VIEWING A MODELING SCENARIO

Once you have set up an option file, the interface allows you to easily submit the option file to the core model to run. Similarly, the interface allows you to access the reporting utility to view the results of your run and prepare printed reports.

To submit an option file to the core model, follow these steps:

1. From the Main Menu, specify **File ➤Open**.

2. Specify the option file you want to model in the open file dialog box. This loads the option file into the interface and the file name is displayed on the main menu title bar. If the option file is already loaded, you can skip steps 1 and 2.

3. From the main menu, specify **Model ➤ Run** (Figure 3-7).

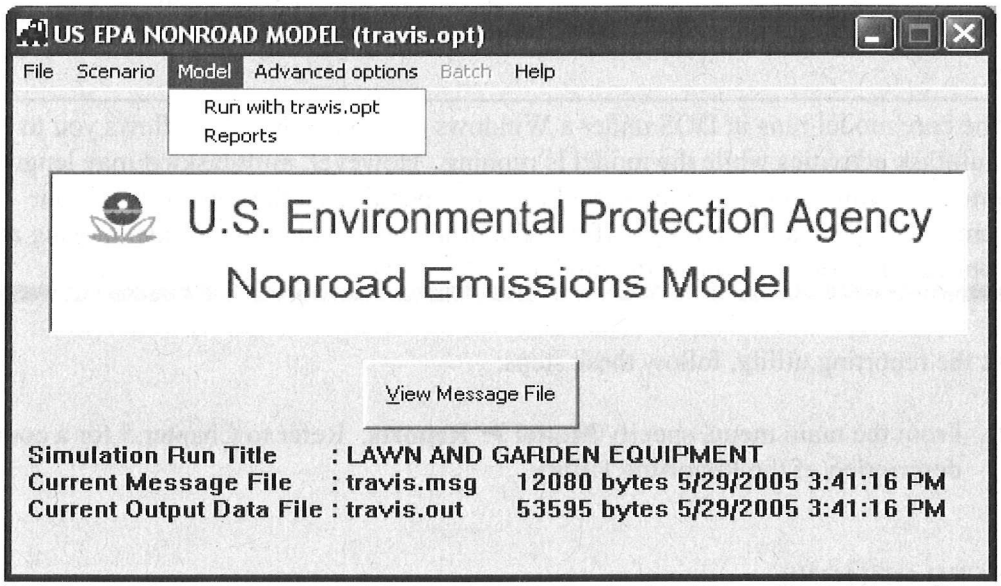


Figure 3-7: Model submenu screen

4. A DOS window will appear. After the run has been completed, a message will appear notifying you that the run was successful.

   If the DOS window disappears after the core model completes and you wish to view the DOS screen, then you need to change the default 'close on exit' in your Windows application. In Windows 95 or above, right click on the *nonroad.exe* file name, select Properties, select the Program tab, and disable the 'Close on exit' box. You will then need to manually close the DOS window when the core model completes.

5. To return to the interface, press **<Enter>**.

6. It is important to review the output message file produced by the core model. In addition to any warning or error messages that are generated during execution, the message file will indicate all of the parameters specified in the option file and all of the input files used in processing. These should be reviewed in order to verify that the simulation performed was what you intended. Specify **View Message File** from the main menu in order to open Windows Notepad and examine the message file.

7. If you are interested in modeling several scenarios prior to viewing and printing a report, repeat the above steps for each of your option files. Be sure to use a different option filename for each scenario, or else the later model runs will overwrite the output files from the previous runs.

Note: The core model runs in DOS under a Windows environment which allows you to multitask activities while the model is running. However, multitasking may lengthen the amount of time it takes for the model to run, depending on the capability of your computer (speed and memory). If this is a problem, you should consider closing all other applications prior to running the model.

To access the reporting utility, follow these steps:

1. From the main menu, specify **Model ➤ Reports**. Refer to Chapter 5 for a complete description of the Reporting Utility.

ADVANCED OPTIONS

The Advanced Options menu allows you to specify your own data files to replace the default files provided with the NONROAD model and to specify certain alternate output file formats. Each submenu selection allows you to specify a different file to use. In some cases, more than one file may be applicable to a selection.

An optional output available from the core model, via the graphic interface, is the Emissions Processor System (EPS) AMS format. This output is generated only if a filename is provided for that format. Another optional output available only from the reporting utility is the NEI Input Format (NIF), which can be used to generate inputs for EPA's National Emissions Inventory (NEI). NIF output is covered in Chapter 5.

Depending on your desired modeling region you may need to change the default Geographic Allocation and Equipment Population file names. These files are provided by state to reduce the size of the files.

EXAMPLE OF CHANGING GEOGRAPHIC ALLOCATION

The Geographic Allocation selection allows you to identify the allocation look-up table (the default is "*allocate.xrf*") and allocation data files that you want to use. The allocation look-up table is an assignment of equipment type to an allocation indicator (e.g., construction equipment assigned to employees in the construction industry). The allocation files contain the actual estimates of indicator values (e.g., the actual number of employees in the construction industry by county and year).

To change the look-up table or allocation data files, follow these steps:

1. From the main menu, select **Advanced options ➤Geographic Allocation**. The Geographic Allocation screen is displayed (Figure 3-8).

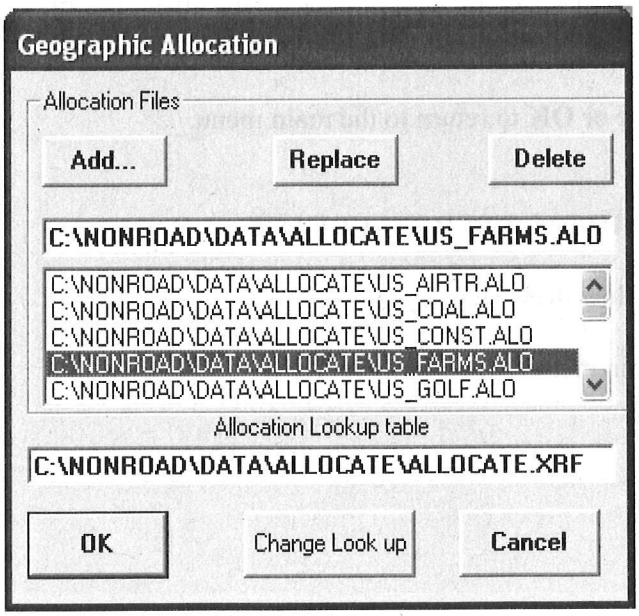


Figure 3-8: Geographic Allocation screen

2. The first step in defining the geographic allocation data files is to remove any previous data files. Highlight the current files and Delete one at a time.

3. Click Add to specify a new list of allocation files. An open file dialog box appears that requests you to select a new allocation file. Locate the directory where the allocation files are saved (when installed: \nonroad\data\allocate) and specify the data file that you want. Repeat this until all necessary files have been added.

4. To change a specific allocation file, select that file from the list. Then enter the path and name of the new file in the text box directly above the list. Click **Replace**.

Note: The specification of modeling region under the Scenario menu automatically selects the appropriate default allocation and population data files. Thus any changes made to these via the Advanced Options menu will be un-done if you access the **Scenario ➤ Region** screen.

5. Specify **Change Look up** to change the allocation look-up table. Again, an open file dialog box appears that requests you to select a new allocation file (this time with the extension *.xrf*). Locate the directory where the allocation files are saved and specify the data file that you want.

6. Specify **Done** or **OK** to return to the main menu.

EXITING THE GRAPHICAL USER INTERFACE

To exit the interface, follow these steps:

1. From the main menu, specify **File ➤ Exit**.

Chapter 4 Core Model

In this chapter of the user's guide, the following topics are discussed:

- a general description of the core model,
- the process of modifying an option file and
- running the core model.

QUICK START

The process of modifying an option file and running the core model using data provided in the NONROAD model is straightforward. In summary, the steps involved in running the core model with existing data are as follows:

1. Modify the core model input option file. To modify an option file, either use the graphical user interface as discussed in Chapter 3 or a text editor, such as Microsoft's Notepad or WordPad, to access the *.*opt* file that you are interested in changing. Alternatively, you can edit the file through DOS. (For more information, see the section below on Creating an Option File.)

2. Once you have an option file defining the scenario that you are interested in modeling, you can run the scenario from the graphical user interface as discussed in Chapter 3, or from DOS by typing "*nonroad (the name of your option file).opt*" from the nonroad directory. (For more information, see the section below on Running the Core Model.)

3. After the model has finished, a message will appear in a DOS window notifying you of the successful completion of the run or of any errors that have occurred.

GENERAL DESCRIPTION

The core NONROAD model contains all of the algorithms used by the model for calculating emissions estimates. The model includes standard data files and tables that allow you to easily estimate the emissions from a wide variety of nonroad equipment and vehicles for any region of the country. The information used by the core model for estimating emissions, including user-specified options, data files, and data tables, are input through an option file.

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. In addition, in order to create/modify an input option file you must be familiar with the use of a text editor. If you prefer you can easily modify the input option file and access the core model from the GUI (Graphical User Interface), which is described in detail in Chapter 3.

When the NONROAD model is installed on your computer, a directory for the model is created. The standard installation creates the NONROAD directory on the c drive; i.e. c:\Nonroad. The core model is executed with the file *NONROAD.EXE*.

Note: In this chapter of the user's guide, information is provided to assist you in setting up an emissions scenario and running the model using the default data provided in the model. If you are interested in modifying the data files to reflect alternatives to the default data, please see Chapter 6 on Advanced Topics.

For more technical information on the core model, please refer to the technical support documents, or the core model source code.

CREATING AN OPTION FILE

Before running the core model, you must define the scenario you are interested in modeling by creating an option file. All model input files and scenario specific parameters are specified in the input option file. The information contained in each option file is separated into "packets" based on common information. For example, all data items related to the period of time for which you are interested in estimating emissions is grouped in a single packet, as are data files related to the population of equipment for a modeling region. You can quickly set up an option file specifying the parameters that are applicable to your modeling scenario using default data.

You can view and modify an option file using a text editor such as Microsoft's Notepad or WordPad or by using the DOS command *edit*. When viewing an option file through a text editor, the keyword that identifies a packet is surrounded by forward slashes ("/") and can appear in upper case, lower case, or mixed case. For example, the packet identifier for all of the data files