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California Population Indoor Exposure Model (CPIEM) (Version 1.4F) User's Guide

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
AIR RESOURCES BOARD
Research Division

CALIFORNIA POPULATION INDOOR EXPOSURE MODEL (CPIEM)
Version 1.4F

Final Report A933-157
User's Guide

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Section 1.0

INTRODUCTION AND OVERVIEW

1.1 INTRODUCTION

Under Section 39660.5 of the California Health and Safety Code, the State of California Air Resources Board (ARB) is charged with assessing human exposure to toxic air contaminants in indoor environments and identifying the relative contribution of indoor exposures to total human exposure, taking into account both ambient and indoor air environments. The Indoor Air Quality/Personal Exposure Assessment Program (Indoor Program), established within ARB's Research Division in 1986 to investigate indoor and personal exposures to air pollutants, has the primary responsibility for obtaining and analyzing information related to this section of the code.

Indoor exposure assessment is a critical component of assessing total exposure to toxic air contaminants because (1) residents in California and other areas of the country spend a significant majority of their time indoors, and (2) for many pollutants, indoor-air concentrations are typically higher than those outdoors. Assessment of indoor exposures can be particularly complicated due to the considerable variety in (1) structure types and building-construction characteristics, (2) indoor sources such as appliances, construction and interior finishing materials, furnishings, and consumer products, and (3) occupant activities including movement patterns, uses of various types of sources, operation of space-conditioning equipment, and opening or closing of windows.

To fully consider indoor exposures in assessing risk, the ARB needs estimates of average and peak indoor exposures of the California population as well as estimates of indoor exposures for sensitive subgroups of that population. However, the quantity and type of data available for use in developing such estimates vary from compound to compound and are usually very limited. Personal exposure data, not necessarily restricted to time spent indoors, are available for some compounds whereas for others only indoor-concentration data or source-emissions data (or none of these) may be available.

Calculating indoor exposures for a given population involves the integration of information on individuals' location/activity patterns (i.e., how and where people spend their time) and concentrations encountered by these individuals at various indoor locations. If concentration measurements have not been collected in some of the locations of interest, then some estimate or prediction of the concentration distribution is also needed. In the past, ARB staff have gone through a fairly involved and time-consuming task of locating, developing and interfacing various pieces of information needed to support indoor exposure assessments. The model described in this document--the California Population Indoor Exposure Model (CPIEM)--is a software product that has been designed to expedite the exposure-assessment process by providing a user interface and calculation tools for supplying and integrating all required information. Two key requirements of the software are that it be (1) user friendly and (2) reasonably accurate without being overly complex.

This document is intended to assist the user in understanding (1) the general structure and purpose of the model, (2) the types of inputs required and how these inputs can be provided or accessed, (3) the types of calculations performed by the model and the extent to which these calculations can be controlled, and (4) how the results of the calculations can be saved and further analyzed. The remainder of this section provides an overview of the model and summarizes the input requirements. Hardware/software requirements and procedures for installing and accessing the software are outlined in Appendix A. Subsequent sections of this document provide guidance and assistance to the user in supplying/accessing model inputs, executing model calculations, and viewing or saving model outputs. Some example applications and results are also provided.

1.2 OVERVIEW OF THE MODEL

The primary function of the model is to combine indoor-air concentration distributions with Californians' location/activity profiles to produce exposure distributions for different types of indoor environments. This function is achieved through a Monte Carlo simulation in which a number of location/activity profiles that were collected in prior ARB-sponsored studies are randomly sampled and combined with randomly chosen airborne concentrations for specific environments. At the user's option, all available location and activity profiles can be selected instead of a random sample. The location/activity profiles

were collected through telephone interviews involving California adults, adolescents and children for a sample of households spread throughout the state. Ideally, the concentration data are derived from air-monitoring studies that have been performed in a random sample of indoor environments in one or more region of the state. However, for many compounds the concentration data are either limited or nonexistent. Consequently, the model also provides a capability for mathematical modeling of hourly and daily average indoor-air concentration distributions, based on distributional information for parameters such as source emission rates, building volumes and air exchange rates.

The conceptual hierarchy of the model is illustrated in Figure 1-1. Level 3 of the model utilizes a mass-balance equation to estimate concentration distributions for specific types of indoor environments such as residences, offices and schools. Level 2 of the model uses measured or modeled concentration distributions for one or more environment, together with location/activity patterns (i.e., amount of time spent in each environment at specific activity levels), to calculate exposure distributions for the chosen environment(s). Level 1 of the model aggregates the environment-specific exposure estimates to develop a distribution of "total indoor air" exposures, that is, the portion of total (24-hour) exposure associated with time spent indoors. Level 1-2 calculations are performed together as one integrated module within the model. Given the functional roles of the model levels, Level 1-2 is used interchangeably with "exposure/dose distributions" throughout the remainder of this document and Level 3 equates to "concentration distributions."

For each sampled location/activity profile, Level 1-2 of the model estimates both inhalation exposure and potential inhaled dose. Inhalation exposure is defined as the time-integrated concentration encountered by an individual while in an indoor environment:

$$C_T = \int_0^T C(t)\ dt$$

where C(t) is the concentration in the environment at time t, T is the amount of time spent in the environment, and C_T is the time-integrated concentration. If the concentration is measured in $\mu g/m^3$ and time in hours, then the units for C_T are $\mu g\text{-}h/m^3$. The average

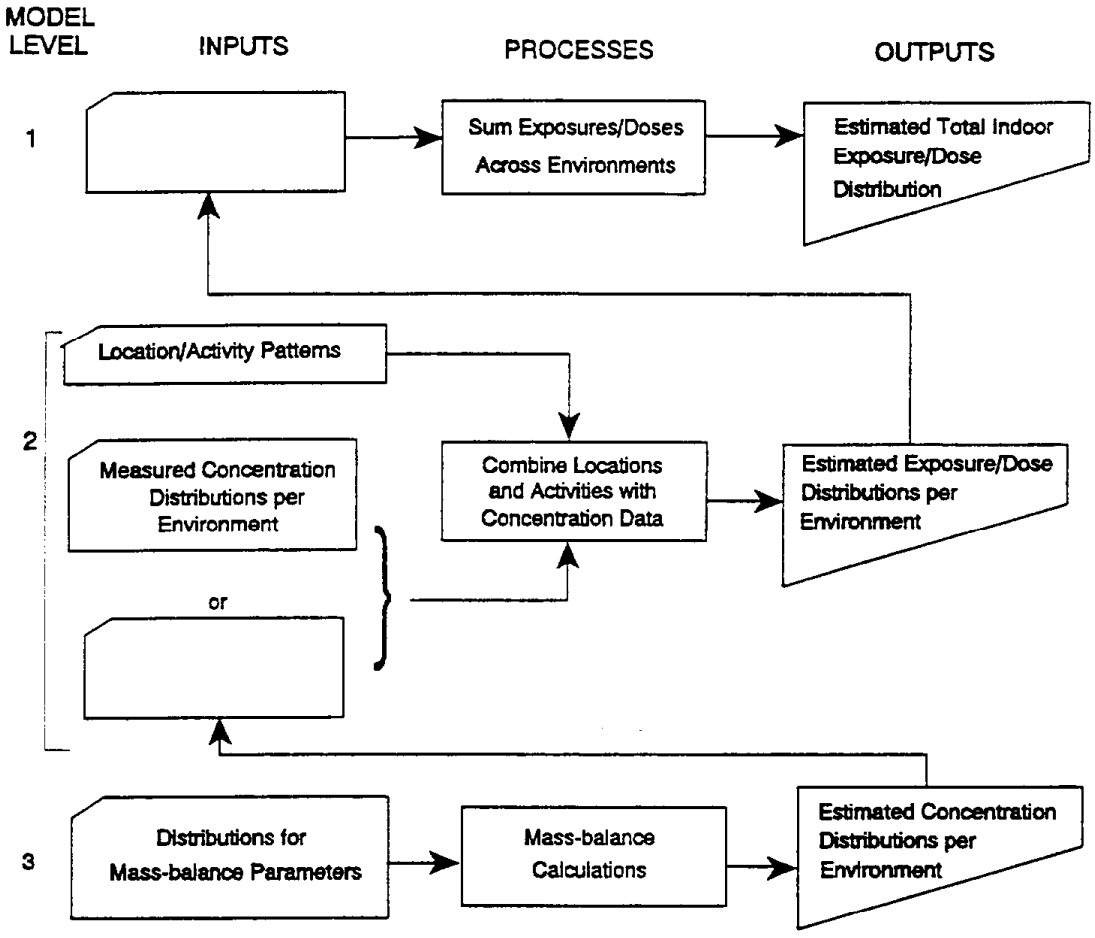


Figure 1-1. Conceptual Hierarchy for the Model

concentration in the environment, $\bar{C}_T$ ($\mu g/m^3$), is equal to C_T divided by T. $\bar{C}_T$ is not included in the summary statistics reported by the model; however, both C_T and T are included in the detailed results that are provided, enabling the user to calculate $\bar{C}_T$ if desired.

Potential inhaled dose is the product of the time-integrated concentration and the individual's breathing rate (i.e., amount of air inhaled per unit time while in the environment):

$$D_T = \int_0^T B(t)\ C(t)\ dt$$

where B(t) is the breathing rate at time t and D_T is the potential inhaled dose over the time duration T. If the breathing rate is assumed to be constant and this constant rate is expressed as $\bar{B}_T$, then the potential inhaled dose can be expressed as:

$$D_T = \bar{B}_T \int_0^T C(t)\ dt = \bar{B}_T \cdot \bar{C}_T \cdot T$$

If the breathing rate is in units of m^3/h and the units for $\bar{C}_T$ and T are as above, then D_T is expressed in μg (i.e., $m^3/h \bullet \mu g/m^3 \bullet h$). For the model, the average breathing rate while in the environment is assigned from activity codes contained in each location/activity profile; this assignment is conditional on the individual age/sex category--adult male, adult female or child (i.e., under age 12).

Each location/activity profile contains a weight variable (TIMEWT) that is used to compensate for unequal selection probabilities across the participants of ARB-sponsored surveys from which the profiles were developed for use in this model. The weight variable is used by the model to calculate weighted summary statistics (see Section 5.0) for exposure or dose. Details on the calculations that use these weights are provided in the accompanying final report on the project (see Section 5.3 of the final report).

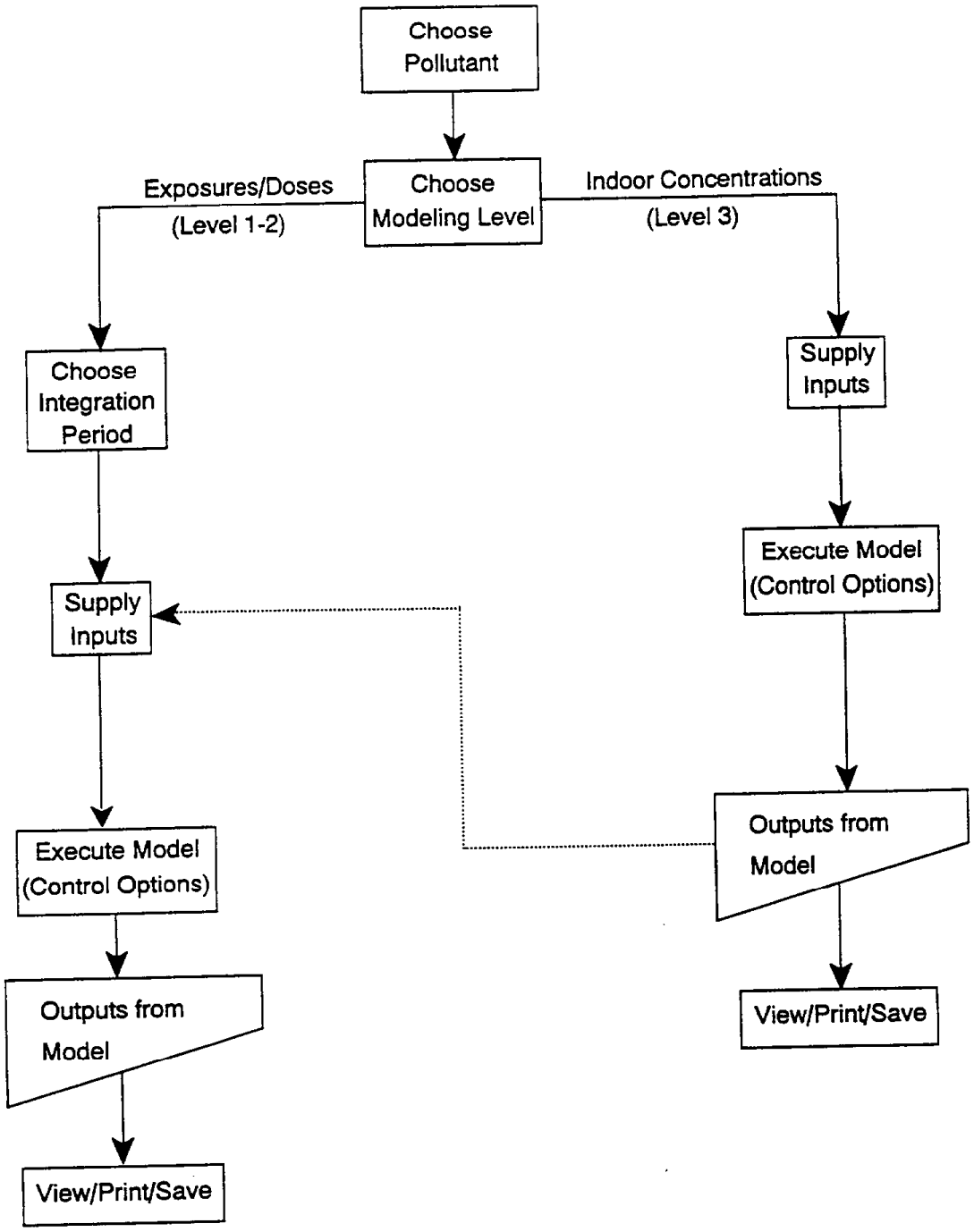


Figure 1-2. Model Overview from Standpoint of User Interface

1.3 INPUT REQUIREMENTS

Figure 1-2 provides an overview of the model from the standpoint of the user interface. In general, the user will need to (1) choose a pollutant to be modeled, (2) choose the level of model calculations (exposure/dose distributions or concentration distributions), (3) supply inputs corresponding to the chosen level and save any new inputs, (4) execute the model after supplying/saving all necessary inputs, and (5) exercise options for viewing, printing or saving model outputs. These functions can be accessed from the opening menu displayed in Figure 1-3.

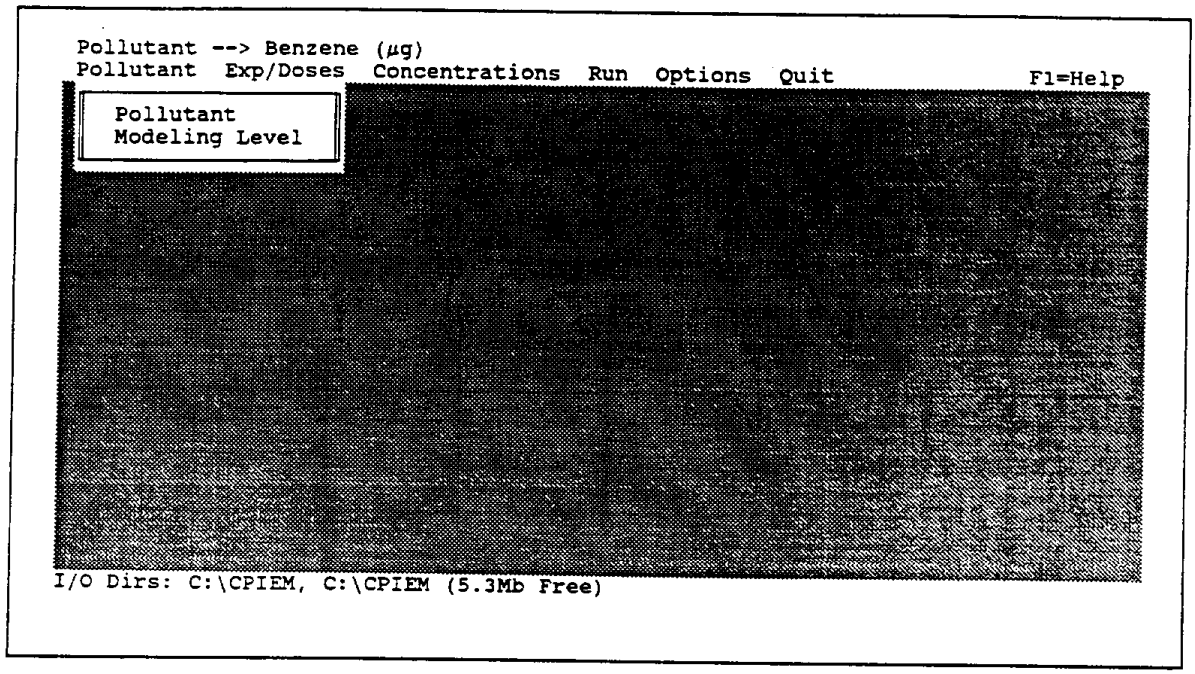


Figure 1-3. Opening Menu for the Model

The pollutant selected (benzene by default) and associated measurement unit (ng, μg, or mg) are displayed above the menu. The information at the bottom of the opening menu indicates the input/output (I/O) subdirectories in use by the model and the amount of free space on the disk drive. By default, the subdirectory from which the user executes the model (CPIEM in this case) contains both the inputs and the outputs. The user can change this default using the "Options" item in the opening menu (see Section 7.2). The

F1 key for help, indicated at the top right of the opening menu, is reserved for future use and currently is not functional.

The types of inputs required for each model level are indicated in Table 1-1. These inputs are supplied through pull-down menus associated with the "Exp/Doses" (Level 1-2) and "Concentrations" (Level 3) menus. Although defaults are provided where possible, the user will still need to take some action in complying with the input requirements. The user also has control (through the "Run" menu) over the level of detail for selected model outputs. For Level 1-2, the user controls whether summary statistics and graphs are provided for total exposure/dose (across environments) only, or for individual environments in addition to the total. For Level 3, the user controls whether statistics and graphs are provided for the daily average concentration only, or for the hourly average as well. Detailed files containing results for each model trial can be saved a the user's option. For Level 1-2, the detailed file contains both exposure and dose for each environment and in total across environments. For Level 3, the detailed file contains both hourly average concentrations and the daily average.

Table 1-1. Inputs Required for Each Level of the Model

Exposure/Dose Distributions (Level 1-2)	
Pollutant Integration Period Population Subgroup Number of Trials	Indoor Concentrations Breathing Rates Random Number Seed
Indoor Concentration Distributions (Level 3)	
Pollutant Indoor Sources Outdoor Concentrations Penetration Factors Indoor Sinks	Volumes Air Exchange Rates Number of Trials Random Number Seed

The screens for supplying inputs can be accessed using either a keyboard or a mouse. For example, choices on the opening menu previously shown in Figure 1-3 can be made (1) with the mouse, by pointing and clicking, or (2) with the keyboard, by (3) moving to the described choice using the left/right arrow keys or (4) using the "Alt" key in combination with the first letter of the choice (e.g., "Alt-Q" for Quit).

Most of the main-menu choices have an associated pull-down menu; an example is shown for the "Exp/Dose" menu in Figure 1-4. Items in the pull-down menu can be accessed in three different ways: (1) by pointing and clicking the mouse; (2) by moving the highlight bar to the desired choice using the up/down arrow keys and then pressing the "Enter" key; or (3) pressing the letter highlighted in green (usually the first letter) that corresponds to the choice. Before accessing an item on this menu, the user can return to "Pollutant" in the opening menu (1) by pressing the "Esc" key, (2) by using the left/right arrow keys, or (3) by using the "Alt-P" key combination.

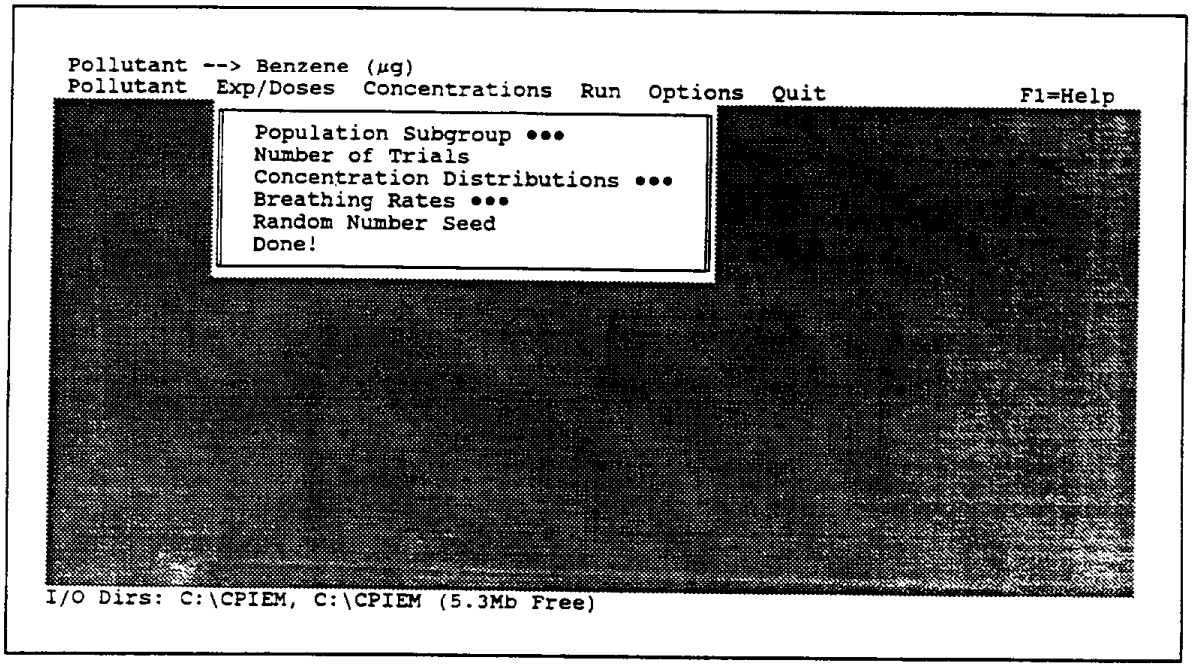


Figure 1-4. Example of a Pull-down Menu

Figure 1-5 shows an example of a submenu that is associated with a pull-down menu; in this case the submenu corresponds to the choice of "Population Subgroup" in the pull-down menu for "Exp/Dose." Items on the left side of the menu can be chosen (1) by pointing and clicking the mouse, (2) by moving the highlight bar with the up/down arrow keys and then pressing "Enter," or (3) by pressing the green highlighted letter that corresponds to the choice. In some cases, several items share the same highlighted letter; in such cases, pressing that letter will move the highlight bar to the first matching choice, pressing the letter again will move the bar to the second matching choice, and so on.

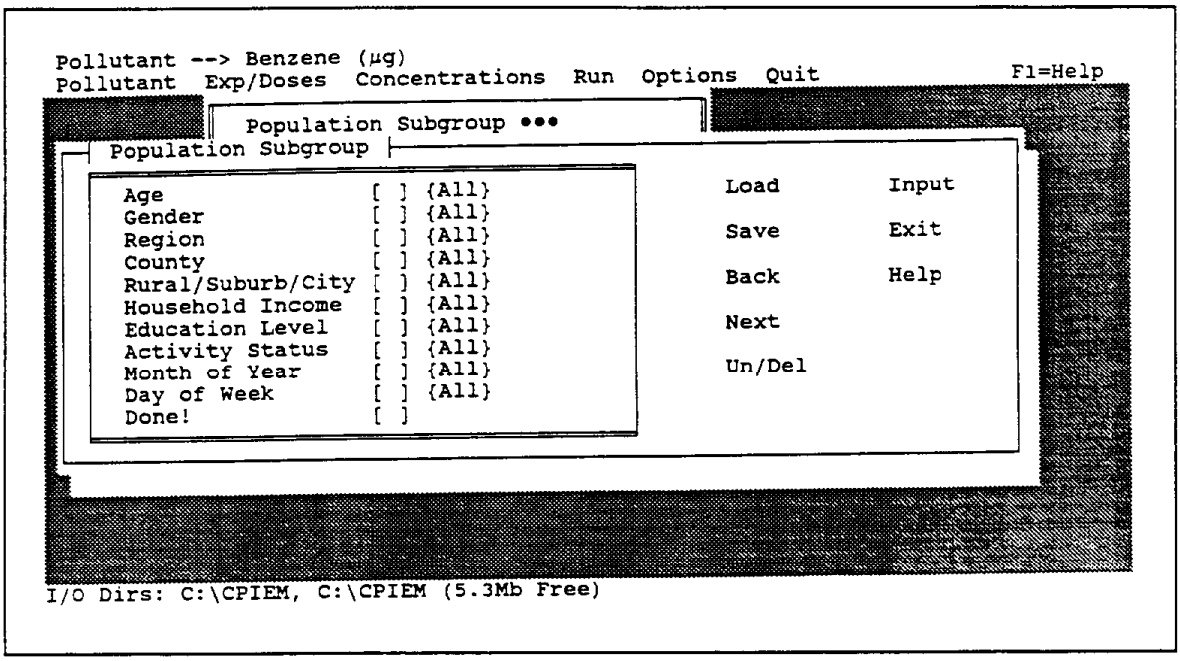


Figure 1-5. Example of a Submenu from a Pull-down Menu

"Buttons" on the right side of the submenu in Figure 1-5 provide special functions. The "Input" button, when activated after moving the highlight bar to the desired item, is used to provide information or to make choices relating to that item. The "Exit" button, equivalent to the "Esc" key, is used to return to the pull-down menu. The "Help" button is reserved for future use and currently provides no function. The "Load", "Save", "Back", "Next", and "Un/Del" buttons enable the user to retrieve, save, view, or delete choices for

items such as age, gender, and region (see Section 3.1). These buttons can be accessed (1) by pointing and clicking the mouse, (2) by pressing the "Alt" key in combination with the first letter of the button (e.g., "Alt-L" for "Load"), or (3) by pressing the "Tab" key until the desired button is highlighted (signified by all uppercase letters) and then pressing the "Enter" key.

Figure 1-6 shows an example of a pop-up menu that is associated with a submenu; in this case, the pop-up menu corresponds to the "Age" item within the submenu for "Population Subgroup." The user can move within the pop-up menu using the mouse, the up/down arrow keys, or the green highlighted letters. For this particular menu, only one choice is allowed; for some others such as "County," multiple choices are allowed. If the user chooses "All," then location/activity profiles will be selected for individuals of all ages; if "Between" is chosen, then the user must provide the age range ("Lowest" and "Highest") by entering numbers followed by the "Enter" key; if "C", "D", "E", or "F" is chosen, then the software will automatically enter the corresponding range.

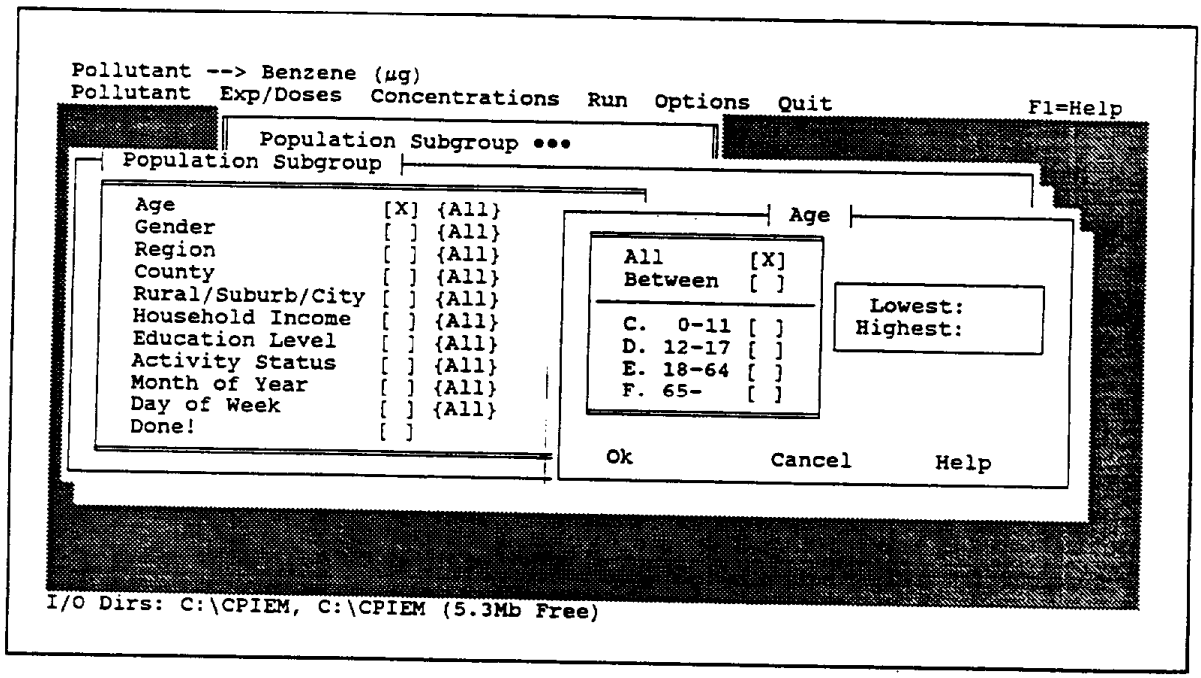


Figure 1-6. Example of a Pop-up Menu for a Submenu

The "Ok" button at the bottom of the pop-up menu, accessed through the mouse, "Tab" key or Alt-O combination, signifies completion of the choice for "Age" and returns the user to the submenu. The "Cancel" button, equivalent to the "Esc" key, also returns the user to the submenu but voids the current choice, leaving the previous or default choice in place. Default choices are provided for some, but not all, of the pop-up menus. In the example case, the defaults will result in selection of all location/activity profiles that are available to the model.

1.4 ACCESSING THE MODEL

The user can access the model by entering the command CPIEM at the DOS prompt from the subdirectory containing the executable files for the model (see Appendix A). This command invokes the CPIEM.EXE file, which in turn invokes all other files as needed. After entering this command, the user will be presented with the introductory screen in Figure 1-7. Pressing any key will then provide access to the opening menu previously shown in Figure 1-3.

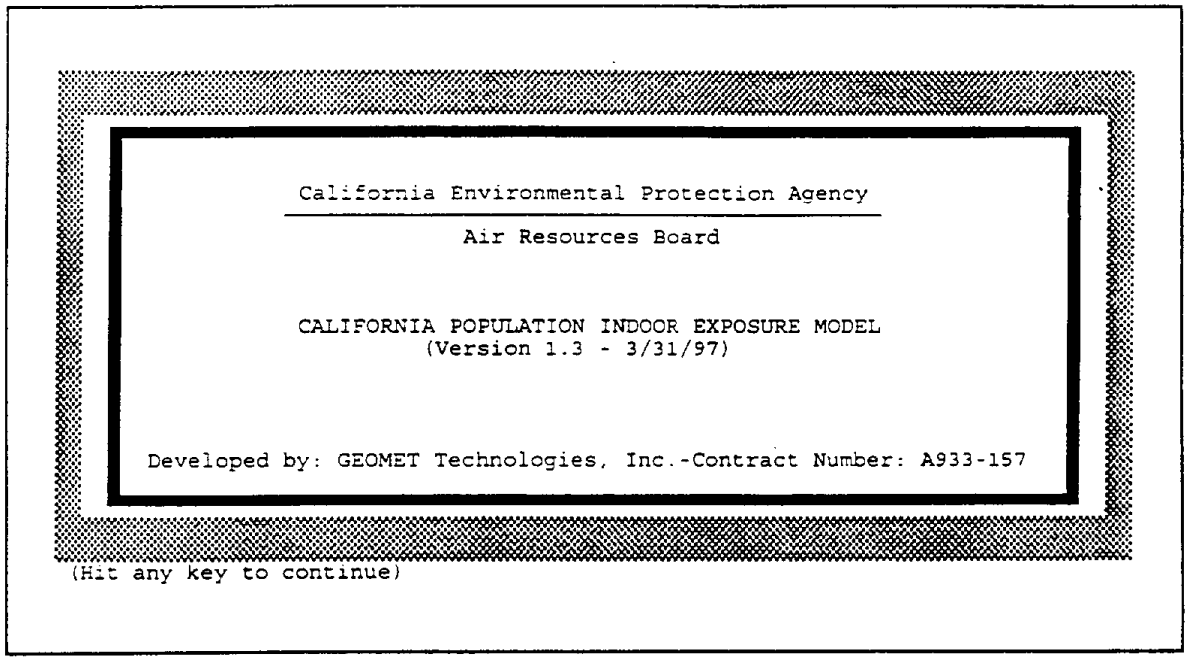


Figure 1-7. Introductory Screen

Section 2.0

SPECIFICATION OF POLLUTANT AND MODELING LEVEL

2.1 POLLUTANT

Only one pollutant can be selected for each "run" of the model. The choice of pollutant is accessed by highlighting "Pollutant" on the opening menu. After selecting a pollutant, the user will be prompted for choice of a modeling level (see Section 2.2).

After "Pollutant" has been chosen in the opening menu, the user will be presented with the submenu shown in Figure 2-1. The software is initially provided with a list of 10 pollutants; others can be added easily, as discussed below. One of the pollutants on the list can be selected by pointing with the mouse, by moving the highlight bar with the up/down arrow keys, or by entering the first letter of the pollutant. (If there are multiple pollutants that start with the same letter, the letter may need to be entered more than

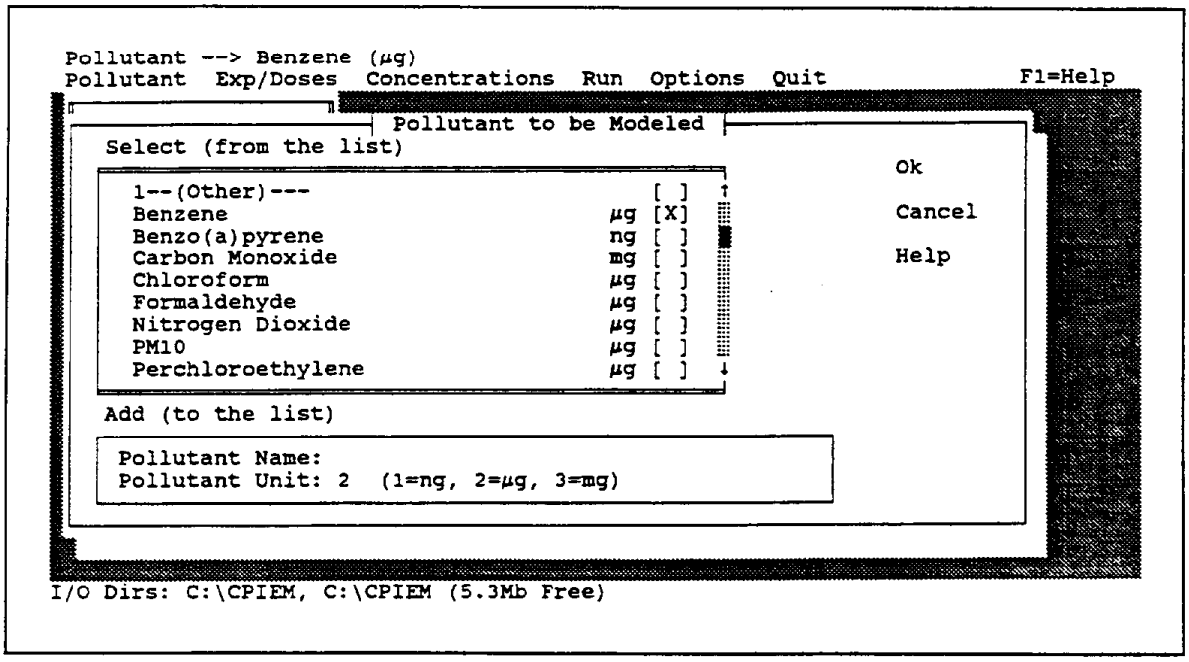


Figure 2-1. Submenu for Selecting a Pollutant

once to access the pollutant of choice.) The choice of pollutant is activated with the mouse, by clicking on the chosen pollutant a second time or by clicking on the "Ok" button, or with the keyboard, by using the "Enter" key or the Alt-O key combination to activate the "Ok" button. There are more pollutants on the list than appear in the "Select (from the list)" box. Choices after perchloroethylene may be viewed by scrolling with the up/down arrow keys. Scrolling can also be activated with the mouse by pointing to the up/down arrows at the right edge of the "Select" box and then clicking.

If the user repeatedly presses the left or right arrow keys, the cursor will eventually activate in the Pollutant Name or Pollutant Unit field near the bottom of this screen. The list of pollutants to be selected can be accessed from there by repeatedly pressing the Tab key or the Shift-Tab key combination, or by clicking on one of the pollutants with the mouse. If the user presses the Alt-O (for Ok) key combination, the Modeling Level submenu will appear, from which the user can return to the pollutant list by pressing the Esc key or the Alt-C (for Cancel) key combination.

The name of the pollutant that is chosen will be displayed above the menu area. By default, when accessing the model for the first time, the first pollutant in the list (benzene) is chosen. It is possible to add new pollutants to the list using the "Add (to the list)" box near the bottom of the Pollutant submenu. This feature can be activated with the mouse by clicking on 1 (Other) under "Select (from the list)" or by clicking on the box next to Pollutant Name under "Add (to the list)." With the keyboard, this feature can be activated by selecting 1 (Other) as the pollutant or by using the Alt-A combination (Alt-S returns the user to "Select"). When this option has been activated, a cursor will appear next to "Pollutant Name." The name of the pollutant to be added can then be entered from the keyboard (maximum length of 20 characters); the return key is used to signify completion of the entry. The user will then be prompted for choice of pollutant measurement unit (ng, μg, or mg). Figure 2-2 shows the revised menu after a new pollutant--Ozone--has been added to the list in the manner described above. The new pollutant will not appear on the list until the user has made a choice of modeling level (see Section 2.2). To use the new pollutant for a modeling run, the user will need to enter and save inputs for the chosen modeling level.

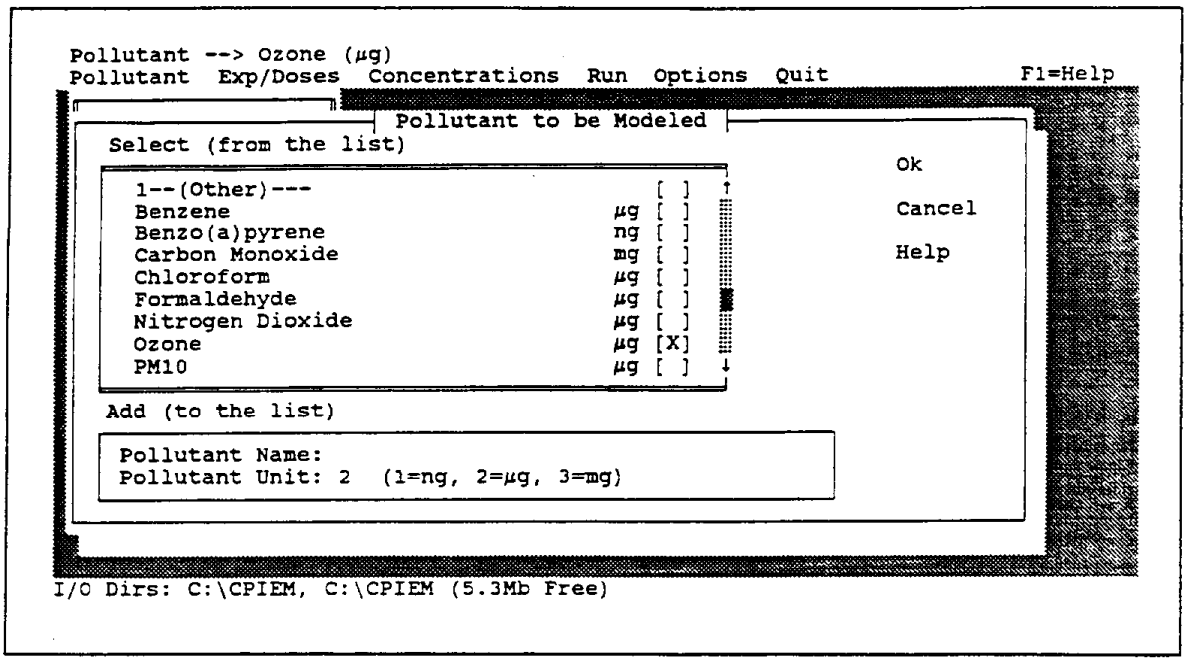


Figure 2-2. Pollutant Submenu with Addition of a New Pollutant (Ozone)

During the first use of the model, during any session, only the "Pollutant", "Options", and "Quit" items in the opening menu will initially be accessible (invoking the "Quit" option will return the user to the DOS prompt). As the user proceeds through the "Pollutant" menu, other choices will become available. For example, depending on the choice of modeling level, either the "Exp/Doses" or "Concentration" menu will be available. After entering choices or inputs for one of those menus, the "Run" menu will then be available. Menu items that are currently available to the user are highlighted in yellow.

2.2 MODELING LEVEL

After selecting a pollutant, the user will be presented with the "Modeling Level" submenu shown in Figure 2-3. Choosing the default (Exposures/Doses for One or More Environment) will take the user to an "Integration Period" submenu (discussed below). The other choice (Concentrations for One Environment) will allow the user to access "Concentrations" in the opening menu.

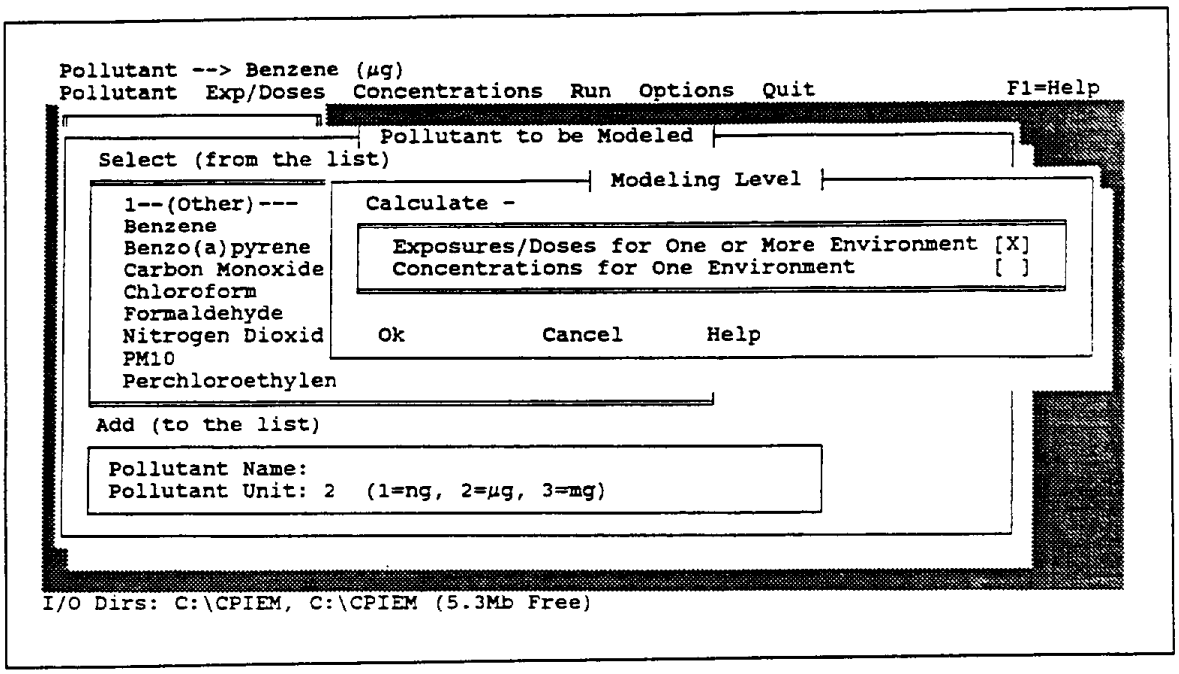


Figure 2-3. Submenu for Modeling Level

When the exposures/doses option is selected, the user will be prompted to choose an integration period (Figure 2-4). For the first three choices (24 hour, 12 hour daytime, and 12 hour nighttime), a daily concentration value will be combined with an activity profile for each trial of the simulation. For the last two choices (1 hour and 8 hour), 24 concentration values per day will be linked with an activity profile for each trial. Files containing properly formatted activity profiles for each of the integration periods are provided with the model (see Section 7.1). For example, for the "12-hour daytime" option, each activity profile in the file WC_ACTAM covers the 12-hour period from 6:00 a.m. to 6:00 p.m.

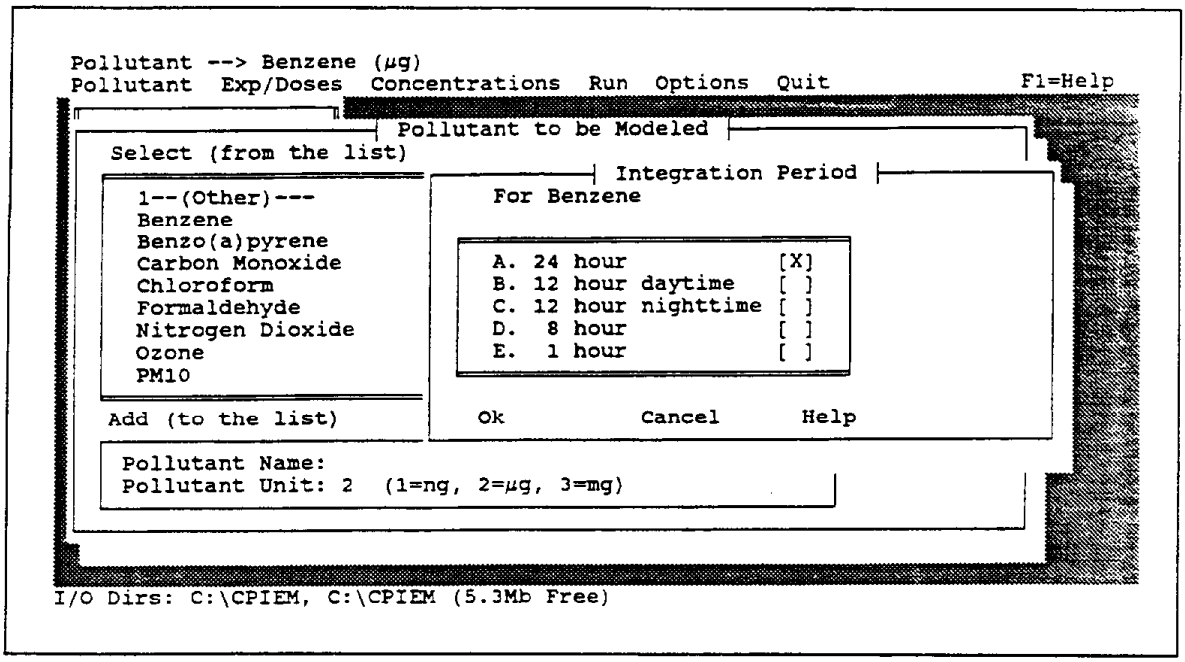
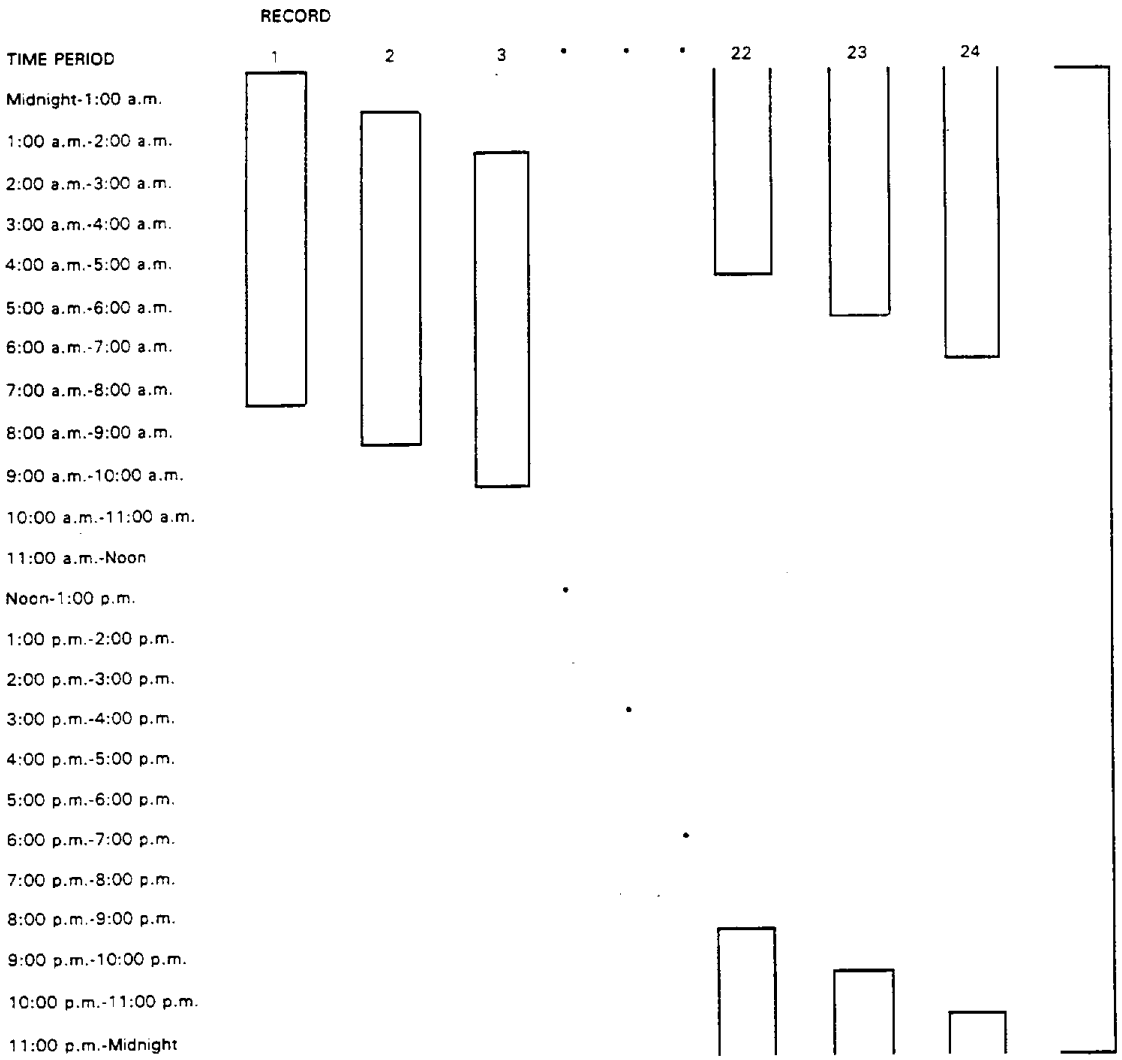


Figure 2-4. Submenu for Integration Period

For the "1 hour" option, the activity profile is segmented into 24 hourly periods (midnight to 1:00 a.m., 1:00 a.m. to 2:00 a.m., etc.). The activity profile for the "8 hour" option is segmented into 24 "running" or overlapping periods. Because activity profiles were collected for a single 24-hour period for each survey respondent, the 8-hour profile "wraps around" the midnight hour (see Table 2-1). That is, the first period is from midnight to 8:00 a.m., the second record is from 1:00 a.m. to 9:00 a.m., the 16th record is from 4:00 p.m. (1600 hours) to midnight, the 17th record is from 5:00 p.m. to 1:00 a.m. (wrapping around midnight), and the 24th record is from 11:00 p.m. to 7:00 a.m.

On completion of the "Integration Period" submenu, the user will have access to "Exp/Doses" in the opening menu. Inputs for exposures/doses (Level 1-2 of the model) are discussed in the next section (Section 3.0), and inputs for concentrations (Level 3) are discussed in Section 4.0.

Table 2-1. Time Periods Covered by Successive Records for an 8-Hour Activity Profile



Section 3.0

INPUTS FOR EXPOSURES/DOSES

After selecting "Exp/Doses" in the opening menu, the user will be presented with the pull-down menu shown in Figure 3-1. Inputs are required for population subgroup, number of trials, concentration distributions, breathing rates, and random number seed. Each of these submenus is discussed separately in the subsections that follow. Three of the submenus--population subgroup, concentration distributions, and breathing rates--have trailing dots (. . .) to indicate that the user has the option of saving inputs for subsequent access in later model runs. If a pollutant is selected for which no inputs have been previously provided, then inputs for concentration distributions for at least one environment must be provided and saved for the model to execute properly.

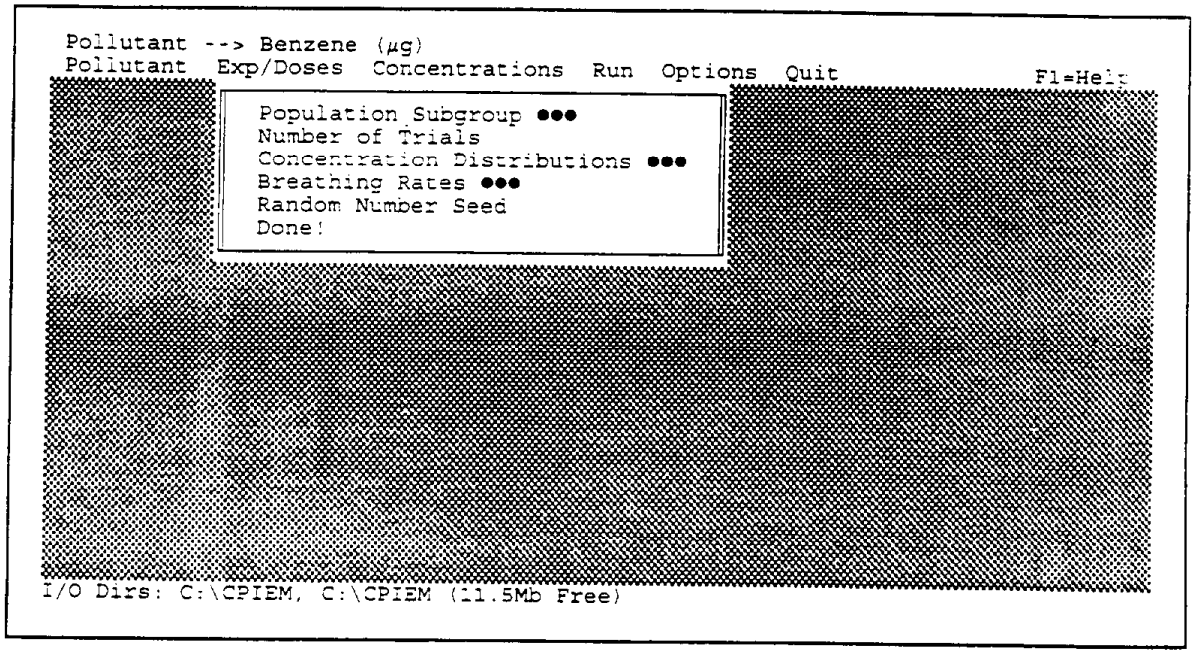


Figure 3-1. Pull-down Menu for Exposures/Doses

The submenus generally do not need to be accessed in any specific order, except that the number of trials cannot be specified until a population subgroup has been selected. A check mark (✓) will be placed next to each submenu after it has been accessed by the user. Strictly speaking, not all submenus need to be accessed, as some

defaults are provided; however, the user is advised to "visit" each submenu to verify that the desired choices are in effect. Completion of inputs for exposures/doses is signaled by choosing "Done!" at the bottom of the pull-down menu. The user will then have access to "Run" (i.e., model execution) in the opening menu (see Section 5.0).

3.1 POPULATION SUBGROUP

The purpose of this submenu (Figure 3-2) is to allow the user to choose a set of activity profiles that will be linked with pollutant-concentration data for selected environments in order to estimate an indoor exposure/dose distribution. By default, a total of 2,962 activity profiles, gathered through ARB-sponsored surveys of adults, adolescents and children (see Section 5.2 of the final report), can be used. Any combination of criteria (age, gender, etc.) can be used as a basis for selecting a subset of the activity profiles. However, the user is cautioned that too many conditions (e.g., young males in low-income households during the winter) may result in a relatively low number of matching activity profiles. Once the choice of matching criteria is made and signaled by entering "Done!" at the bottom of this submenu, the software will locate and store all matching profiles and will report the number of matches at the top of the screen. It is recommended that the number of matching profiles be at least 100 for a meaningful model run.

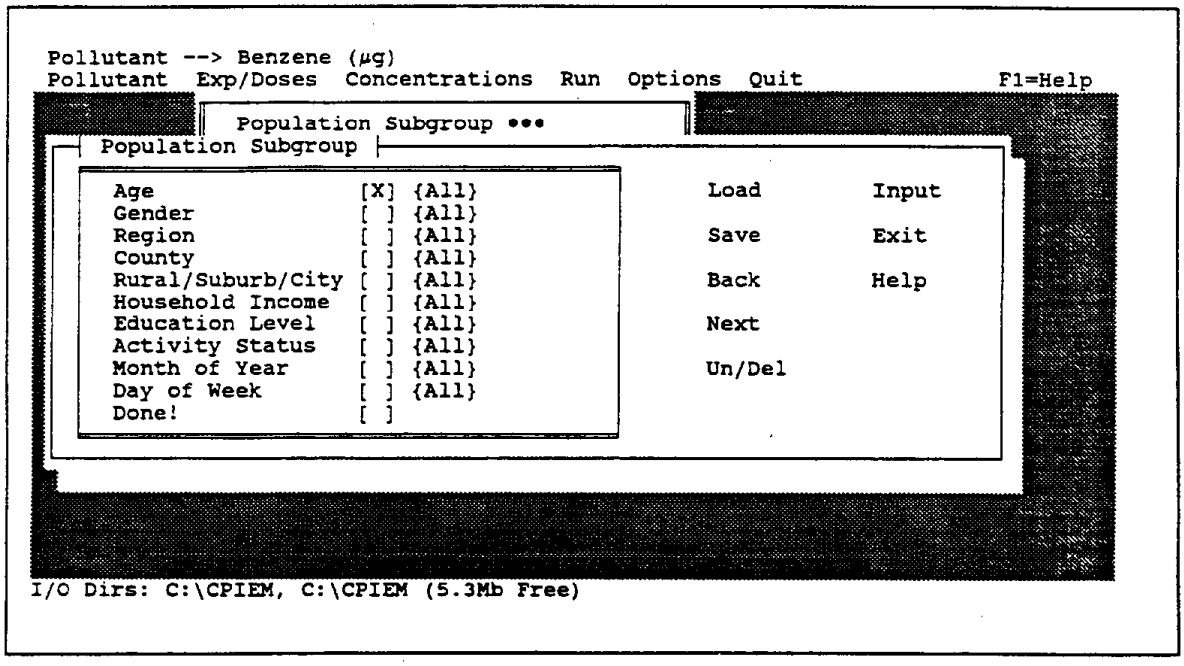


Figure 3-2. Submenu for Population Subgroup (Initial Default Setting)

By default, at initial access of the model the legend "All" appears next to each criterion for population subgroup, indicating that all cases associated with each criterion (e.g., all ages) are to be selected (after initial access, the user's most recent choices will be displayed as the default). A specific subset of cases (e.g., children under age 12) can be selected by choosing the corresponding criterion (in this case "Age"). After choosing age, for example, the pop-up menu in Figure 3-3 will appear. If the user chooses the "Between" option, then the cursor will appear next to the field for "Lowest." As shown in Figure 3-3, 0 was entered for lowest and 11 for highest to choose the subset of children under age 12 (this particular choice can be made more directly by selecting the "0-11" category below the "Between" option). An "X" next to the "Age" criterion indicates that the corresponding submenu has been accessed by the user. Only those criteria that are desired as a basis for selecting a subgroup need be accessed.

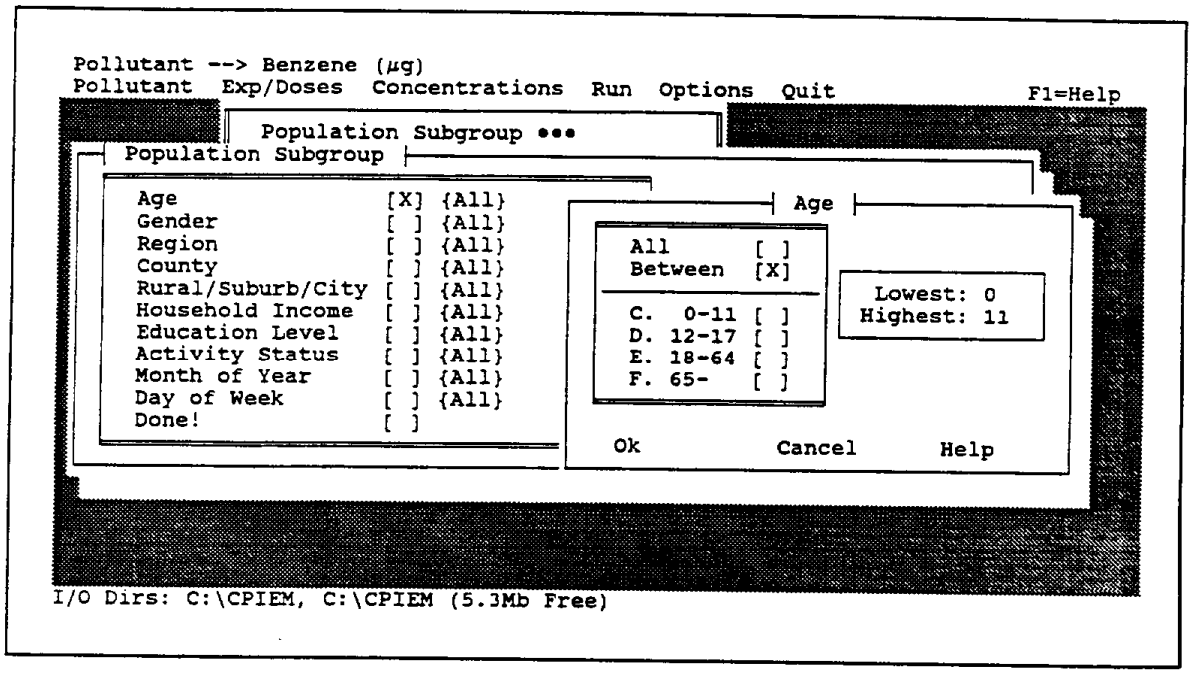


Figure 3-3. Pop-up Menu for the Age Criterion

Continuing with this example, if "Region" were chosen as the next criterion, then the pop-up menu in Figure 3-4 would appear (note that the legend "0-11" now appears

next to the "Age" criterion, reflecting the choice made above). Multiple choices are allowed for the "Region" criterion; in this case, two regions were selected. The mouse or "Enter" key can be used to toggle choices on or off; choosing "All" removes all other choices.

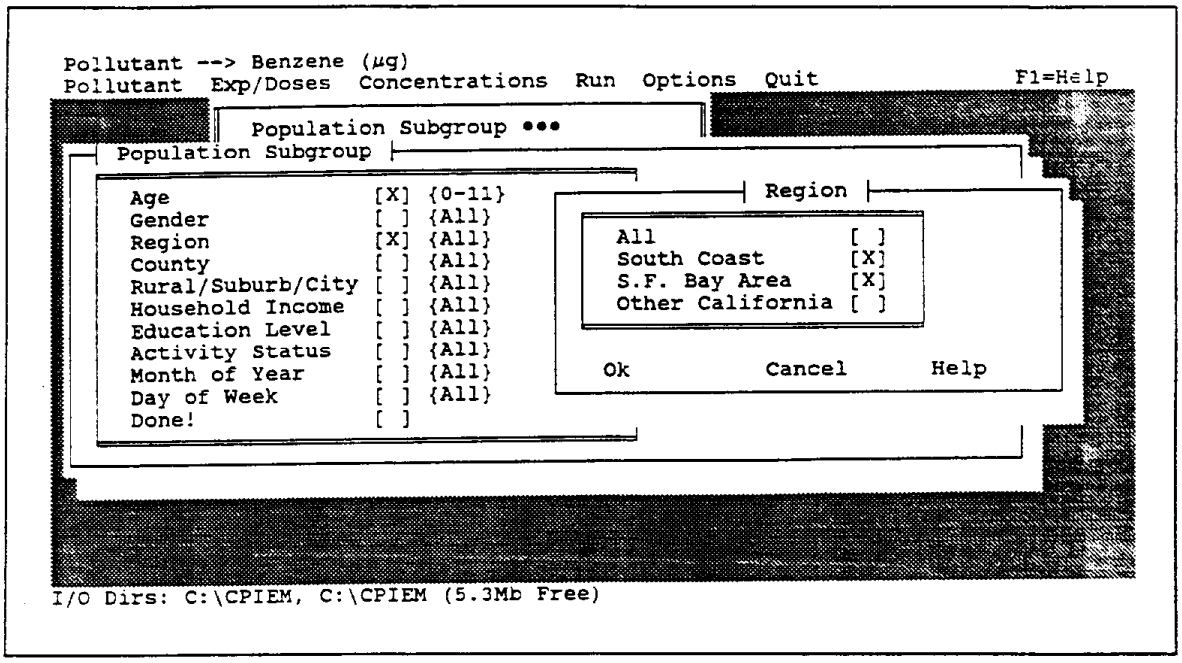


Figure 3-4. Pop-up Menu for the Region Criterion

The buttons to the right of the "Population Subgroup" submenu (see Figure 3-2) allow the user to load, save, view or delete various combinations of choices. (Saving choices is not mandatory, but would be useful if the user were planning on making a series of runs involving different population subgroups.) For example, if the user wished to save the selections for age and region, then he/she would use the "Save" button. Once this choice is made (see Figure 3-5, note "Save" is now capitalized), the user is prompted for a "Case Name" (up to 8 characters) and "Description" (up to 40 characters). For this example, the case name AGEREGN was chosen (note also that the legend "2 chosen" now appears next to the "Region" criterion). By a similar process (not shown), a second case (LOWINC, households with annual incomes of $20,000 or lower) was saved for this example.

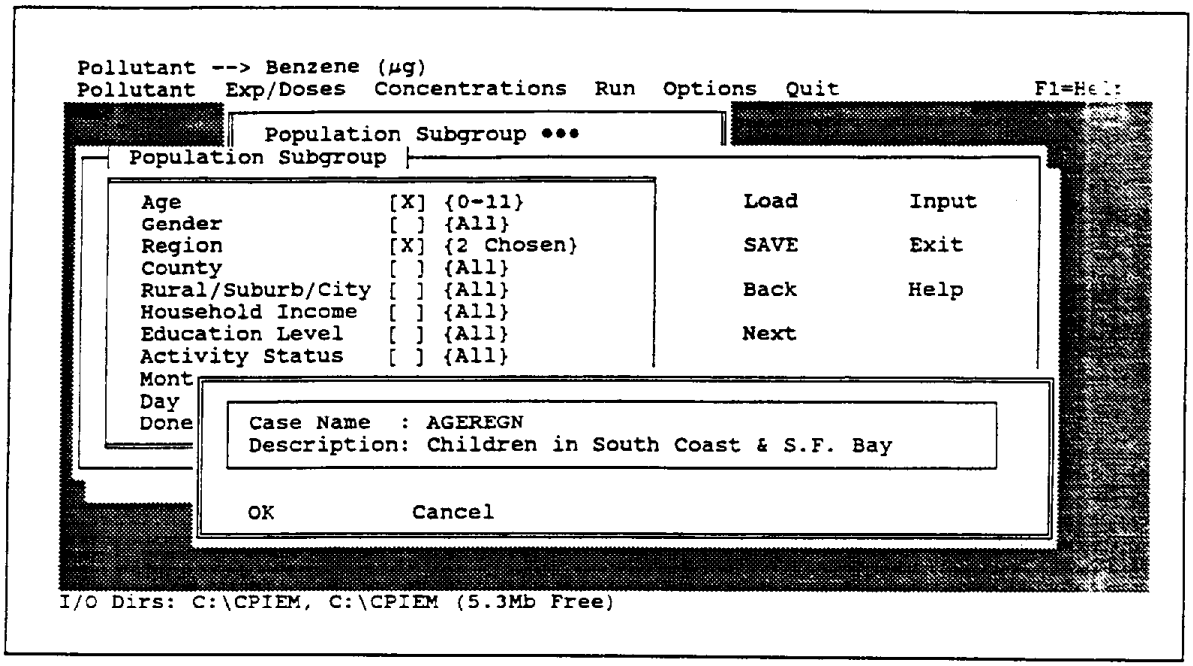


Figure 3-5. Entries Associated with the Save Button for Population Subgroup

The "Load" button allows the user to access all previously saved cases. Figure 3-6 shows the screen that appears after making this choice. In this example, both AGEREGN and LOWINC were selected; after choosing the "Ok" button, the user can then review the choices associated with these cases using the "Prev" and "Next" buttons (Figure 3-7); the active case, LOWINC in the figure, is indicated above the "Load" button.

Case names can be temporarily deleted (and restored) using the "Un/Del" button. Any case for which this option is toggled on will be marked for deletion, but will not actually be deleted until another case is saved. The next saved case, which is not required to have the same name as the case marked for deletion, will be saved in the file location previously occupied by the deleted case, and the deleted case will no longer be accessible. A special case name "INITIAL," accessible through the "Load" button, can be used to restore the "Population Subgroup" submenu to its default setting ("All" for each criterion).

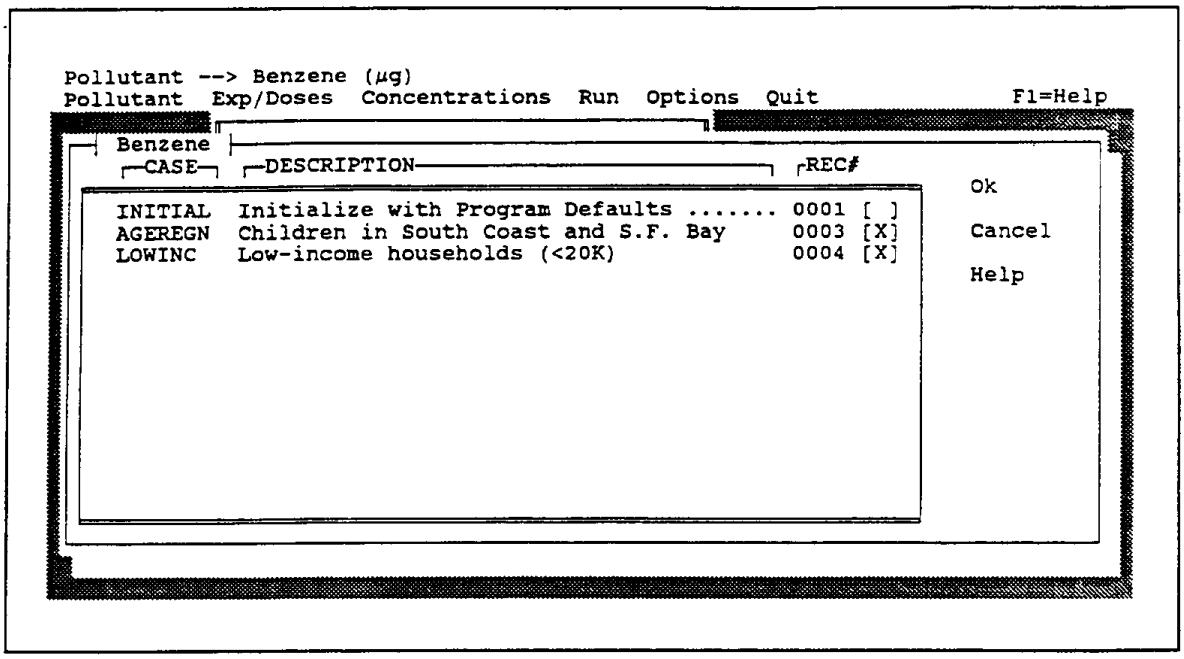


Figure 3-6. Choice of Two Case Names (AGEREGN AND LOWINC) through the Load Button for Population Subgroup

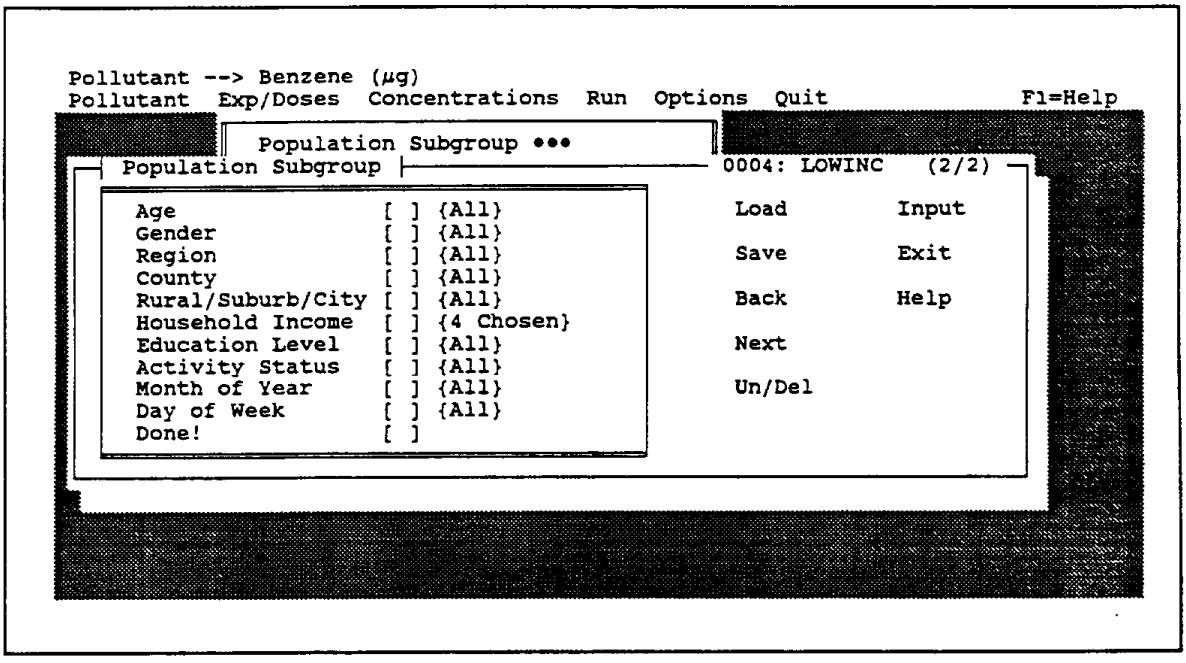


Figure 3-7. Choices Associated with the LOWINC Case Name Accessed Through the Prev or Next Button After Loading

Completion of choices for the "Population Subgroup" menu, or choice of the active case from various cases that are loaded, is signaled by choosing "Done!" at the bottom of the criteria list. The software then searches for all available matches, returns to the opening menu, and indicates the number of matches that have been found. For the example shown in Figure 3-8, corresponding to the choice of AGEREGN as the active case name, 487 matches were found. The matching process generally takes only a few minutes to complete, unless 1-hour or 8-hour has been chosen as the integration period. In such cases, there are 24 records associated with each activity profile, and about 30 to 60 minutes will be required to locate and save the matching profiles, depending on the speed of the user's computer.

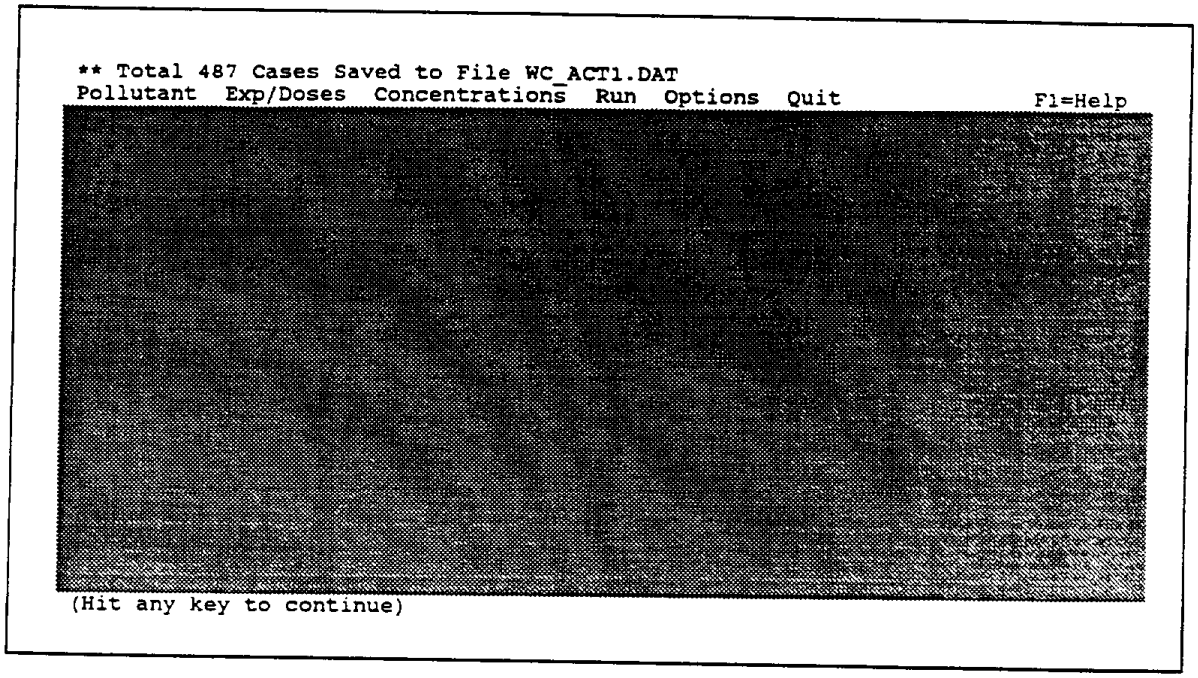


Figure 3-8. Number of Matched Activity Profiles Associated with Case Name AGEREGN

Several of the other criteria within the "Population Subgroup" submenu warrant some discussion. For example, for the "County" criterion, any combination of 58 counties can be chosen. Because of the large number of choices, a scrolling pop-up menu is provided. The "Month of Year" criterion also has a scrolling pop-up menu; at the bottom of this menu, months associated with specific seasons can be chosen (e.g., choosing "Winter" is equivalent to choosing "December," "January" and "February"). Similarly, for the "Day of Week" criterion, "Weekdays" or "Weekend" can be specified in addition to specific days of the week. The "Education Level" and "Activity Status" criteria apply only to adults, but adolescents and/or children can be chosen through these criteria by selecting "Teen" or "Youth." Table 3-1 summarizes features such as multiple choices, scrolling menu and default combinations of choices in relation to the items (criteria) on the "Population Subgroup" submenu.

Table 3-1. Features of Pop-up Menus for Items on the Population Subgroup Submenu

Item	Multiple Choices Allowed	Scrolling Menu	Default Combinations of Choices	Choices specific to Children	Entry of Values
Age			X		X
Gender					
Region	X				
County	X	X			
Rural/Suburb/City	X				
Household Income	X	X	X		
Education Level	X			X	
Activity Status	X			X	
Month of Year	X	X	X		
Day of Week	X		X		

3.2 NUMBER OF TRIALS

The "Number of Trials" submenu generally refers to the number of times the software will randomly choose an activity profile from the matched subset (487 cases for the example previously shown in Figure 3-8) and link this profile with randomly chosen concentrations for various environments (see Section 3.3). However, the user can also choose to use all available profiles and instruct the model to use each matching profile once, rather than sample profiles at random. As shown in Figure 3-9, this option ("Use All") is the default. Additional choices provided by the model are 100, 500, and 1,000 trials; any other choice can be specified by selecting "Other." When choosing this option, the user generally should not specify a number of trials that is more than half the number of matching profiles; otherwise, the likelihood is high that some profiles may be selected more than once.

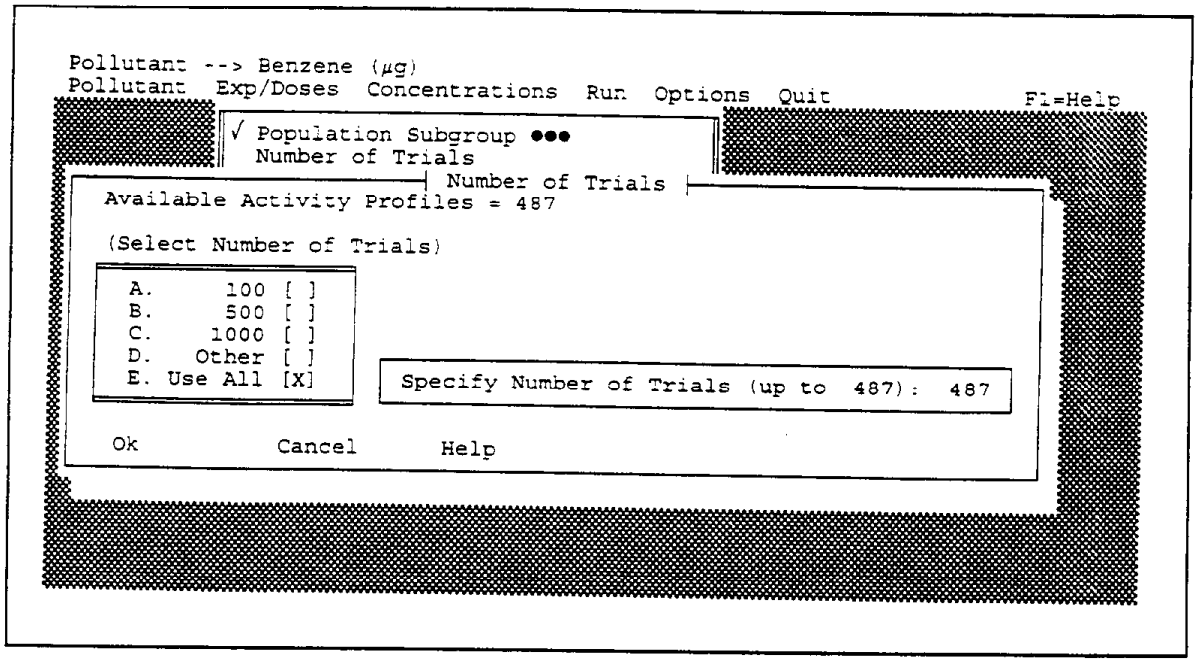


Figure 3-9. Submenu for Number of Trials (Default Setting)

If the chosen number of trials exceeds the number of available profiles, a warning is issued (Figure 3-10) but the user is allowed to proceed with that choice. There is a trade-off between the number of trials and the stability of estimates from the simulation, particularly for parameters such as the upper percentiles of the exposure or dose

distribution--the larger the number of trials, the more stable the estimates will be. Thus, in some cases, the user might elect to choose a number of trials that is larger than the number of profiles, despite the warning message, in order to increase the stability of parameter estimates. In this case, there is absolute certainty that some activity profiles will be selected more than once. Because each randomly selected profile is combined with a randomly chosen concentration for each environment, sampling a profile twice is essentially equivalent to monitoring an individual on two days, except that his or her activity profiles would be identical for each of those days.

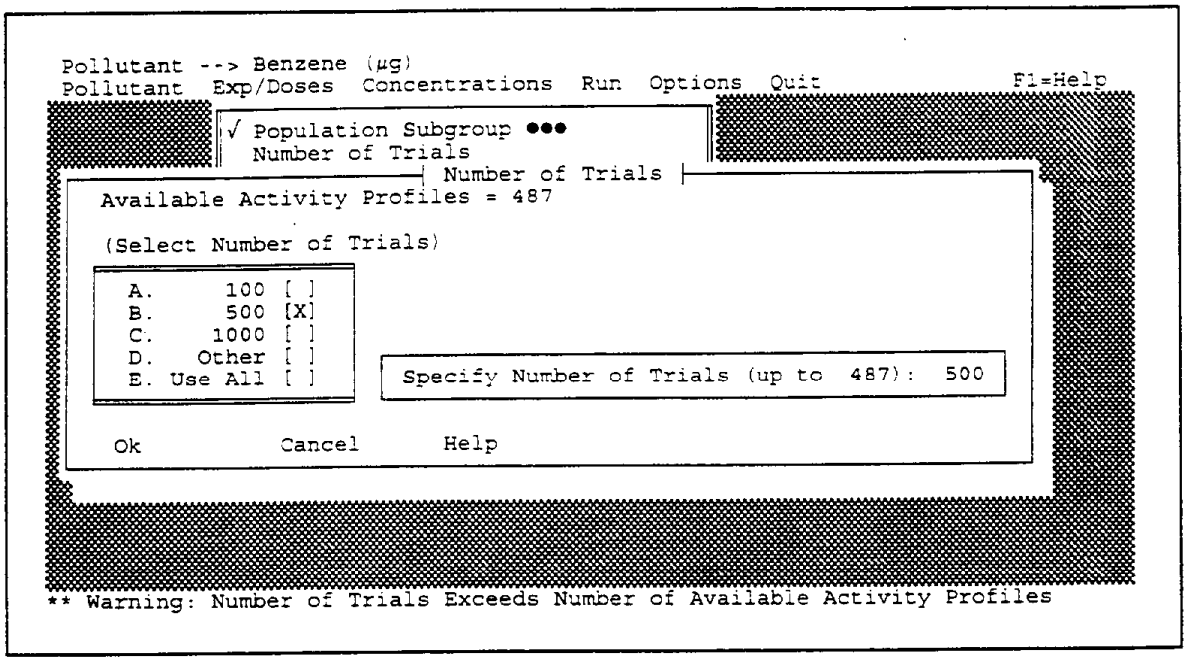


Figure 3-10. Warning Message When the Chosen Number of Trials Exceeds the Number of Available Activity Profiles

The maximum number of trials allowed is 9999. If the user selects an 8-hour or 1-hour integration period (see Section 2.2), then the maximum number of trials will be constrained by available conventional memory because 24 concentration values are sampled for each trial. For example, if the available memory is 585K, then the maximum number of trials is approximately 650. However, there are in effect 15,600 trials (i.e., 650 x 24) in this instance.

3.3 CONCENTRATION DISTRIBUTIONS

The purpose of this submenu (Figure 3-11) is to provide concentration inputs for the exposure/dose calculations. (In cases where no concentration data are available from previous field-monitoring studies, the "Concentration" option in the opening menu can be used to estimate concentration distributions as a basis for providing inputs to this submenu.) As shown in Figure 3-11, concentration inputs can be provided for any of nine environments; however, only those environments selected by the user (indicated by an "X" next to the environment) will be included in the simulation.

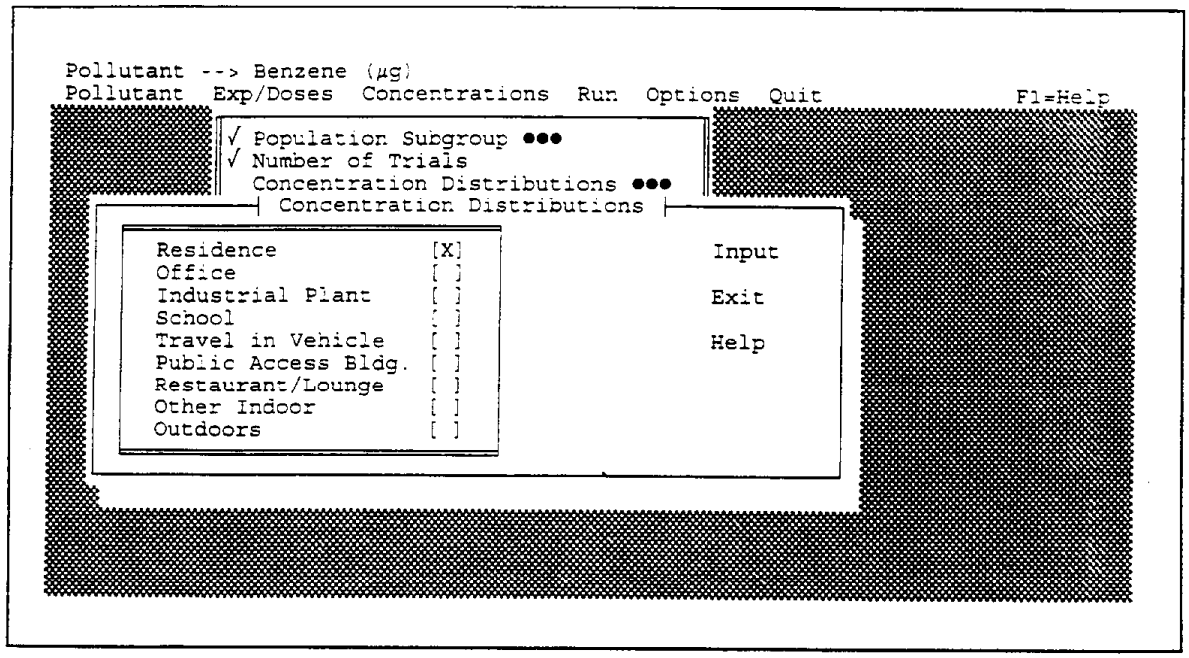


Figure 3-11. Submenu for Concentration Distributions (Initial Default Setting)

Inputs are to be provided for one environment at a time, by choosing an environment and then pressing the "Input" button to gain access to the pop-up menu for type of distribution shown in Figure 3-12 (note that concentration units, $\mu g/m^3$ in this case, are indicated at the bottom of the screen). Within this pop-up menu, buttons to the right ("Load," "Save," etc.) function in the same manner as described in Section 3.1 for population subgroups. The one exception is the addition of a "Weight" button. This button, which allows the user to provide more than one concentration distribution for a given environment (e.g., if results from two field studies with equal credibility but somewhat different results are available), is described in greater detail near the end of this section.

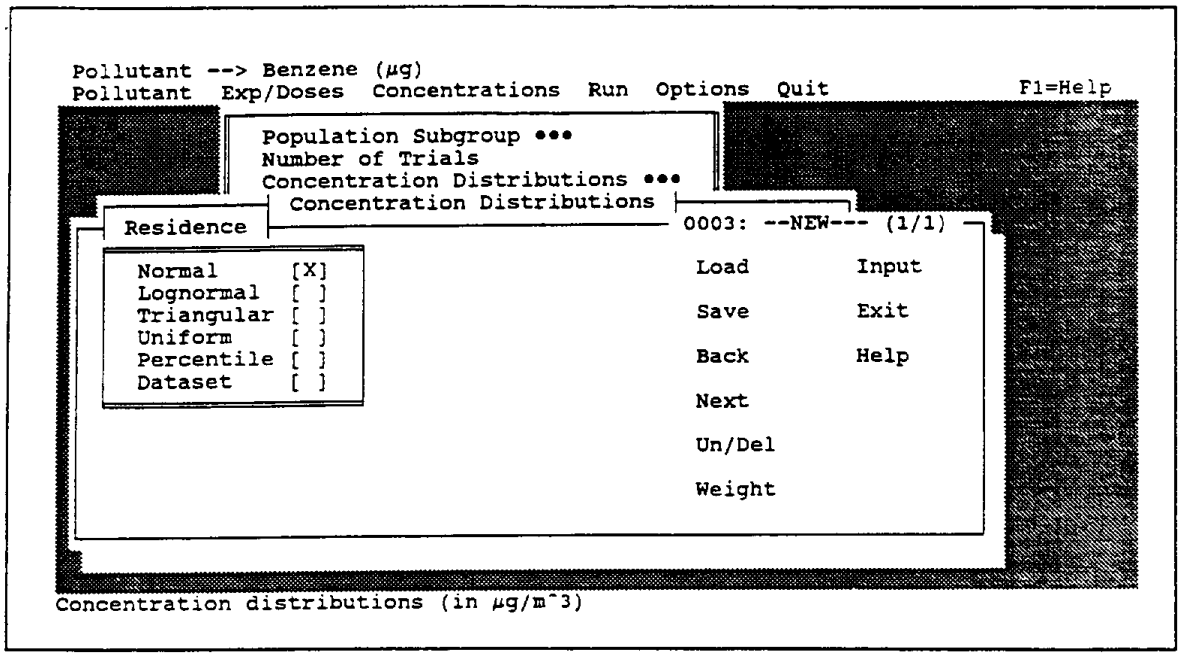


Figure 3-12. Pop-up Menu for Type of Distribution (Initial Default Setting)

The pop-up menu for type of distribution functions identically for each of the nine environments and is shown here only for "Residence." If "Normal" is selected (Figure 3-13), then the user will be prompted for the arithmetic mean and standard deviation. Input requirements for other types of distributions are summarized in Table 3-2. If "Lognormal" is selected, then the user will be again prompted for the arithmetic mean and standard deviation (not the geometric mean and standard deviation), but the concentration values randomly selected by the model will follow the shape of a lognormal, rather than normal, distribution. If the user chooses "Normal" and specifies a standard deviation with a magnitude approaching that of the mean, then negative values could theoretically be sampled. The software is programmed to discard such values, resulting in a left-truncated (i.e., zero-bounded) normal distribution. Such occurrences generally should be avoided, unless the user has strong evidence that a left-truncated normal distribution is appropriate. To prevent such occurrences, the standard deviation generally should be a third (or less) the magnitude of the mean when the "Normal" distribution is selected, or the user should choose some other type of distribution.

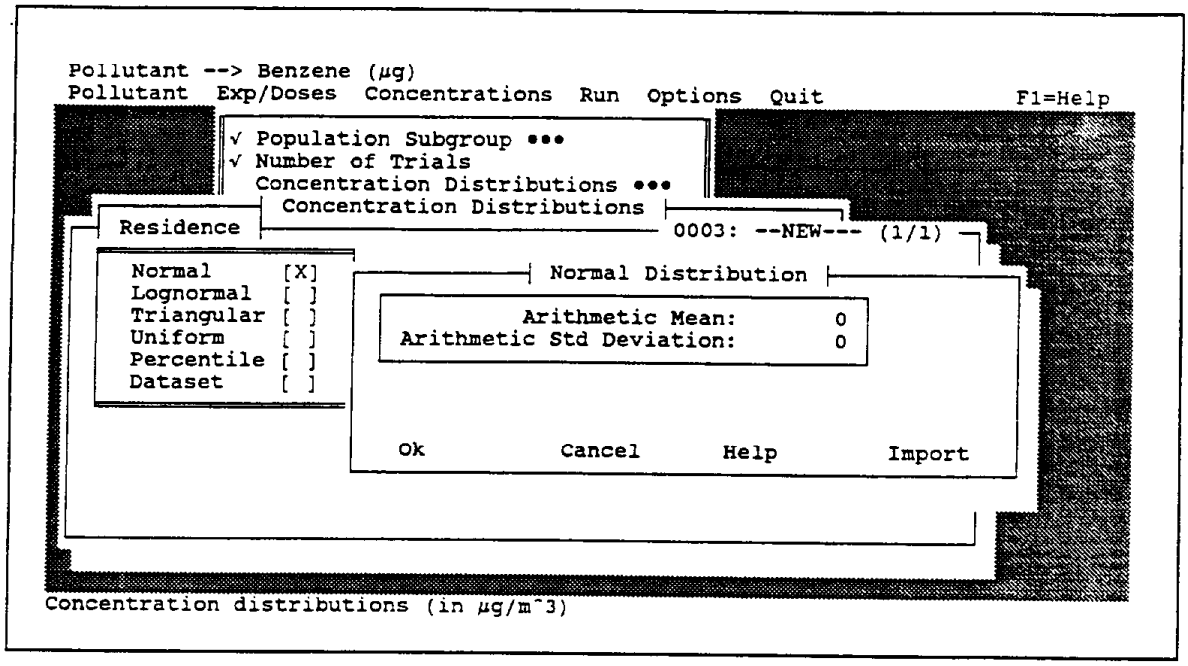


Figure 3-13. Pop-up Menu for Normal Distribution

Table 3-2. Types of Concentration Distributions Available in the Model and Associated Input Parameters

Type of Distribution	Input Parameters
Normal	Mean, standard deviation
Lognormal	Mean, standard deviation
Triangular	Minimum, mode, maximum
Uniform	Minimum, maximum
Percentile	Up to 12 pairs of percentiles and associated values
Dataset	Name of file (.DBF format)

If "Triangular" is selected, then the user will be prompted for the minimum, mode and maximum. This particular distribution can provide a reasonable approximation for many other types of distributions, including normal and lognormal; for example, a triangular distribution with the mode equidistant from the maximum and minimum would approximate a normal distribution. If "Uniform" is selected, then only the minimum and

maximum values need be provided; however, concentration distributions typically do not follow this shape.

If "Percentile" is selected (Figure 3-14), then the user can provide as many as 12 pairs of percentiles and associated concentration values. These inputs are to be provided in ascending order, typically starting with the minimum (0th percentile) and ending with the maximum (100th percentile). In many cases, particularly when the shape of the distribution is unknown (although lognormal would be a reasonable assumption), percentile would be the best choice. Ideally, the following nine percentiles would be provided by the user: 0, 5, 10, 25, 50, 75, 90, 95, and 100. A value for the 100th percentile (i.e., maximum) must be provided. If no value is provided for the 0th percentile (i.e., minimum), then a value of zero is assumed. Thus, by not specifying a value for the 0th percentile (i.e., using the default of zero), the user can provide as many as 13 percentiles of the concentration distribution.

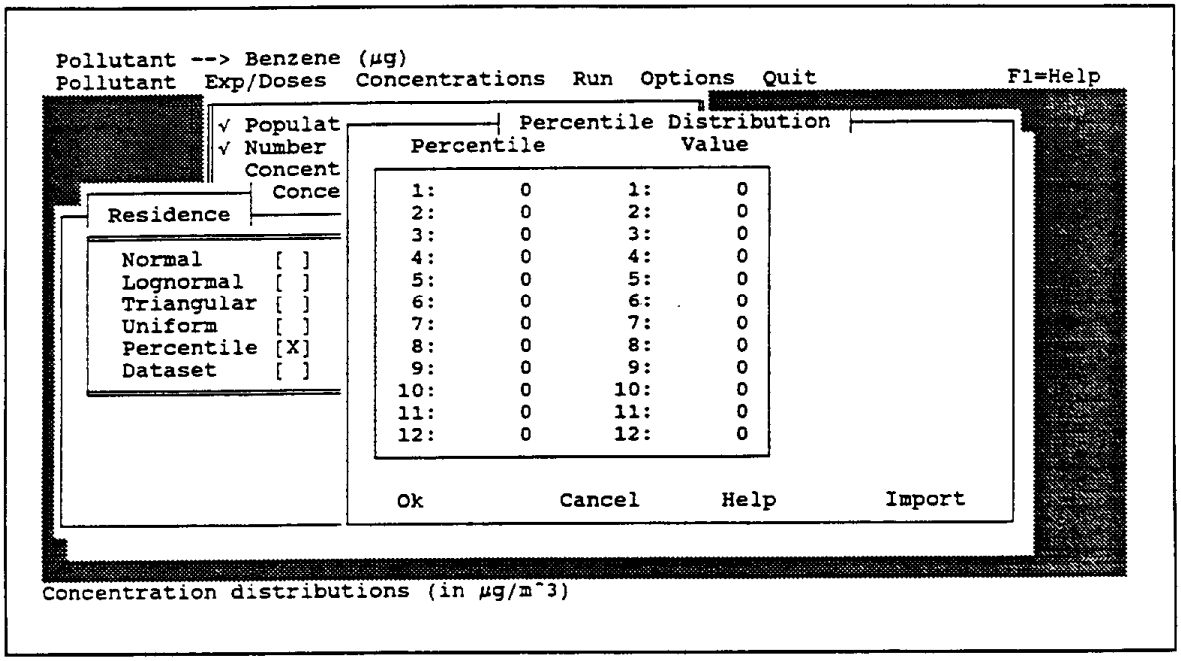


Figure 3-14. Pop-Up Menu for Percentiles

Concentration results from a number of field studies (primarily in residences) are provided with the model. The user should be aware that many of these results apply to a specific region of the state and/or a specific time of year (such conditions are noted in the case-name descriptions for each distribution). Ideally, the criteria for selecting a population subgroup should be consistent with the region/time of the chosen concentration distribution(s).

The final choice for type of distribution is an actual data set containing concentration values to be sampled (Figure 3-15). Such data sets must be provided in dBASE-compatible format (.DBF file-name extension) and contain an index number (1, 2, 3, etc.) for successive records as the first field. The file format must be compatible with the chosen integration period (see Section 2.2). For 12-hour and 24-hour integration periods, a single concentration value for each record comprises the second (and only other) field. For 1-hour and 8-hour periods, 24 ordered fields follow the index field (e.g., for the 1-hour period, the first of these 24 fields is a concentration value from midnight to 1:00 a.m., the second is a value from 1:00 to 2:00 a.m., etc.). The user must provide the name of the .DBF file. Instructions for creating a .DBF in the required format are given in Section 7.0.

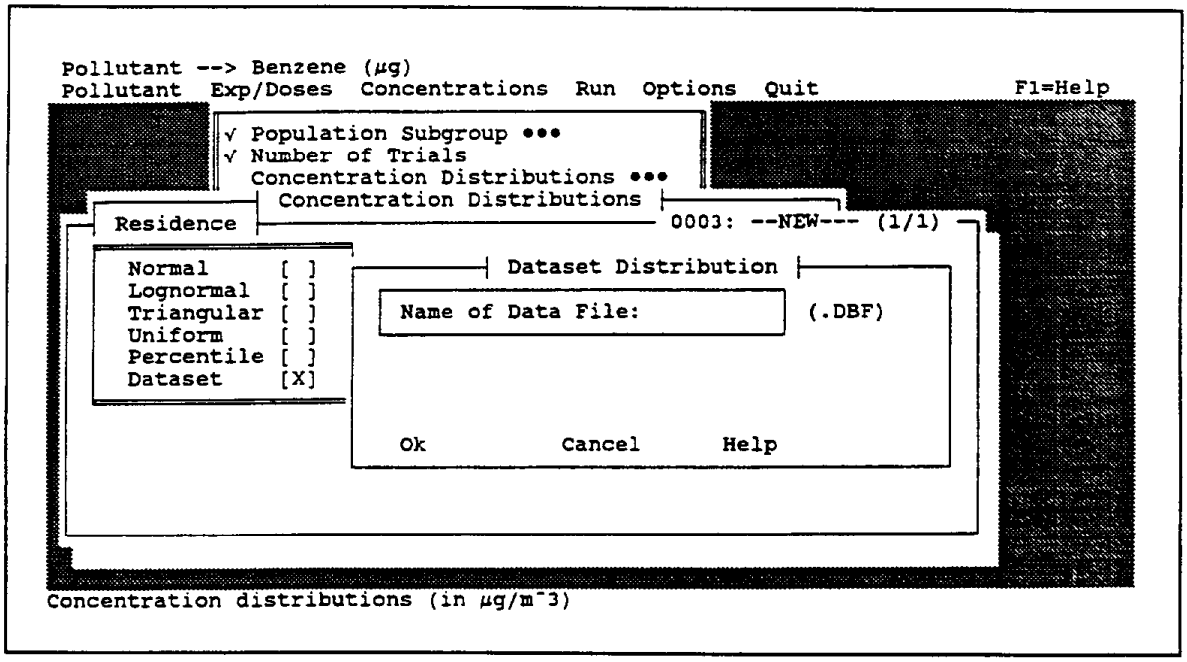


Figure 3-15. Pop-up Menu for Dataset

For 1-hour and 8-hour integration periods, "Dataset" is the only option for concentration distributions (all other choices are "grayed out"). The model does not accept distributional information as input for these integration periods because 24 concentration values are required for each trial in the simulation, as opposed to one value per trial when a 24-hour or 12-hour integration period is used.

An "Import" button, available only for the pop-up menus for concentration distributions, can be used to retrieve summary statistics generated from a Level 3 model run (see Sections 4.0 and 5.2), which is used to estimate a concentration distribution for one environment. The name of the file containing the summary statistics, with an extension of .STC, must be provided by the user (Figure 3-16). The software will then retrieve statistics from the file that are appropriate for the type of distribution chosen by the user. The "Import" button can be used for all distribution types except "Dataset." However, the file containing detailed results from a Level 3 run can be used to create a data set for access by Level 1-2 of the model (see Section 7.1.5).

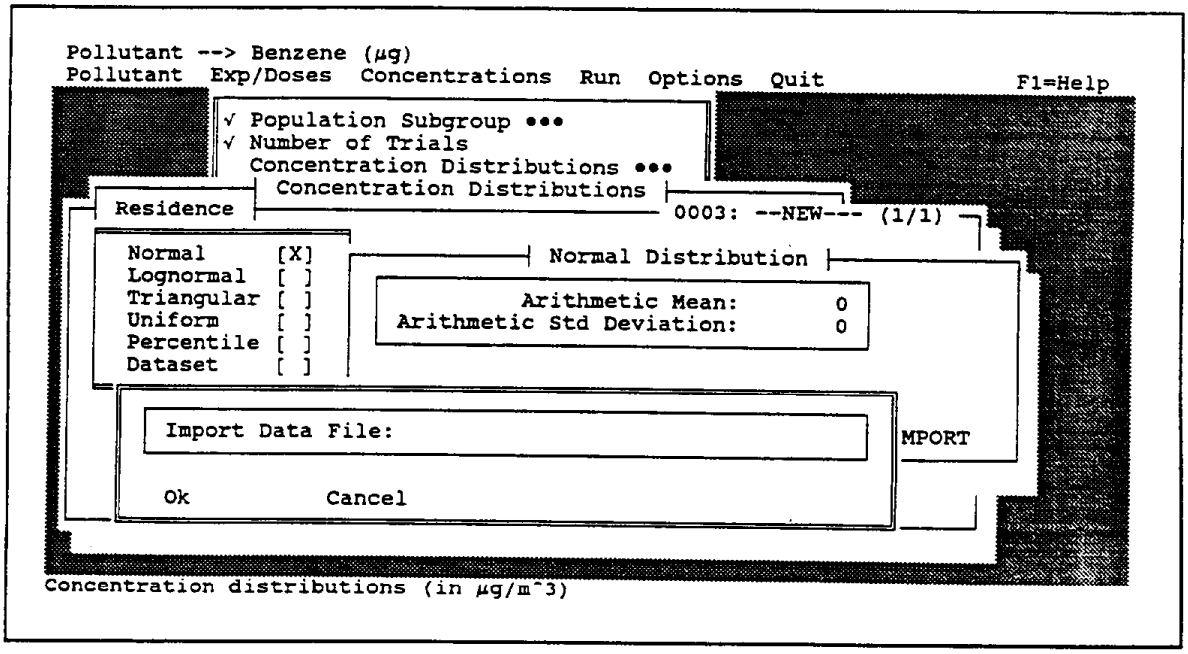


Figure 3-16. Prompt for Name of Input File When Import Button is Used for Concentration Distribution

As with the population subgroup, concentration distributions can be saved for later access through the "Save" button; access is obtained through the "Load" button. All saved cases are linked to a pollutant and integration period; the examples given in Figure 3-17 are associated with a 24-hour period for benzene. Unlike the population subgroup, for which only one case name can be chosen for a given run, more than one of the loaded choices can be retained by using the "Weight" button. The user is then prompted for weights (expressed as percentages) to be attached to each case name; these weights must sum to 100 (if not, the software will assign equal percentages). For the example in Figure 3-18, the user chose to use three case names and had higher confidence in the "NTILE" case, which was assigned a weight double that of the other two cases. When the user elects to input more than one distribution for a given environment, the software will randomly access one of the distributions for each trial; the probability of choosing a specific distribution will be proportional to its weight.

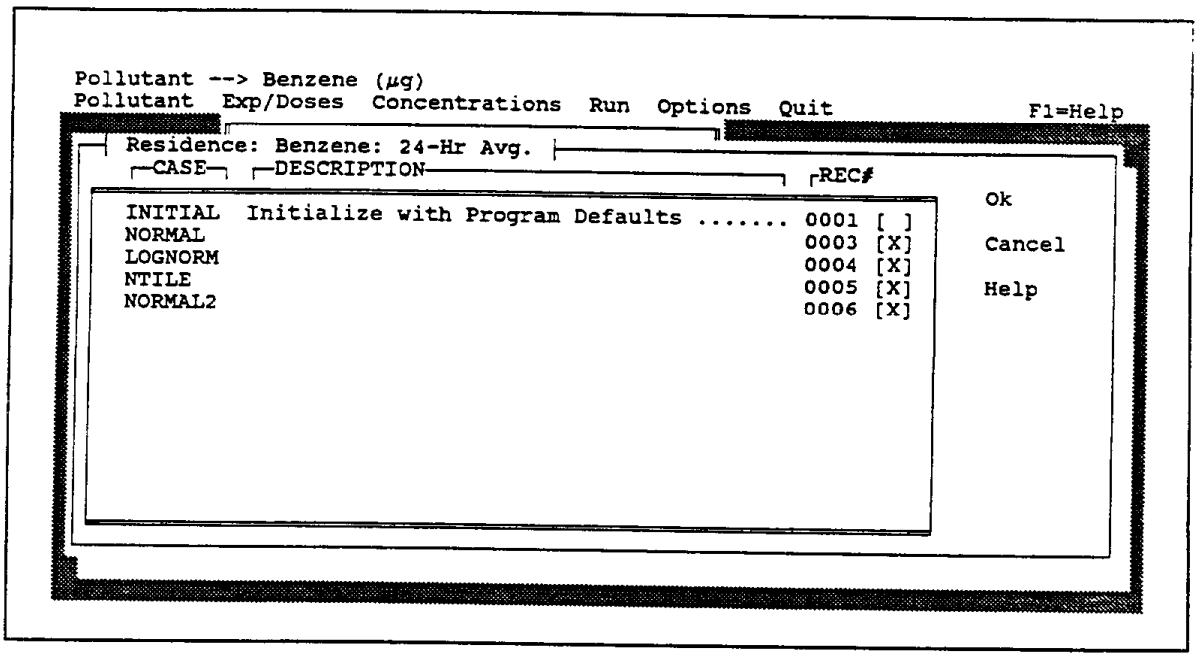


Figure 3-17. Choice of Case Names After Pressing Load Button for Residence

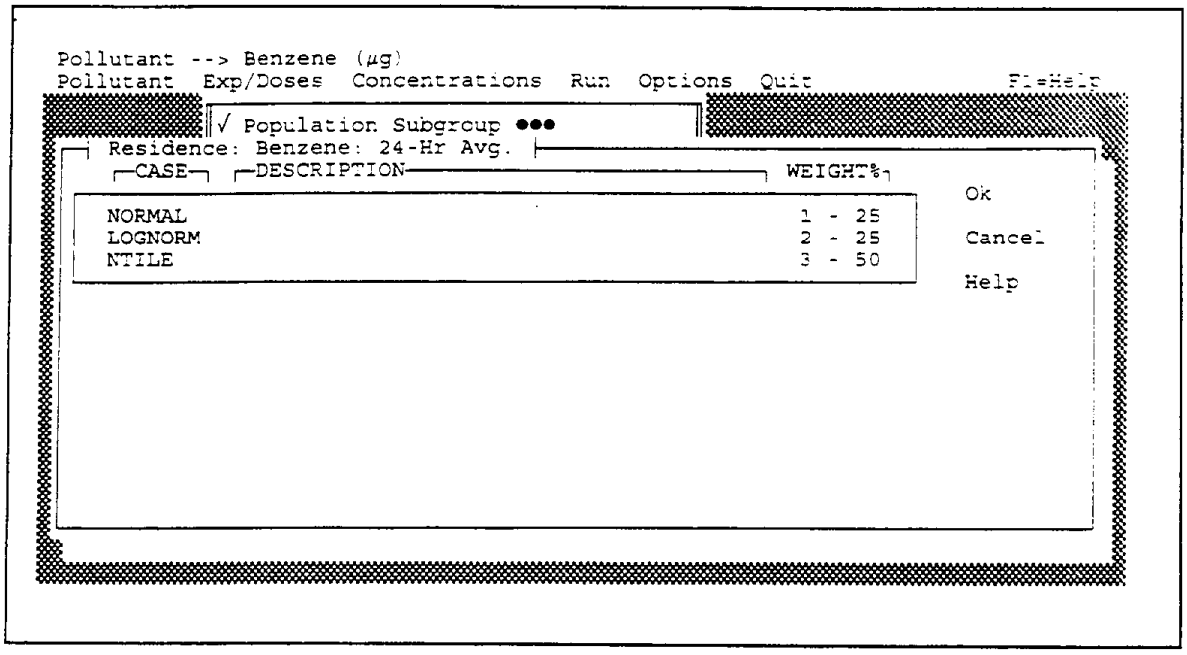


Figure 3-18. Assignment of Weights After Pressing Weight Button for Residence to Indicate Multiple Concentration Distributions

The user must ensure that at least one concentration distribution has been saved for each chosen environment; if no inputs are saved but the environment is left marked (with an "X") in the submenu, then the default (normal distribution with mean and standard deviation both equal to zero) will be in effect and misleading results will be obtained. Such occurrences can be readily detected in the model output (see Section 5.0) by the outcome that the exposure or dose distribution for that environment will have a value of zero for every trial.

Once the input describing a concentration distribution has been saved, it is available for subsequent runs by simply selecting it. In other words, the input needs to be saved only once.

3.4 BREATHING RATES

This submenu (Figure 3-19) provides one of the inputs to dose calculations. The potential inhaled dose for each microenvironment is calculated by multiplying the airborne concentration in that environment (as sampled by the model) by the amount of time spent

in the environment by an individual and his/her breathing rate. A sampled activity profile provides the information on time spent in each environment and associated activity level(s), from which breathing rates are assigned. As shown beneath the submenu in the figure, the units for breathing rate are m^3/h.

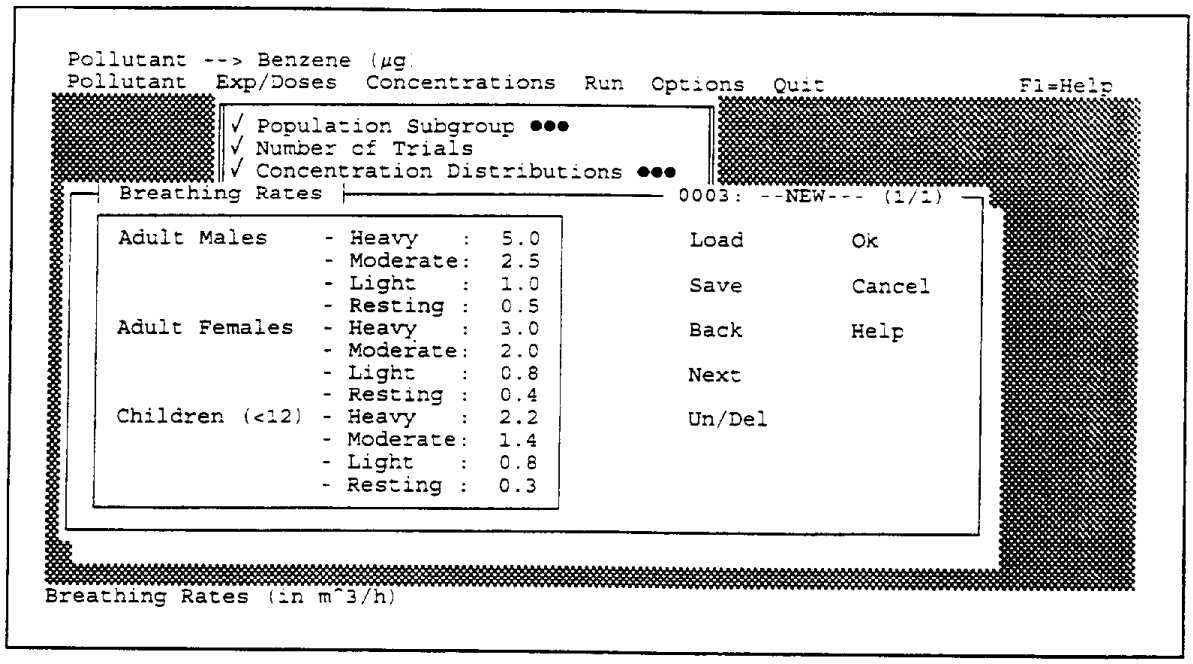


Figure 3-19. Submenu for Breathing Rates

The "Breathing Rate" submenu allows the user to control the assignment of breathing rates. As evident from Figure 3-19, breathing rates can be assigned to four activity levels (heavy, moderate, light, and resting) for each of three age/sex classes (adult males, adult females, and children under 12 years of age). The default values provided in the model were determined by staff in ARB's Research Division and are recommended for use until such time as future research indicates more appropriate values. As with inputs for population subgroup, sets of alternative values can be saved, loaded and viewed through the buttons to the right of the input array. Only one set of breathing rates can be used for a given run of the model. If the user is concerned only with estimating time-integrated exposure, which does not require breathing rates for calculations, then this submenu does not need to be accessed.

3.5 RANDOM NUMBER SEED

This submenu (Figure 3-20) allows the user to provide a random number seed that controls the sampling of activity profiles and microenvironmental concentrations for the simulation. By default, the user is asked to provide a 4-digit seed. As shown in Figure 3-20, the user entered 7777 as the seed; this seed will remain the default until changed by the user. Had the user instead opted to use the seed from the clock (3732 in Figure 3-20), then this seed would remain the default until changed by the user (see Figure 3-21).

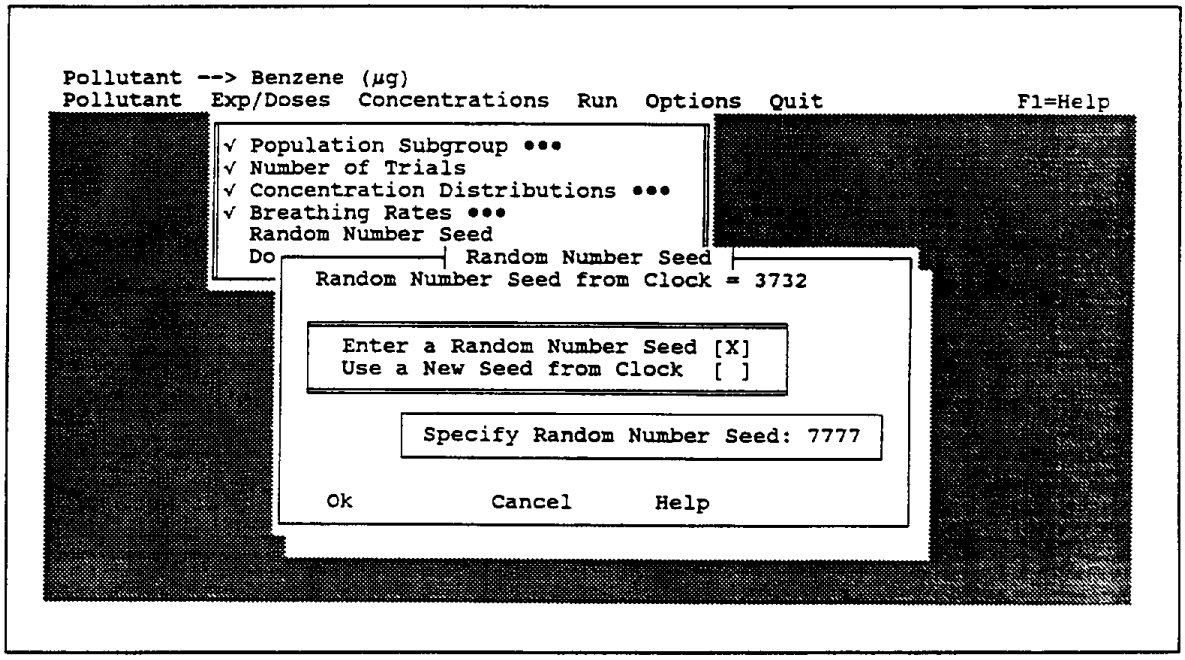


Figure 3-20. Submenu for Random Number Seed with Value Provided by the User

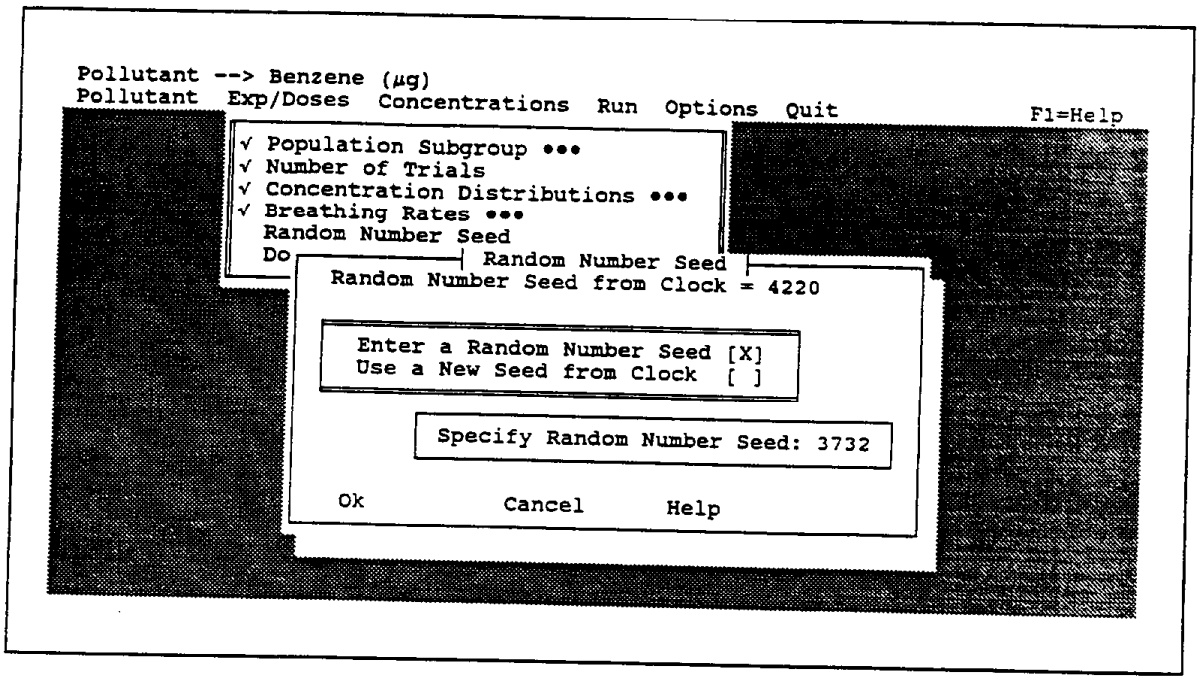


Figure 3-21. Submenu for Random Number Seed After Requesting a New Seed from the Clock

By making repeated model runs with all inputs the same, except for the random number seed, it is possible to assess the stability of various parameters of the estimated exposure/dose distribution. For example, after making 10 such runs, the user could compile a list of the 10 values obtained for the 90th percentile, from which the average value (and standard deviation) for this parameter could be calculated. Although the model will provide the values for such calculations, the calculations themselves would need to be performed "outside the model."

3.6 SIGNALING COMPLETION OF INPUTS

Once all necessary inputs have been provided for the "Exp/Doses" pull-down menu, the user is ready to execute the model. Completion of inputs is signaled by choosing "Done!" on the menu (Figure 3-22). As shown in the figure, check marks indicate that each submenu has been "visited" by the user. Once the user signals that all inputs have been provided, he/she will have access to the "Run" option on the opening menu, from which the model can be executed (see Section 5.0).

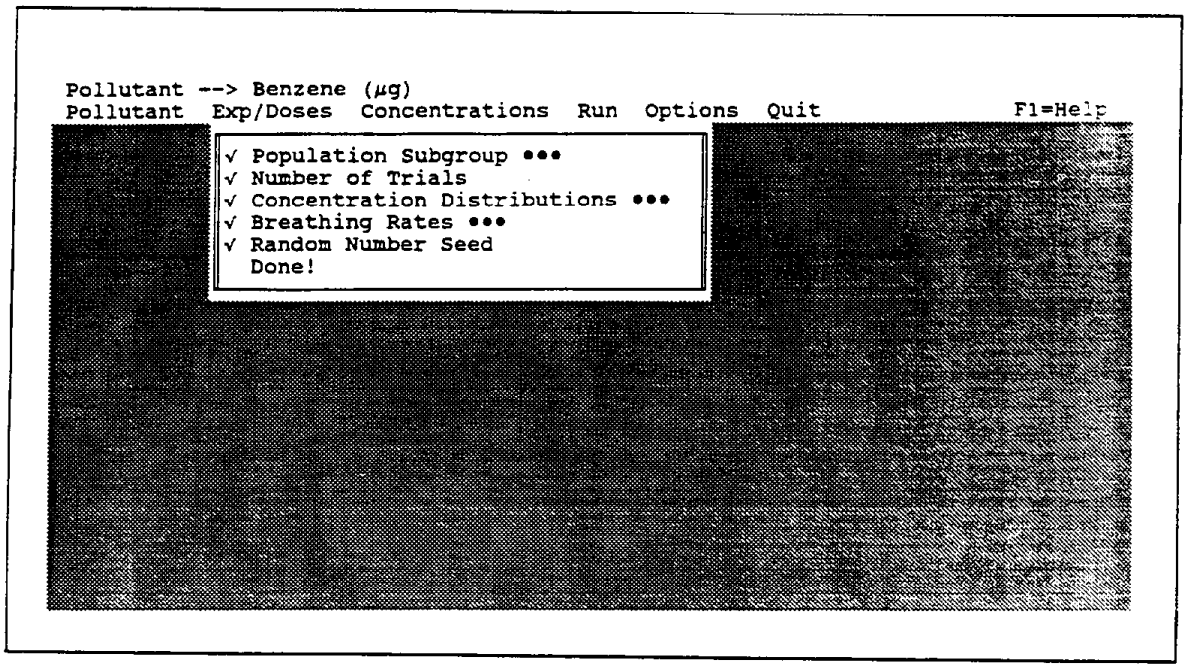


Figure 3-22. Exp/Dose Menu After All Inputs Have Been Provided

Section 4.0

INPUTS FOR CONCENTRATIONS

After selecting "Concentrations" in the opening menu, the user will be presented with the pull-down menu show in Figure 4-1. Inputs are required for indoor sources, outdoor concentrations, penetration factors, indoor sinks, volumes, air exchange rates, number of trials, and random number seed. Each of these submenus is discussed separately in the subsections that follow. For the first six submenus (indoor sources through air exchange rates), which relate to parameters for a mass-balance model, the user can save inputs for subsequent access in later model runs. For the current model run, at least one set of inputs must be saved under each submenu for the model to execute properly.

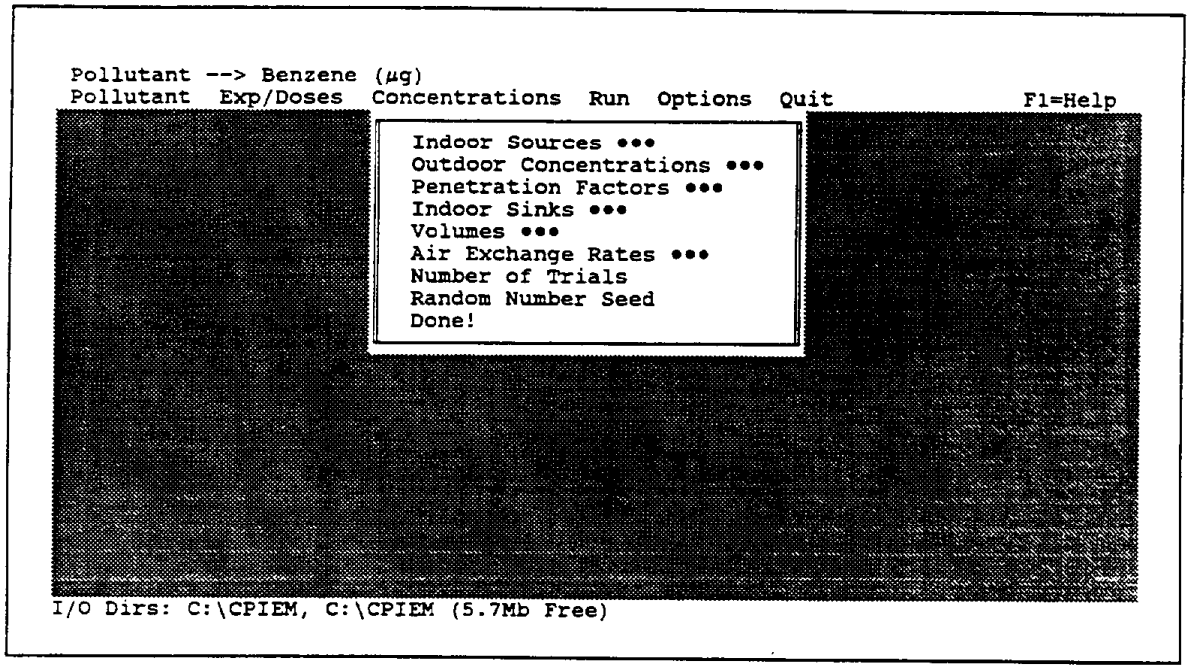


Figure 4-1. Pull-down Menu for Concentrations

The submenus do not need to be accessed in any specific order, but all of the menus should be "visited." A check mark (√) will be placed next to each submenu after it

has been accessed by the user. As with exposure/dose inputs, completion of inputs for concentrations is signaled by choosing "Done!" at the bottom of the pull-down menu. The user will then have access to "Run" (i.e., model execution) in the opening menu.

4.1 INDOOR SOURCES

For this submenu (Figure 4-2) the user must go through a sequence of screens for each indoor source that is to be described. Indoor sources are classified into three types--long-term, episodic and frequent. Long-term sources, such as interior finishings, furnishings and some appliances, tend to be relatively static features of buildings. Episodic sources typically are used or present on a weekly, monthly or less frequent basis; some examples are carpet cleaning, painting and bringing home dry-cleaned clothes. Frequent sources tend to be used on a daily basis, often more than once a day; cooking, showering and tobacco smoking are good examples. Sources that occur only episodically, but which may also occur on consecutive days (e.g., vacuuming, use of a fireplace), generally are best treated as frequent sources within the model.

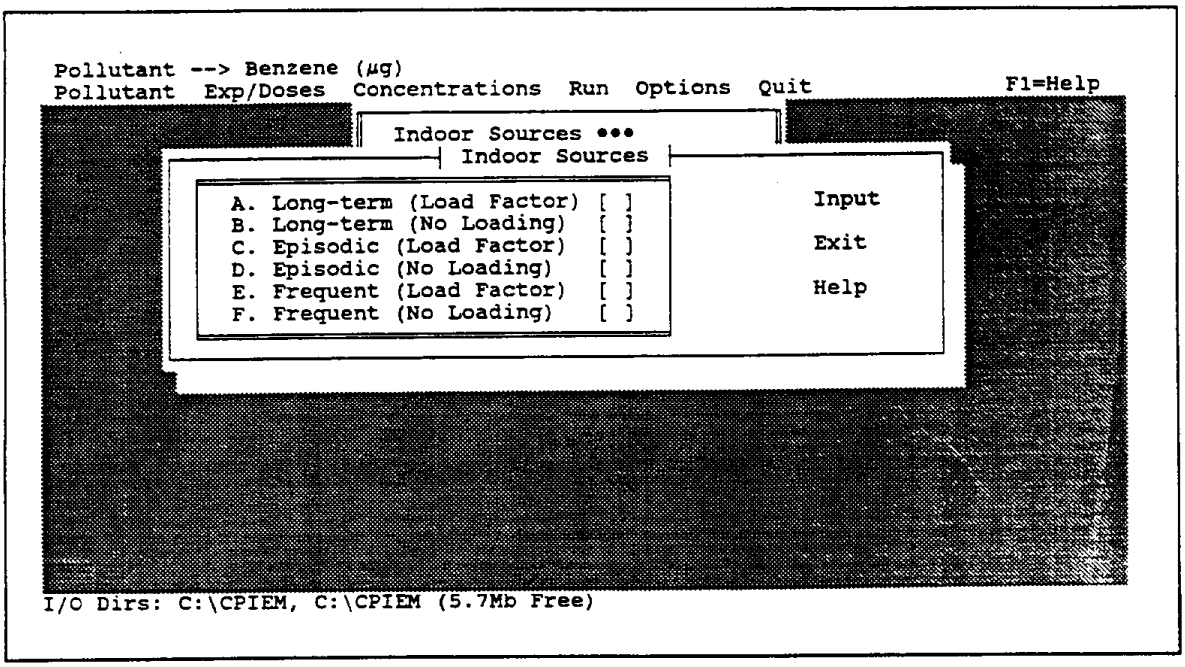


Figure 4-2. Submenu for Indoor Sources

Each of the three types of sources is further distinguished as "Load Factor" or "No Loading". That is, for each type the user can described the quantity of material present or used either in absolute terms (no loading, e.g., square feet of finishing material) or in relation to building volume (load factor, e.g., square feet per unit volume). The choice is at the user's discretion--for some sources, such as pilot lights, the quantity (e.g., amount of fuel used) is not logically related to volume, whereas for sources such as carpeting the quantity (e.g., square feet installed) would be related. In the latter case, the model multiplies the volume (in m^3) by the load factor (quantity of material per unit volume) to determine the quantity present or used in a given structure.

The various inputs required for the three types of sources are summarized in Table 4-1. The following inputs are common to all three types: percent of cases (structures) in which the source is present or used; the quantity of material present or product used; the initial emission rate from the material or product; and the rate of decline in the emission rate over time (if the rate of decline is zero, then the emission rate is constant over time). The input for duration since installation ("When Installed") is unique to long-term sources, and the time since use is unique to episodic sources. The input for duration of use is common to episodic and frequent sources. Inputs for number of episodes per day and start time (hour of the day during which the episode starts) are unique to frequent sources.

4.1.1 Long-term Sources

The submenu for long-term sources with quantity expressed as a load factor (Figure 4-3) requires five types of inputs. As with certain inputs for the exposure/dose model, choices can be saved for later access. However, because the source inputs are relatively complex, multiple descriptions are not allowed; that is, the user cannot make multiple descriptions and assign weights to each. For a given model run, each source description is either "on" (i.e., selected by the user) or "off" (not selected). As noted in the introduction to this section, at least one type of source must be "on" for the model to execute properly.

Table 4-1. Inputs Required for Three Types of Indoor Sources

Inputs	Type of Indoor Sources		
	Long-term	Episodic	Frequent
Percent of Cases	X	X	X
Quantity Present/Used*	X	X	X
When Installed	X		
Time Since Use		X	
Duration of Use		X	X
Episodes per Day			X
Start Time			X
Initial Emission Rate	X	X	X
Decline in Rate	X	X	X

* At the user's option, this input can be expressed as an absolute quantity (e.g., grams used for a product or m^2 present for a material) or in relation to the volume of a structure (e.g., g/m^2 or m^2/m^3). Absolute quantities are input through the "No Loading" option (choice B, D, or F on the menu in Figure 4-2), whereas relational quantities are input with the "Load Factor" option (choice A, C, or E). For relational quantities, the actual quantity of product used or material present is calculated by the model, through multiplication of the load factor times the volume of the structure.

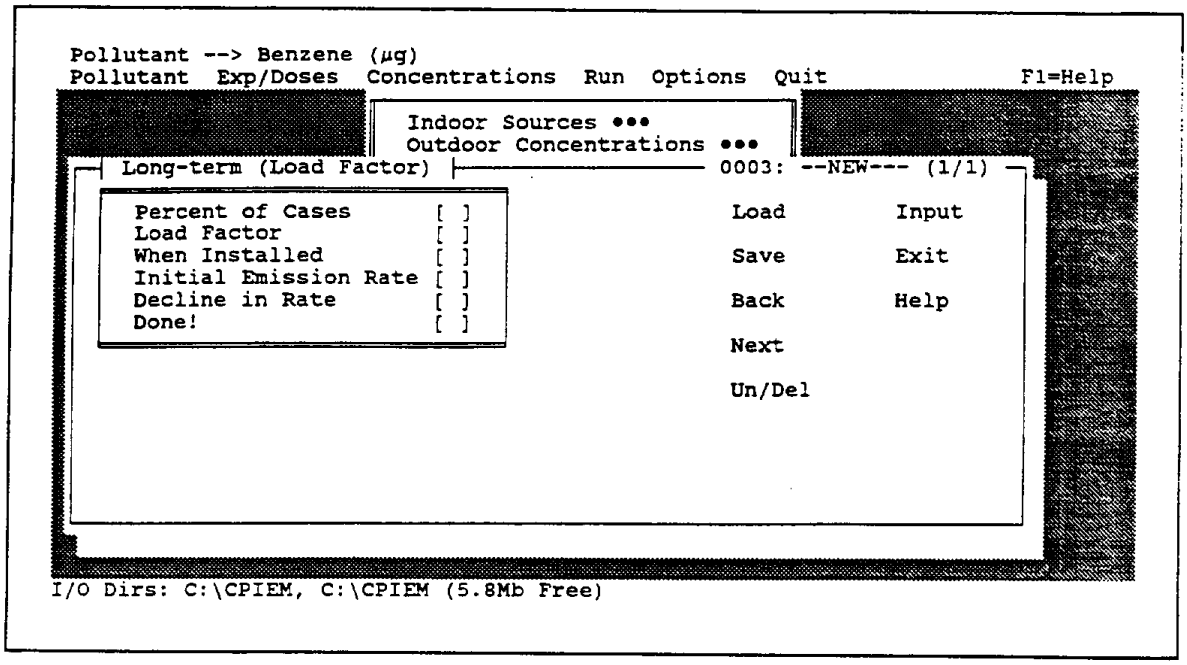


Figure 4-3. Submenu for Long-term Sources (Load Factor)

The pop-up menu in Figure 4-4 appears when the user provides inputs for "Percent of Cases." The primary input is the percent of cases (structures) with the source present. A special feature that can be used here relates to the notion of linked sources. An example of linked sources, for a pollutant such as NO_2, is use of a gas range for cooking and pilot lights on the range. Cooking with the range is a frequent source (discussed later), whereas a pilot light is a long-term source (i.e., always in operation). A subset of gas ranges have pilot lights. In this case, after providing inputs for gas-range cooking and then saving these inputs (e.g., with the name "GASCOOK"), the user can then provide inputs for pilot lights and link this source to GASCOOK (see Figure 4-5). The model will first sample whether a gas range is present in the structure and, if so, will then sample whether the gas range has pilot lights. The guiding theme here is that the source present in a subset of cases should be linked to the source that is present in a greater percentage of cases. If both sources are present in the same fraction of cases, the direction of the linkage is arbitrary.

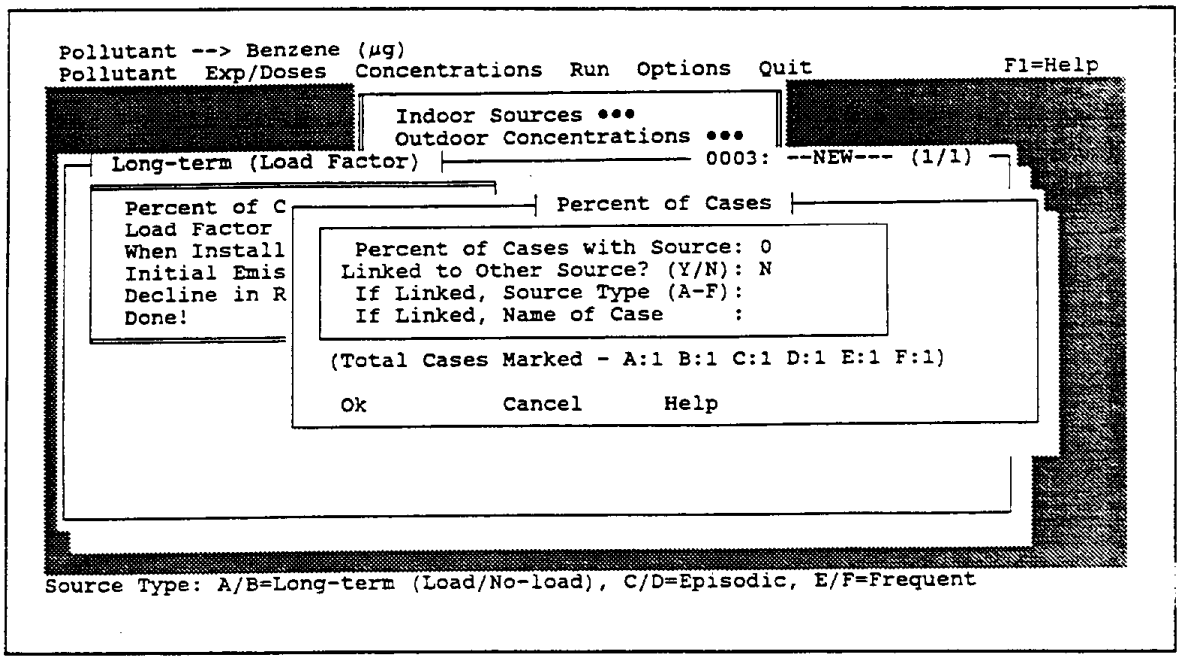


Figure 4-4. Pop-up Menu for Percent of Cases (Initial Default Setting)

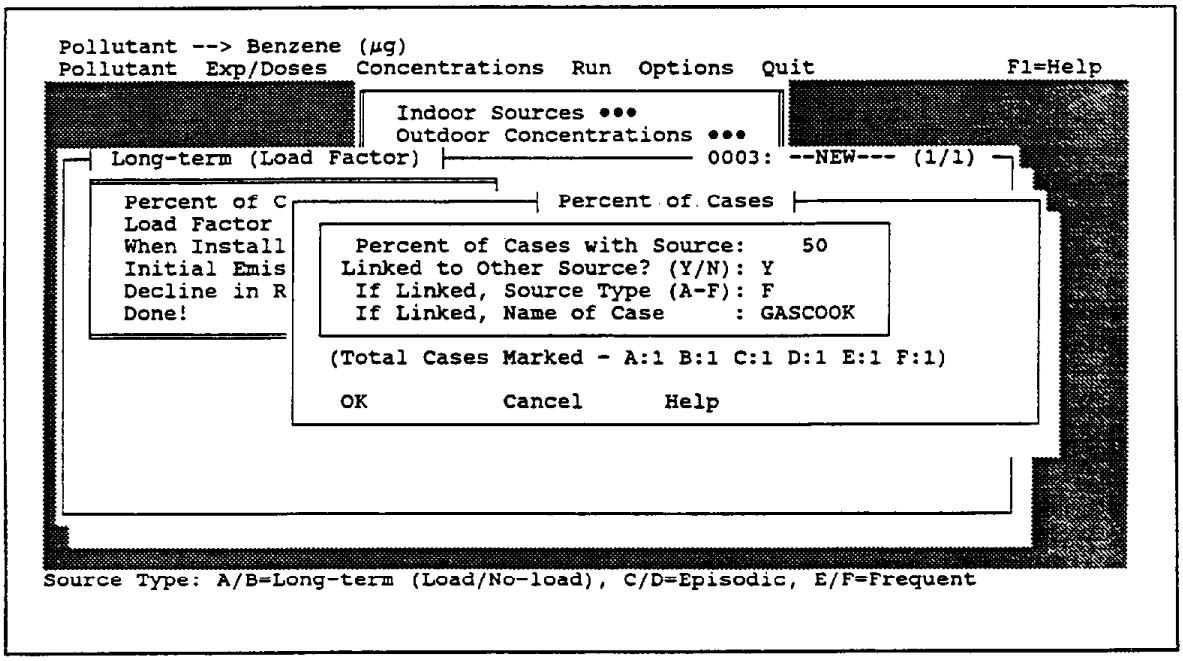


Figure 4-5. Input for Percent of Cases for a Linked Source

More than one type of source can be linked to the same file (e.g., range pilot lights and use of the range for heating can both be linked to "GASCOOK"), but a file that has other sources linked to it is not allowed to be linked to another source. Thus, in the above example, "GASCOOK" cannot be linked to some other source. If the user inadvertently made this link, then the model would ignore it. (The model does not provide any indication to the user that the link is ignored in such cases.)

The pop-up menu for "Load Factor" (Figure 4-6) is identical in format to that for environments within the exposure/dose model, with five options for describing the distribution. The units for load factor are at the user's discretion and are expressed in relation to structure volume (e.g., square feet per m^3 volume, grams per m^3 volume). The main point to remember is that the input for initial emission rate must be in complimentary units. For example, if the load factor is in ft^2 per m^3 volume, then the emission rate must be in units of μg/h (or ng/h or mg/h, depending on the pollutant) per ft^2. Multiplication by the volume will then result in an emission rate expressed in units of μg/h.

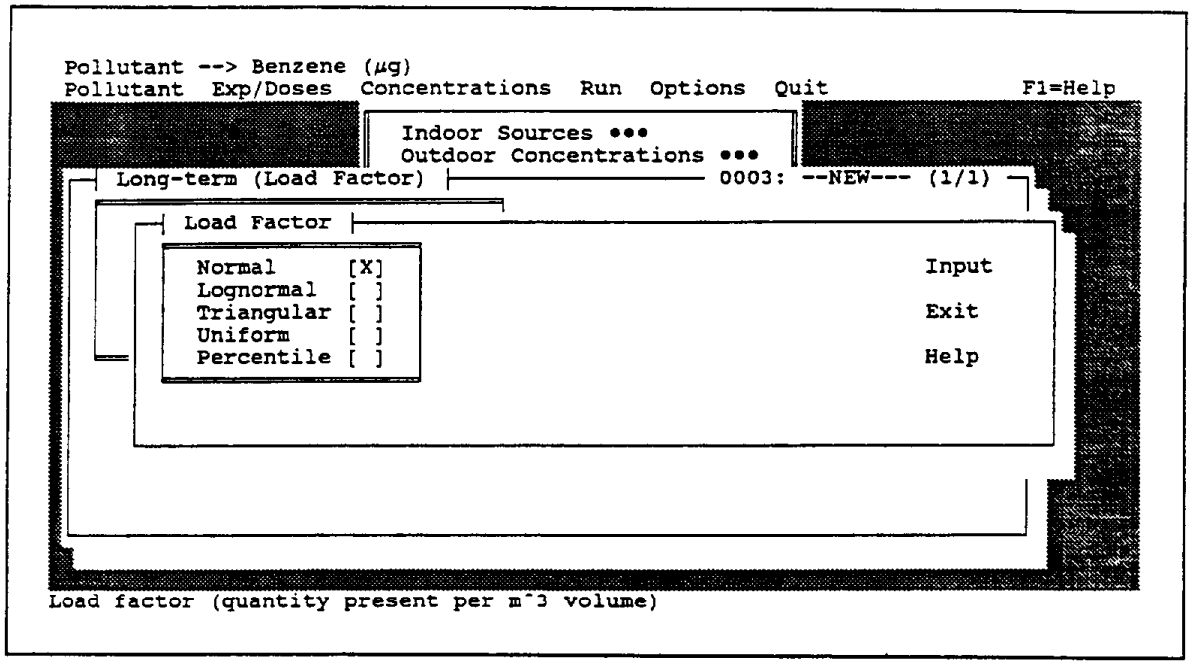


Figure 4-6. Pop-up Menu for Load Factor

The choice of input distributions for "When Installed," Initial Emission Rate," and "Decline in Rate" is the same as for load factor (see Figure 4-3). The input for decline in the emission rate over time warrants further discussion. Many sources, because they contain a finite amount of material that can be emitted (as in the case of interior finishings that offgas VOCs), emit at a declining rate over time as the reservoir of available material is gradually depleted. For many sources it has been found that the declining rate can be described as follows:

$$E_t = E_o e^{-rt}$$

where E_o is the initial emission rate, r is the rate of decline, t is the time since installation, and E_t is the rate at time t. The terms r and t must be in complimentary units; for long-term sources, t is to be input in months and r in inverse months (i.e., $months^{-1}$).

The following example provides some insight on an appropriate value for r. If the emissions half-life is on the order of 12 months (i.e., the emission rate 12 months after installation is half the initial rate), then we have:

$$E_{12} = 0.5 \bullet E_o = E_o e^{-r \bullet 12}$$

After canceling the E_o term and taking the natural logarithm of each side of the equation, we have:

$$\ln (0.5) = -r \bullet 12$$

from which the value of r is calculated to be $-\ln (0.5) \bullet 12$, or 0.058 $months^{-1}$.

For some sources, such as pilot lights, the emission rate does not decline over time, but is essentially constant. The appropriate value for r in this case is zero. This input can be described, for example, as a normal distribution with mean and standard deviation both equal to zero, or as a uniform distribution with minimum and maximum both equal to zero. More generally, any constant can be expressed as a normal distribution with a mean equal to that constant and a standard deviation of zero, or as a uniform distribution with both minimum and maximum equal to the constant.

The submenu for long-term sources with no loading (Figure 4-7) is nearly identical to that for long-term sources with a load factor. The only difference is input of quantity present (e.g., ft^2) instead of the load factor. The emission rate, which can be constant or

declining over time, must be input in complimentary units (e.g., μg/h per ft^2). The quantity "present" can also express a quantity used, as in the case of pilot lights. In this case, the quantity used would be expressed in ft^3 of gas or Btu per hour, and the emission rate in μg per ft^3 or per Btu. The resultant emission rate would have units of μg/h (e.g., μg/Btu times (Btu/h).

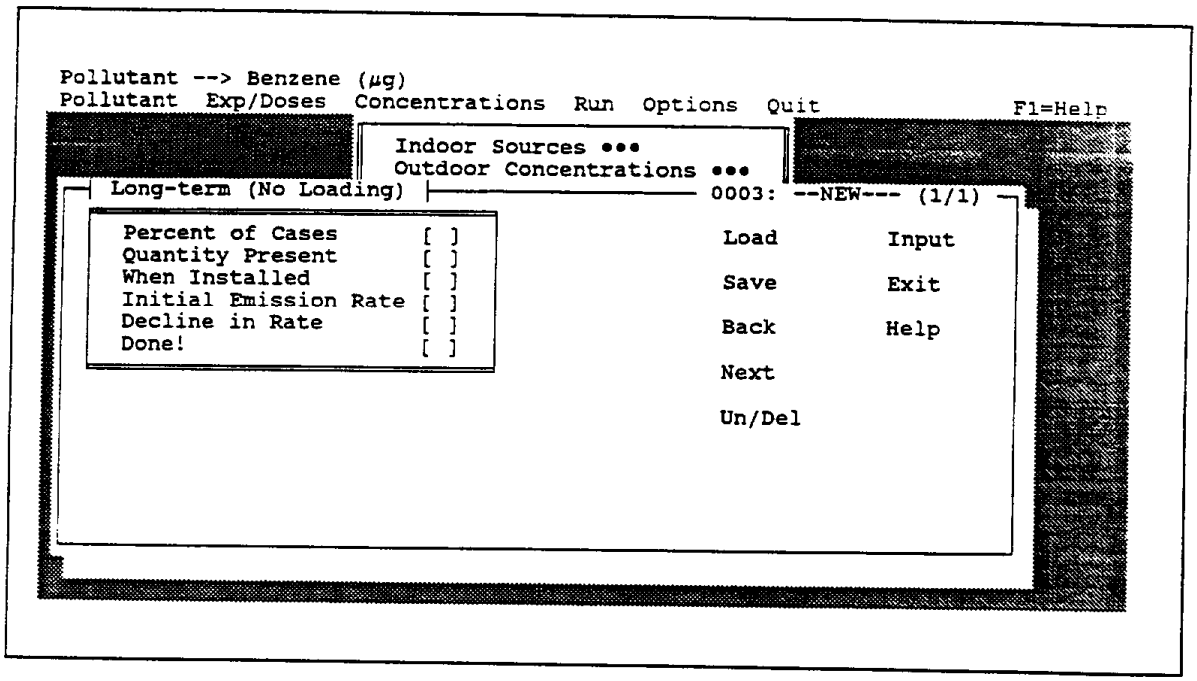


Figure 4-7. Submenu for Long-term Sources (No Loading)

4.1.2 Episodic Sources

The inputs for episodic sources (Figure 4-8 shows the "Load factor" case) are similar to those for long-term sources, with three differences. First, the time since use is expressed in days, and the decline in the emission rate is in inverse days (days^{-1}). For paint products, for example, whose emissions half-life might be on the order of 6 hours (0.25 days), an appropriate value for r would be -ln(0.5)/0.25, or 2.77 days^{-1}. Second, a sixth type of description--the exponential distribution--can be used for the time since use (Figure 4-9). A single parameter--the mean time since last use--is sufficient to characterize the exponential distribution. Third, an input is required for duration of use, expressed in hours.

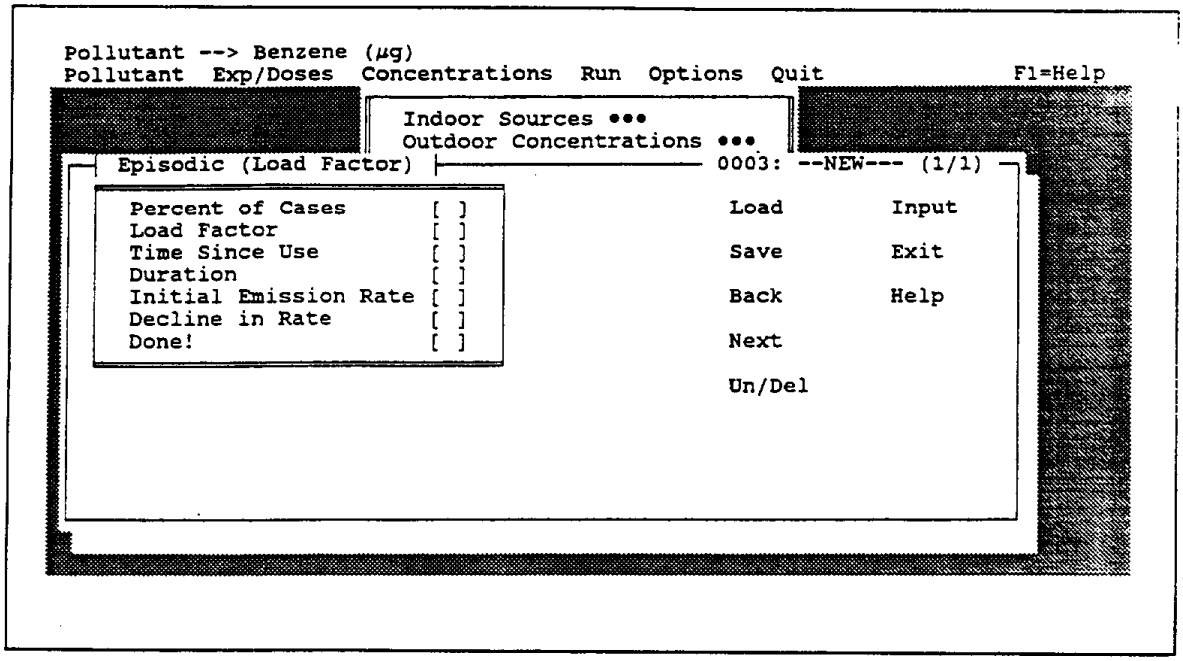


Figure 4-8. Submenu for Episodic Sources (Load Factor)

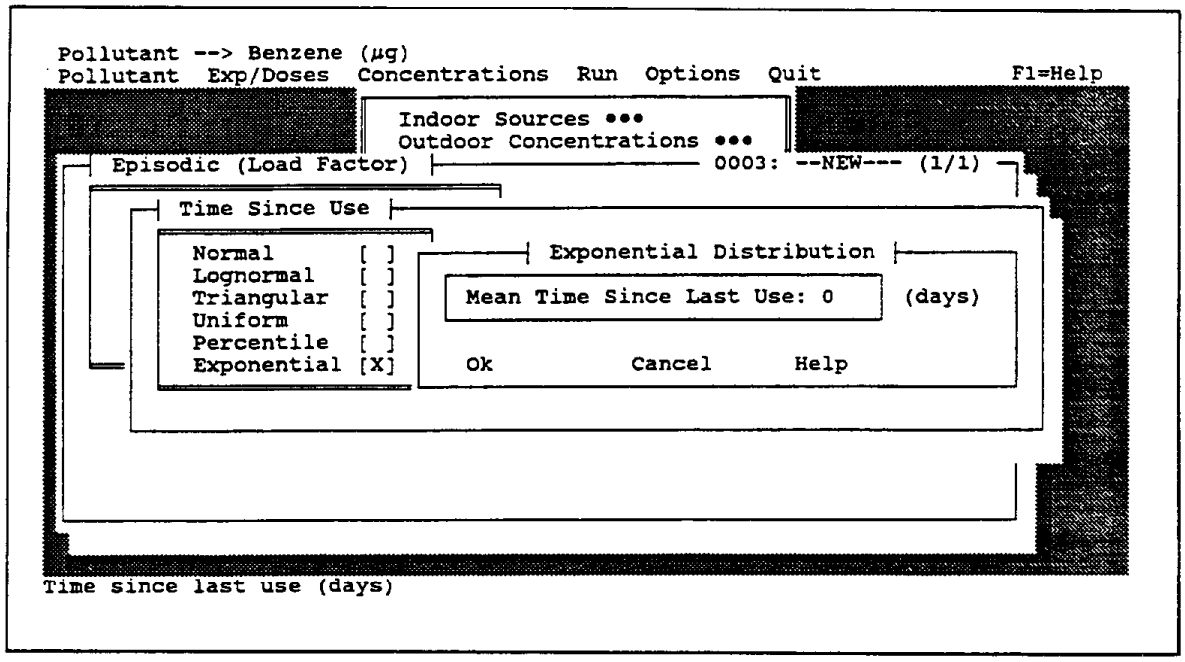


Figure 4-9. Pop-up Menu for Time Since Use with Exponential Distribution

The model also requires a value for the hour of the day when use of the episodic source begins. However, no user input is required for this value, as the model randomly selects an hour between 9:00 a.m. and 8:00 p.m. The inputs for episodic sources with no loading are the same as for episodic sources with load factor, except that quantity present or used is input instead of the load factor. The quantity present/used is expressed as a rate term--number of sources or amount of source per hour. For the no-loading case, this quantity will be multiplied by the duration of use, in hours, to determine the total quantity used. For the load-factor case, the quantity used per unit volume will be multiplied by the structure volume to determine the total quantity used.

4.1.3 Frequent Sources

Frequent sources (Figure 4-10 shows the "Load Factor" case) require more inputs than long-term or episodic sources. Inputs for percent of cases, load factor, duration of use, initial emission rate, and decline in the emission rate are similar to the previous cases, with a few minor exceptions. The duration is to be input in minutes and the decline in the emission rate carries the unit of inverse hours (hours^{-1}). The quantity for load factor is the same as before (quantity per m^3 of volume). For the no-loading case, however, the quantity used is expressed as quantity used per minute; this rate of use will be multiplied by the duration of use, in minutes, to determine the total quantity used. For the load-factor case, the quantity per unit volume will be multiplied by the structure volume to determine the total quantity used, as in the previous cases.

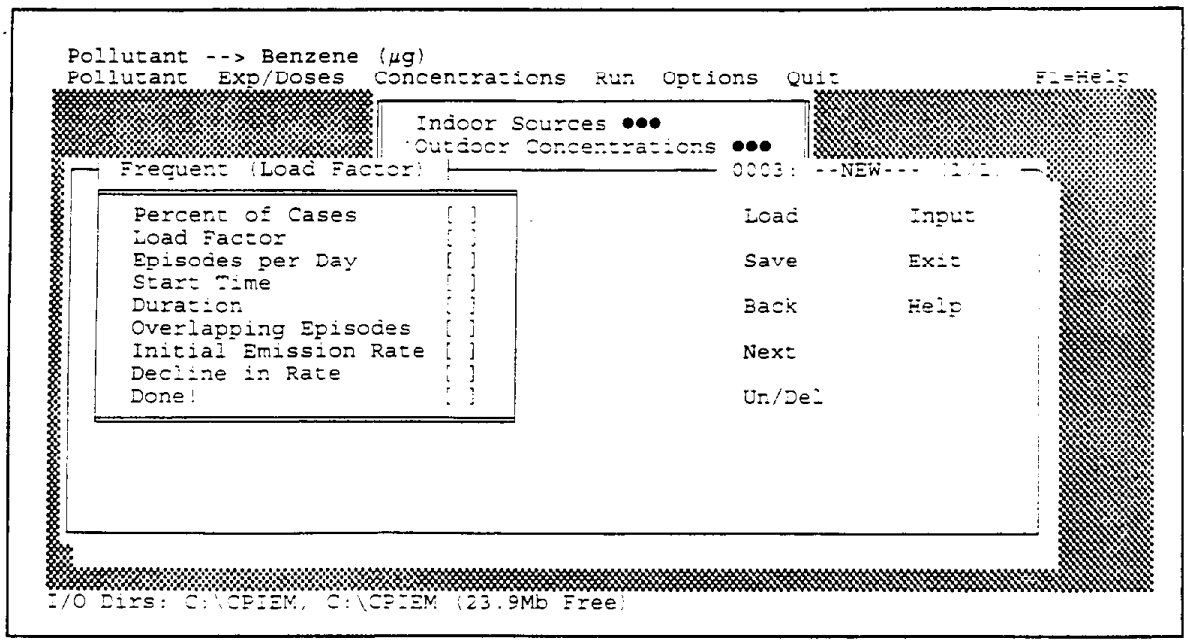


Figure 4-10. Submenu for Frequent Sources (Load Factor)

Episodes Per Day

The input for episodes per day is similar to most other inputs in that five types of distribution are allowed. However, the "percentile" distribution (Figure 4-11) requires slightly different inputs in this case. Instead of the cumulative frequency associated with each value, the absolute frequency is to be input (as a percent) for each case, and the sum of the absolute frequencies must equal 100 percent. Note that the absolute frequency (% of cases in Figure 4-11) is entered in the left-hand column and the associated value in the right-hand column.

Start Time

For start time (Figure 4-12), only one type of input is allowed--the share assigned to each hour of the day (input as a percent). The sum of the hourly shares must equal 100 percent. For overlapping episodes (Figure 4-13), the only input is whether such occurrences are allowed. Overlapping episodes can be allowed if it is plausible for more than one episode to occur during the same hour. Overlapping episodes could occur, for example, for relatively brief activities such as showering or smoking tobacco products, but are considerably less likely for longer activities such as cooking.

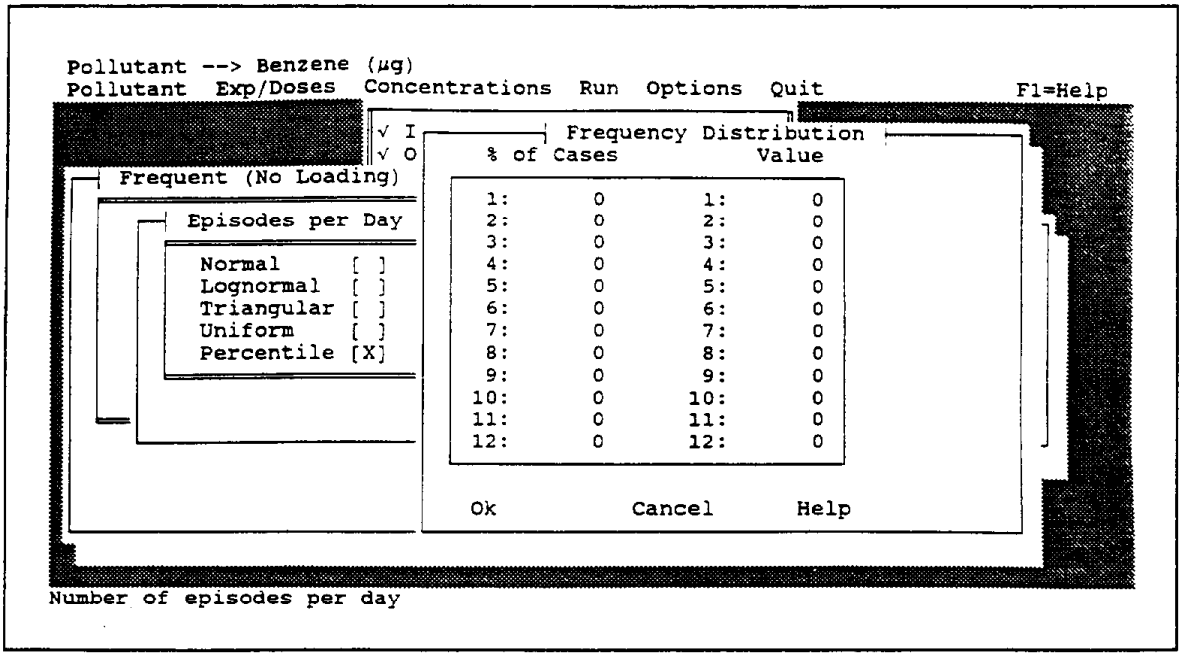


Figure 4-11. Pop-up Menu for Episodes per Day with Percentile Distribution

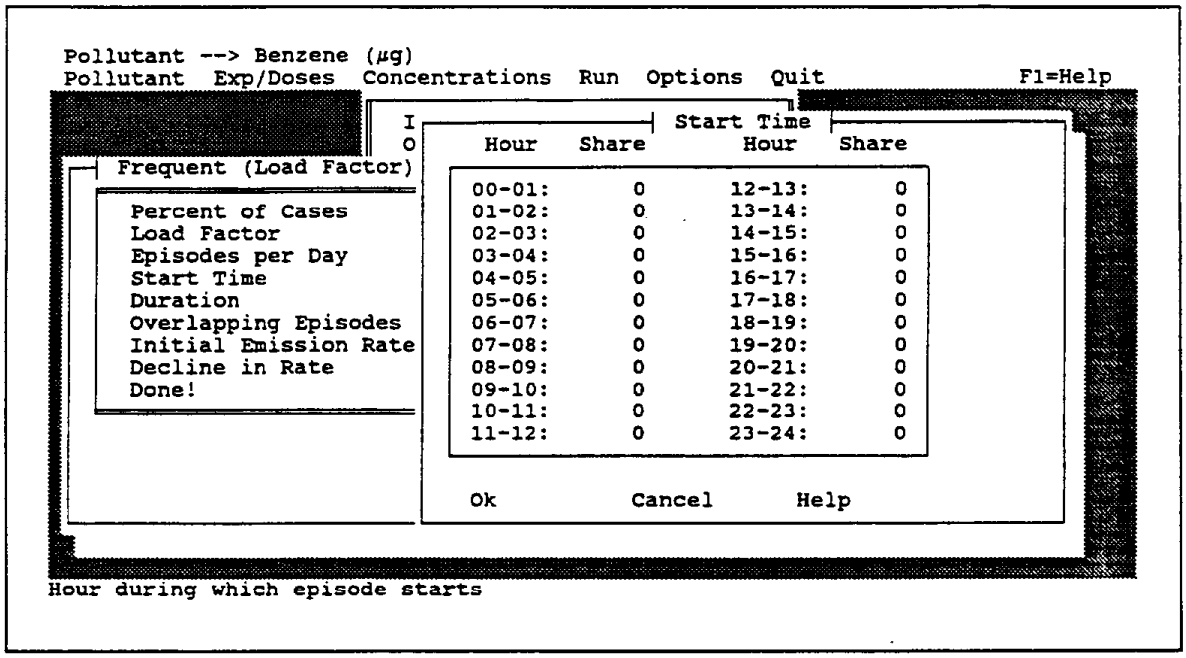


Figure 4-12. Pop-up Menu for Start Time

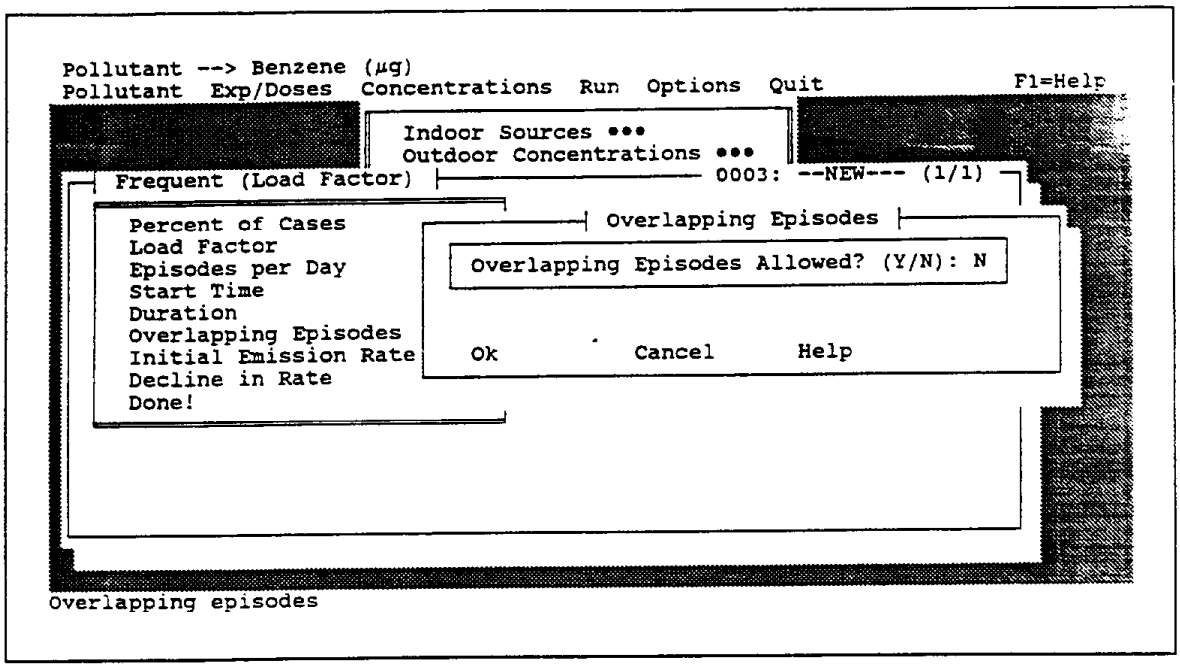


Figure 4-13. Pop-up Menu for Overlapping Episodes

For the no-load case, the total emissions for one episode of use of a frequent source (in μg or ng or mg, depending on the pollutant) are determined by multiplying together the quantity used, the duration of use, and the emission rate. The user must take care to provide inputs for these three factors in units that, when multiplied together, will yield a product with units of μg or ng or mg. Examples for three types of frequent sources--cooking, showering and tobacco smoking--are given in Table 4-2. For the first two cases, the product of the three factors is in units of μg. For the third case (tobacco smoking), the duration could have been input in variable numbers of minutes, as for cooking and showering, with an emission rate in μg/min per cigarette. Instead, a fixed duration of 1 minute was chosen so that the emission rate could be expressed as μg per cigarette. With a fixed duration equal to unity, the product becomes number of cigarettes times μg/cigarette, or μg.

Table 4-2. Examples of Input Combinations for Frequent Sources

Inputs	Type of Source		
	Cooking with Gas Range	Showering	Tobacco Smoking
Quantity Used	Btu/minute	Liters/minute	Number of cigarettes
Duration	Minutes (variable)	Minutes (variable)	1 Minute (fixed)
Emission Rate	μg/Btu	μg/liter	μg/cigarette
Overlapping Episodes	No	Yes	Yes

For a given hour during which a cooking, showering, or smoking episode begins, the model divides the total emissions by the number of hours associated with the episode to derive an emission rate in μg/h, consistent with the units for long-term and episodic sources. For example, for a cooking episode that is 75 minutes long and begins during hour 16 (4:00 p.m. to 5:00 p.m.), the model calculates the total emissions and apportions them equally to hours 16 and 17. Because cooking episodes can last this long, overlapping episodes (i.e., multiple cooking episodes during the same hour) should not be allowed. For showering and tobacco smoking, which are relatively brief events, more than one shower or smoking event during an hour can be allowed.

4.2 OUTDOOR CONCENTRATIONS

Either daily-average or hourly-average values can be input for outdoor concentrations. If hourly values are chosen (Figure 4-14), then the only allowable input is a dataset, in the form of a .DBF file with an index value (1,2, etc.) in the first field, followed by 24 fields containing concentration values for hours 1 through 24. The procedure for developing such a file is described in Section 7.1.5. If daily values are chosen (Figure 4-15), then the same distribution types as allowed for environment concentrations in the exposure/dose model can be used here, and the user is allowed to load multiple descriptions and assign weights to each.

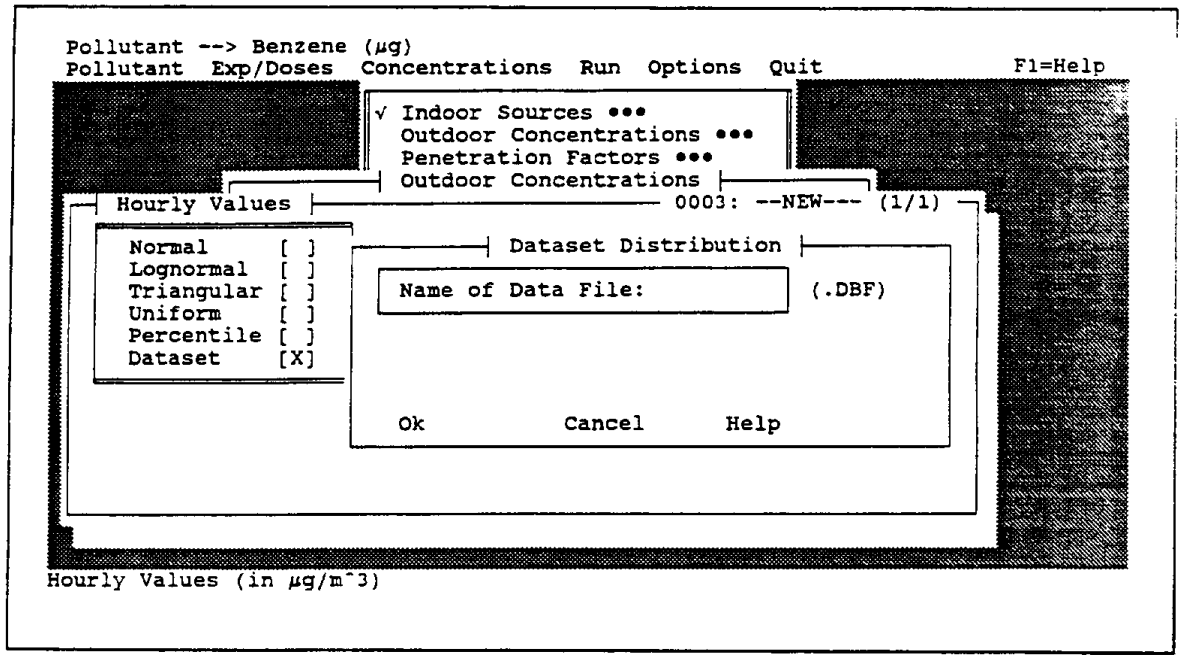


Figure 4-14. Submenu for Outdoor Concentrations with Pop-up Menu for Hourly Values

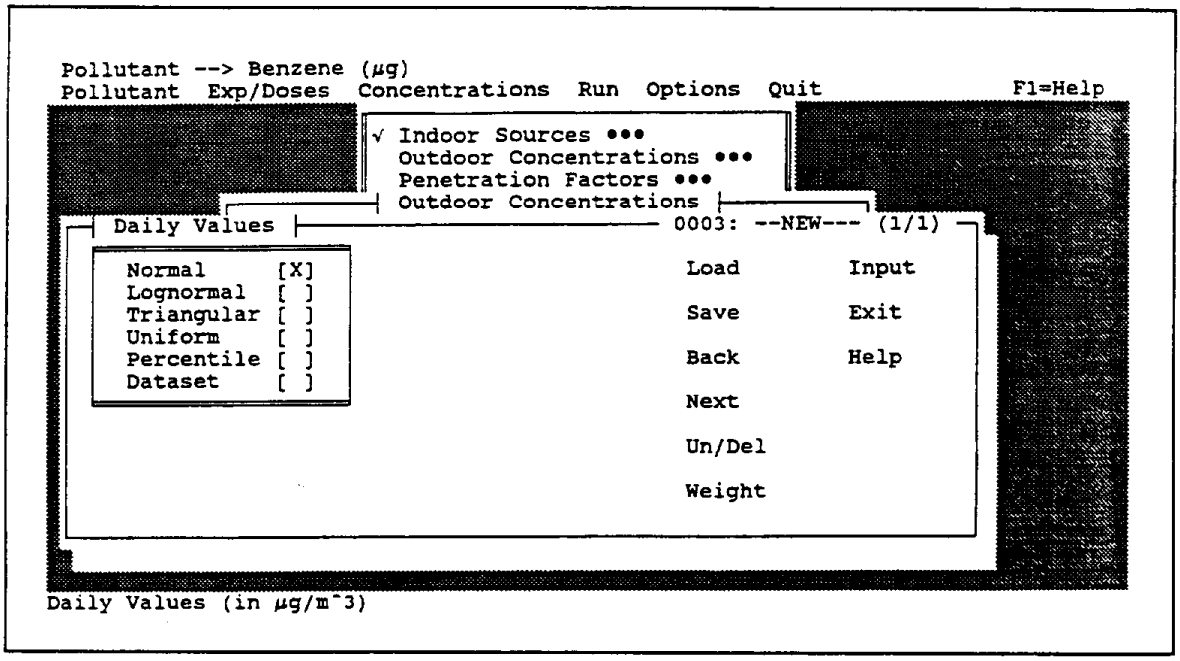


Figure 4-15. Pop-up Menu for Daily Values for Outdoor Concentrations

4.3 OTHER MASS-BALANCE PARAMETERS

For the remaining mass-balance parameters--penetration factors, indoor sinks, volumes and air exchange rate--inputs are allowed with the same choice of descriptors as for daily outdoor concentrations. The penetration factor, which can range from zero to one, conveys the fraction of the outdoor concentration that "penetrates" (i.e., is not intercepted by) the building envelope. The indoor-sink term, expressed as a first-order decay rate with units of inverse hours, conveys irreversible losses to indoor sinks such as finishing materials and furnishings. In the absence of reliable information, conservative assumptions of one for the penetration factor (i.e., no interception by the building envelope) and zero for the decay rate (i.e., no pollutant decay) are advised. By comparison, several sources of information on building volumes and air exchange rates are available. As with daily values for outdoor concentrations, multiple descriptions and user-assigned weights are allowed for these parameters. Further discussion of these parameters and sources of information are provided in Section 6.2.3 of the final report.

4.4 NUMBER OF TRIALS AND RANDOM NUMBER SEED

The "Number of Trials" submenu (Figure 4-16) functions similarly to that for the exposure/dose model. The default number of trials is 100 (any number below 100 is probably useful only for initial testing purposes). A trial in this case is a structure; for each structure, the model will sample values for each indoor source, and for all other mass-balance parameters, and will then calculate hourly- and daily-average concentrations for the structure.

The maximum number of trials will depend on available conventional memory, due to limitations on the size of various arrays used in the calculation routines. For example, if 585K of conventional memory is available, then the maximum number of trials is approximately 1,300 (a number larger than the maximum will result in an error message, and the software will then instruct the user to hit any key to return to the system). This number should be sufficient for most applications. For example, the hourly statistics would be based on 31,200 (1300 x 24) values, because 24 sequential hourly concentrations are modeled for each trial. For daily concentrations, the estimates for the mean and standard deviation should be quite stable, whereas for an upper-percentile value such as the 95th

percentile there may be some instability. If desired, a larger number of trials can be generated by making two or more separate runs, keeping all inputs the same except the random number seed. The detailed results from the individual runs would then need to be combined and analyzed outside the model.

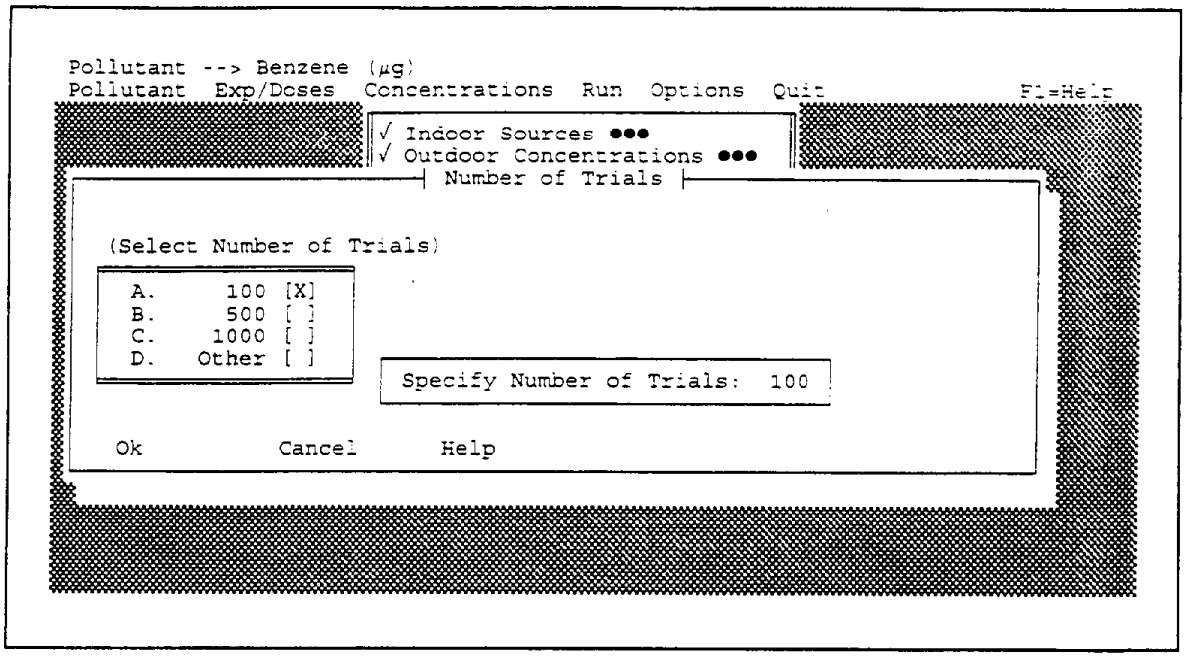


Figure 4-16. Submenu for Number of Trials

The random number seed (Figure 4-17), which controls the sampling of values for the simulation, functions in the same manner as for the exposure/dose model. The user can either enter a four-digit seed or request that the model determine a value for the seed from the system clock. By making repeated model runs with all inputs the same, except the random number seed, it is possible to assess the stability of various parameters of the estimated concentration distribution.

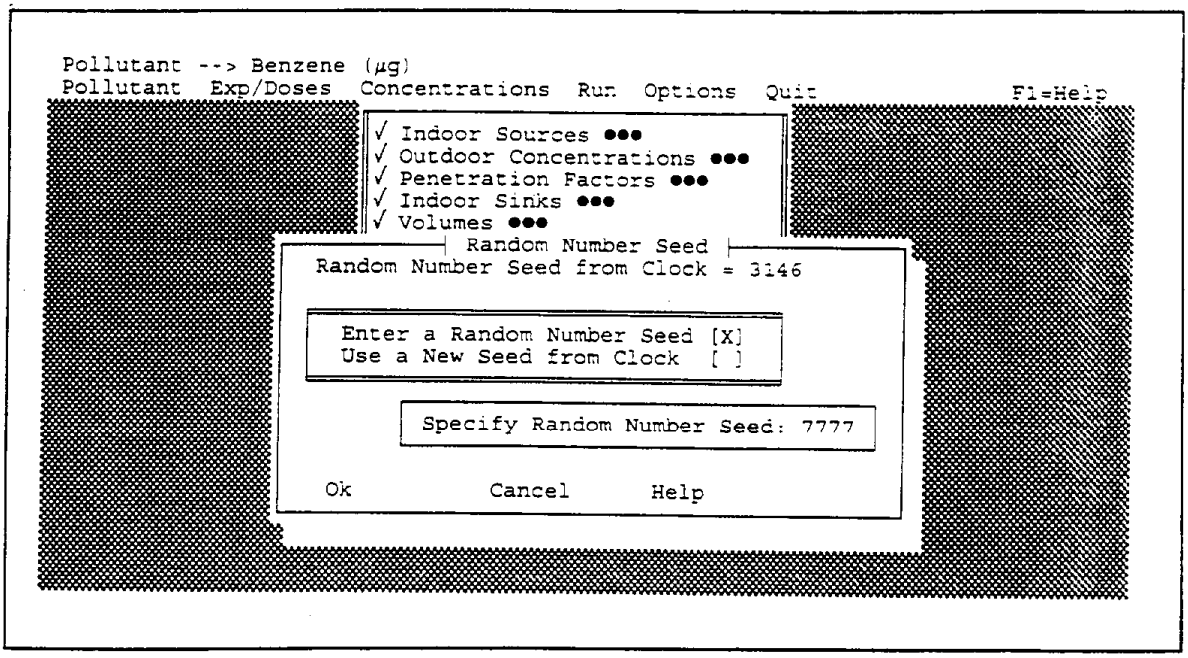


Figure 4-17. Submenu for Random Number Seed

4.5 SIGNALING COMPLETION OF INPUTS

Once all necessary inputs have been provided for the concentration part of the model, the user is ready to execute the model. Completion of inputs is signaled by choosing "Done!" on the "Concentrations" menu (Figure 4-18). As shown in the figure, check marks indicate that each submenu has been "visited" by the user. Once the user signals that all inputs have been provided, he/she will have access to the "Run" option on the opening menu, from which the model can be executed (see Section 5.0).

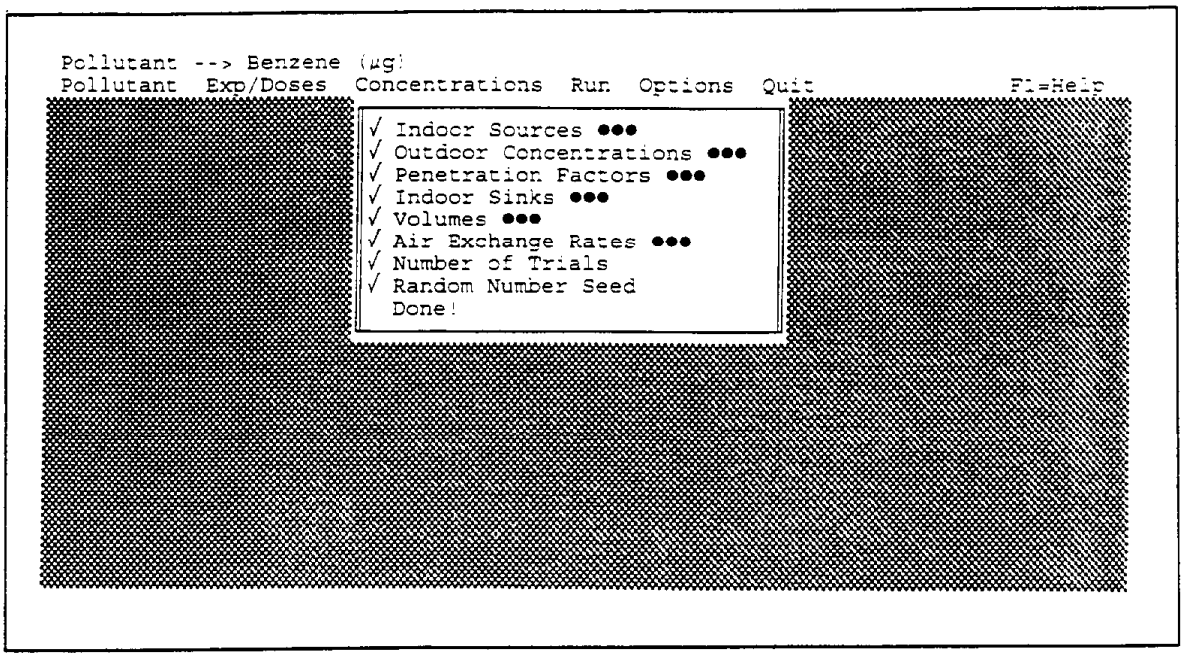


Figure 4-18. Concentrations Menu After All Inputs Have Been Provided

Section 5.0

EXECUTING MODEL CALCULATIONS

5.1 EXPOSURE/DOSE CALCULATIONS

After the user has supplied all necessary inputs and signaled completion of inputs by choosing "Done!" on the "Exp/Doses" menu (see Section 3.6), access to the "Run" menu is provided, from which the model can be executed. The run options available within this menu are shown in Figure 5-1. The user can instruct the model to calculate either exposure or dose (this option pertains to graphical and statistical outputs; the file of detailed results contains both exposure and dose calculations for each trial). Results can be calculated for total exposure/dose (summed across environments) only, or for each individual environment in addition to the total. The user also can provide a title for the run (up to 40 characters) and an output filename (up to 8 characters). By default, the run is untitled and the output filename is "NONAME."

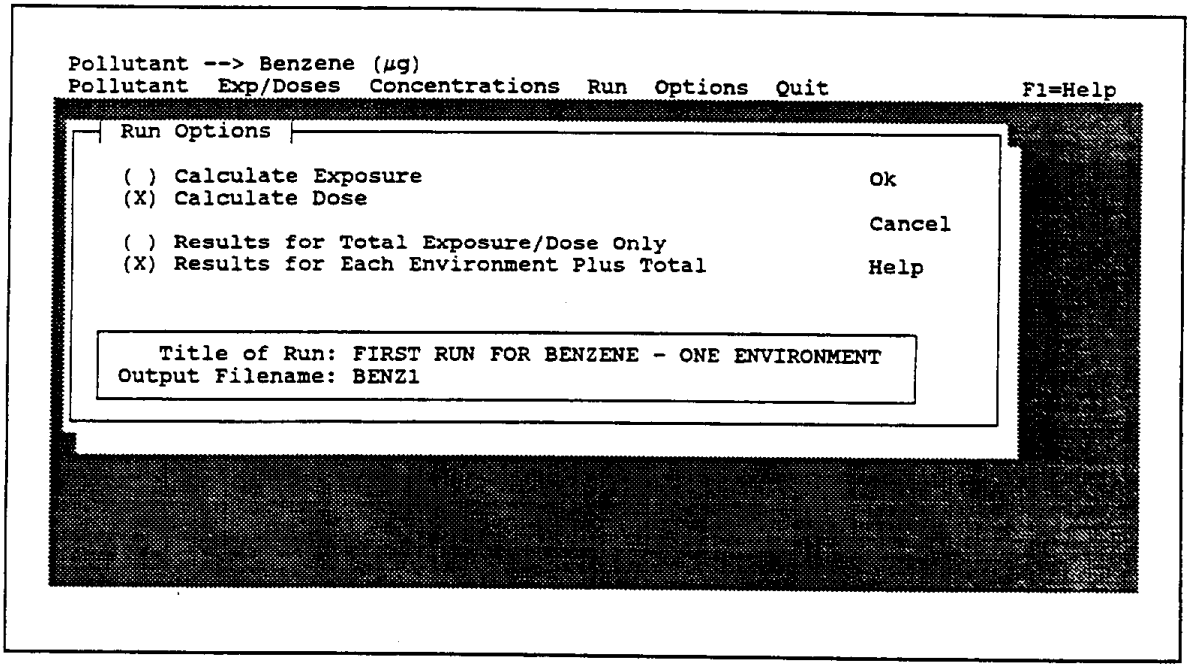


Figure 5-1. Options Associated with Run Menu for Exposure/Dose Calculations

After completing this menu and signaling completion with the "Ok" button, the model will execute. Progress is displayed on the screen (percent completed) while the model is executing. After model execution is complete, a graphical output is displayed for the first environmental (or TOTALS, if the user opted for results for total exposure/dose only). An example of the graphical output is given in Figure 5-2. Two graphs are plotted--a probability density function (PDF), or histogram, and a cumulative distribution function (CDF). The location of the mean is indicated in the PDF and CDF plots by a dotted line, and the locations of the 50th and 95th percentiles are indicated by dashed lines in the CDF plot. Statistics are also provided for the arithmetic mean and standard deviation, geometric mean and standard deviation, minimum, maximum, and various percentiles of the exposure or dose distribution (dose was selected for the case in Figure 5-2).

Buttons to the lower left of the screen containing the graphical output allow the user to view results for other environments ("Next" and "Back" buttons), save the graphical output for later printing ("File" button), or print the output ("Print" button). The first part of the name for a graphical output file is that provided by the user (see Figure 5-1). The first letter of the file-name extension is G (for graph), the second letter indicates whether the graph pertains to exposure (E) or dose (D), and the third letter indicates the environment (1 to 9) or total (T) to which the graph pertains. For example, a graph pertaining to the total dose distribution would have a file-name extension of .GDT. Graphical output files can be printed using the DOS command COPY [filename] LPT1: /B.

After the user has viewed, saved or plotted any graphs of choice, he/she exits this part of the run sequence using the "Exit" button. Access is then gained to options for saving statistics and/or saving a file containing detailed results. If the user does not have a mouse, it is still possible to move between these choices using the "Tab" key (to move up or down) and the space bar (to toggle each choice on or off). The statistics file (Figure 5-3) contains only the statistics previously displayed in Figure 5-2, and has a file extension of .STE (exposure) or .STD (dose). The format (Figure 5-4) for the detailed file has a file extension of .FMT. As indicated by the format file, the first field in the file of detailed results is an index number--1 for the first trial, 2 for the second trial, and so on up to the number of trials specified by the user. The case ID is the identifier assigned by

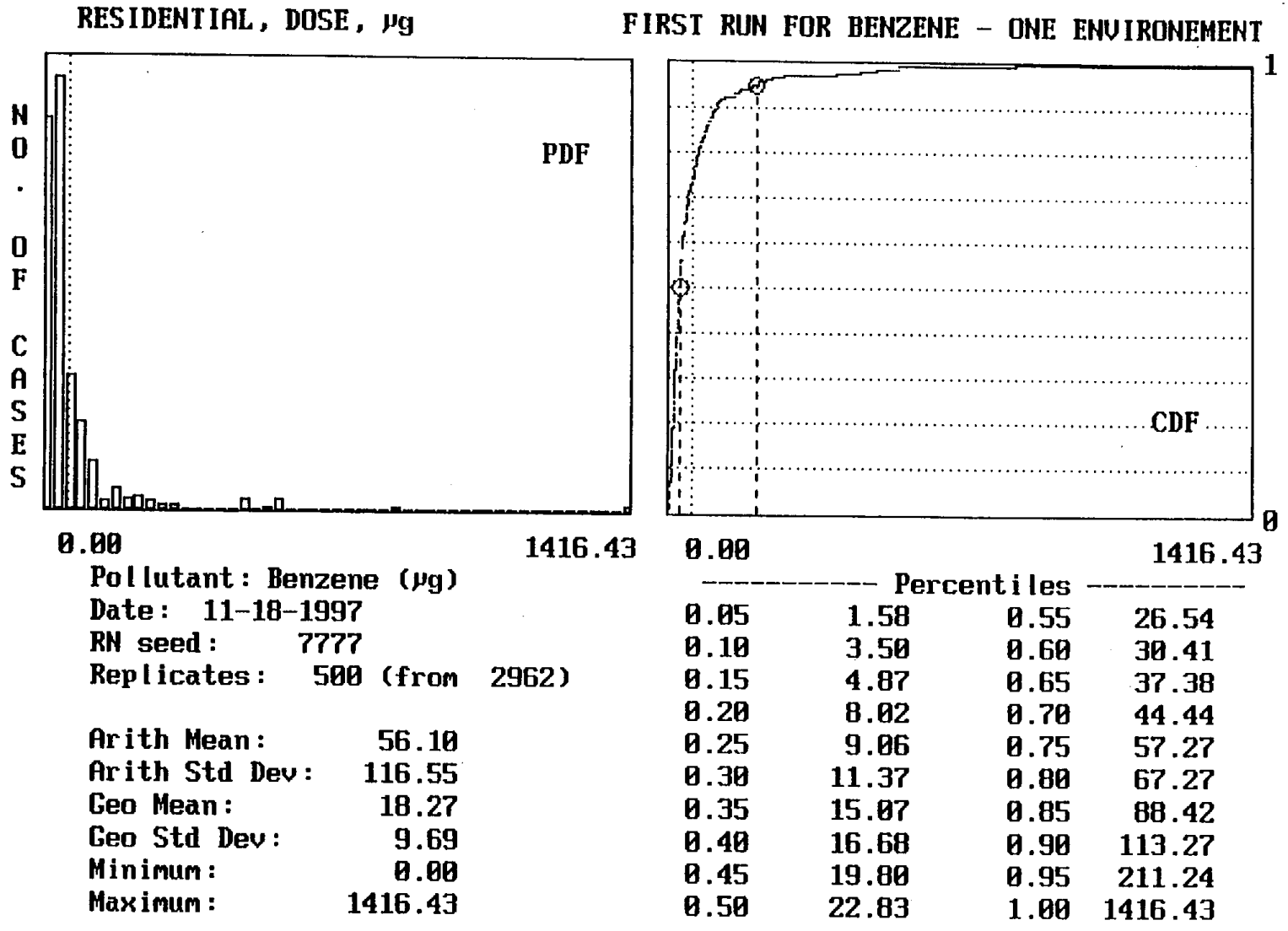


Figure 5-2. Example of Graphical Output from Exposure/Dose Calculations

```
Title:        FIRST RUN FOR BENZENE - ONE ENVIRONMENT
Pollutant:    Benzene (ug)
Trials:           500  (from  2962)
Random seed:     7777
```

	ENV1	TOTALS
Arith Mean	56.10	56.10
Arith Std Dev	116.55	116.55
Geo Mean	18.27	18.27
Geo Std Dev	9.69	9.69
Minimum	0.00	0.00
Maximum	1416.43	1416.43
5%	1.58	1.58
10%	3.50	3.50
15%	4.87	4.87
20%	8.02	8.02
25%	9.06	9.06
30%	11.37	11.37
35%	15.07	15.07
40%	16.68	16.68
45%	19.80	19.80
50%	22.83	22.83
55%	26.54	26.54
60%	30.41	30.41
65%	37.38	37.38
70%	44.44	44.44
75%	57.27	57.27
80%	67.27	67.27
85%	88.42	88.42
90%	113.27	113.27
95%	211.24	211.24
100%	1416.43	1416.43

LEGEND:

```
ENV1 =  RESIDENTIAL                 ENV6 = PUBLIC ACCESS BLDG.
ENV2 =  OFFICE                      ENV7 = RESTAURANT/LOUNGE
ENV3 =  INDUSTRIAL PLANT            ENV8 = OTHER INDOOR
ENV4 =  SCHOOL                      ENV9 = OUTDOORS
ENV5 =  TRAVEL IN VEHICLE
```

Figure 5-3. Example of a Statistics File for Doses

FIELD NAME		COLUMNS
Index Number		1 - 7
Case ID		9 - 13
Sex/Age		15 - 15
Time Weight		17 - 21
Time in	RESIDENTIAL	22 - 29
Exposure in	RESIDENTIAL	31 - 38
Dose in	RESIDENTIAL	40 - 48
Total Time		49 - 56
Total Exposure		58 - 65
Total Dose		67 - 74

Figure 5-4. Example of a Format File for Exposures and Doses

ARB to individuals who participated in the activity surveys. The sex/age field denotes the three subgroups for whom breathing rates have been assigned--a value of 1 indicates adult males, 2 indicates adult females, and 3 refers to children. The time-weight field, developed by ARB staff to compensate for unequal selection probabilities among participants in the activity surveys, is used by the model to develop weighted summary statistics. The other fields in the detailed file are the amount of time, the time-integrated exposure, and the potential inhaled dose for each environment chosen by the user and for totals across all chosen environments. For the example in Figure 5-3, the user chose only one environment (residential).

The detailed file itself (Figure 5-5) has a file extension of .PRN. The fixed-column numeric format for the detailed file allows it to be readily imported into spreadsheet software such as Lotus 1-2-3. Note that the results for residential, which start in the fifth column, are identical to those for the total across environments, which start in the eighth column. The results are identical for this example case because the user chose only one environment.

After the user has made choices related to statistics and the detailed file, he/she can return to the graphical outputs (using the "Back" button) or return to the main menu (using the "Exit" button). At this point, the user can exit the model using the "Quit" option or change inputs to make additional runs. Should the user wish to obtain graphical outputs for both exposure and dose, this can be accomplished by running the model twice, making a choice to calculate exposure the first time and dose the second time.

1	35035	3	0.134	20.58	18.11	9.43	20.58	18.11	9.43
2	24745	3	0.174	16.75	23.55	11.23	16.75	23.55	11.23
3	64175	3	0.189	24.00	46.32	24.65	24.00	46.32	24.65
4	68985	3	0.100	22.58	831.58	404.44	22.58	831.58	404.44
5	42505	3	0.234	12.75	8.67	3.71	12.75	8.67	3.71
6	28525	3	0.067	15.75	8.27	4.19	15.75	8.27	4.19
7	5861	1	0.294	9.75	18.98	12.17	9.75	18.98	12.17
8	63901	2	0.626	11.75	103.45	51.07	11.75	103.45	51.07
9	29791	1	0.669	18.12	248.31	183.20	18.12	248.31	183.20
10	66695	3	0.100	22.17	20.77	9.28	22.17	20.77	9.28
11	32591	2	2.723	15.25	16.86	9.07	15.25	16.86	9.07
12	41	1	1.178	19.75	123.82	90.91	19.75	123.82	90.91
13	28805	3	0.221	20.00	77.26	45.48	20.00	77.26	45.48
14	64001	1	0.626	22.33	9.75	8.22	22.33	9.75	8.22
15	24255	3	0.458	23.50	160.64	134.66	23.50	160.64	134.66
16	21663	1	0.730	16.67	84.63	61.78	16.67	84.63	61.78
17	64361	1	0.940	9.67	31.06	18.21	9.67	31.06	18.21
18	32725	3	0.458	16.50	6.86	4.27	16.50	6.86	4.27
19	62355	3	0.301	19.92	72.42	37.15	19.92	72.42	37.15
20	42483	2	1.986	12.27	45.22	26.34	12.27	45.22	26.34
21	13175	3	0.999	21.40	9.60	5.78	21.40	9.60	5.78
22	64421	2	0.266	22.00	120.14	105.94	22.00	120.14	105.94
23	9421	1	0.181	12.33	5.22	3.63	12.33	5.22	3.63
24	6011	2	0.648	11.17	81.61	40.88	11.17	81.61	40.88
25	48891	2	1.880	10.50	130.74	72.22	10.50	130.74	72.22
26	30615	3	0.096	16.50	8.72	4.99	16.50	8.72	4.99
27	68355	3	0.174	23.00	34.80	16.11	23.00	34.80	16.11
28	5601	1	0.648	14.83	112.73	83.92	14.83	112.73	83.92
29	62855	3	0.341	23.25	8.30	4.36	23.25	8.30	4.36
30	21293	2	1.095	24.00	50.37	28.47	24.00	50.37	28.47
31	66561	1	0.368	15.50	13.12	9.52	15.50	13.12	9.52
32	55525	3	0.299	19.75	7.65	4.36	19.75	7.65	4.36
33	32111	2	0.680	10.50	67.52	33.44	10.50	67.52	33.44
34	46055	3	0.216	24.00	54.36	34.20	24.00	54.36	34.20
35	63911	1	0.313	19.92	44.51	37.24	19.92	44.51	37.24
36	30971	2	0.669	20.25	48.97	30.23	20.25	48.97	30.23
37	8643	2	1.306	12.83	1.44	0.77	12.83	1.44	0.77
38	25645	3	0.067	15.50	154.51	88.22	15.50	154.51	88.22
39	67571	2	0.399	17.58	24.83	15.63	17.58	24.83	15.63
40	25675	3	0.134	15.22	27.12	10.11	15.22	27.12	10.11
41	32701	2	1.337	21.00	136.62	90.43	21.00	136.62	90.43
42	51435	3	0.247	15.00	49.88	23.28	15.00	49.88	23.28
43	251	2	0.589	0.00	0.00	0.00	0.00	0.00	0.00
44	23935	3	0.147	19.25	12.48	6.42	19.25	12.48	6.42
45	22313	1	1.460	17.50	170.27	115.54	17.50	170.27	115.54
46	36565	3	0.188	22.50	29.40	14.02	22.50	29.40	14.02
47	51501	2	0.313	12.50	32.36	19.67	12.50	32.36	19.67
48	21141	2	0.453	14.25	48.62	26.61	14.25	48.62	26.61
49	22355	3	0.341	17.92	8.15	4.04	17.92	8.15	4.04
50	73375	3	0.126	24.00	798.37	500.64	24.00	798.37	500.64

Figure 5-5. Example of Detailed Results File for Exposures and Doses

5.2 CONCENTRATION CALCULATIONS

The "Run" menu for concentrations, shown in Figure 5-6, is accessed after the user has signaled completion of inputs by choosing "Done!" on the "Concentrations" menu (see Section 4.5). The user can instruct the model to display results for daily-average concentrations only or for both hourly and daily averages. The file of detailed results, shown later, contains both the hourly and daily values.

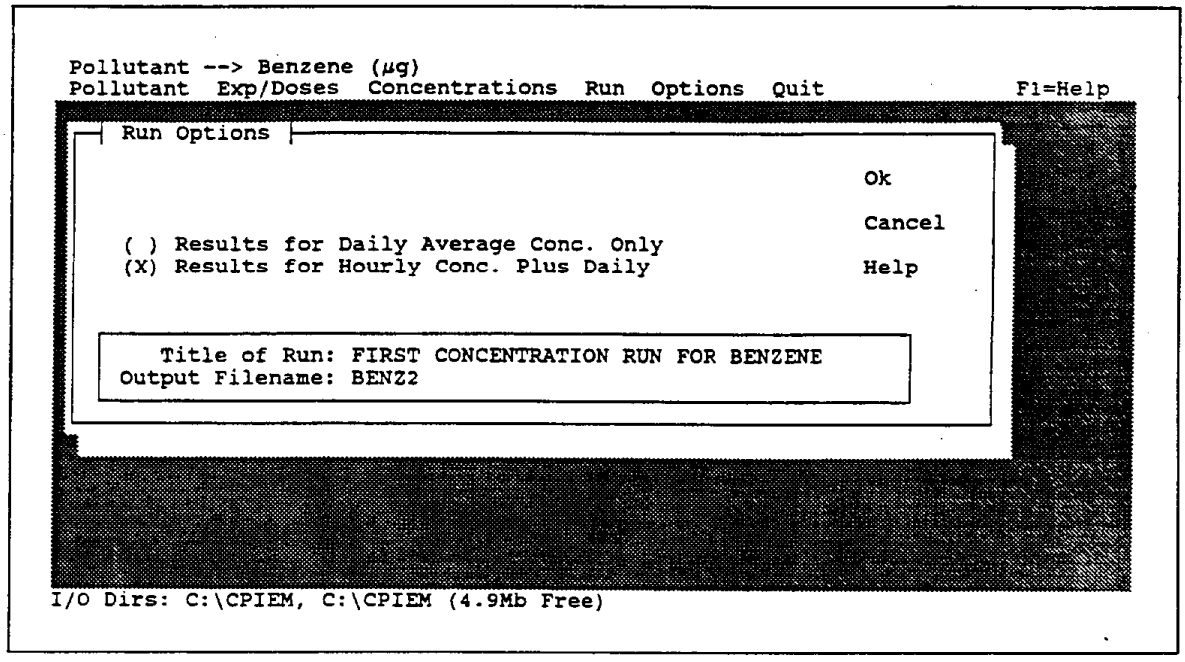


Figure 5-6. Options Associated with Run Menu for Concentration Calculations

The user must select at least one type of indoor source to make concentration calculations. If the user attempts a run without selecting any indoor sources, then the warning message shown in Figure 5-7 will be displayed and the user will be returned to the "Run" menu, from which he/she must return to the "Concentrations" menu. If the user wishes to make a run with no indoor sources (to assess the impact of outdoor concentrations on indoor levels), then he/she can select one type of indoor source and set the emission rate to zero for that source.

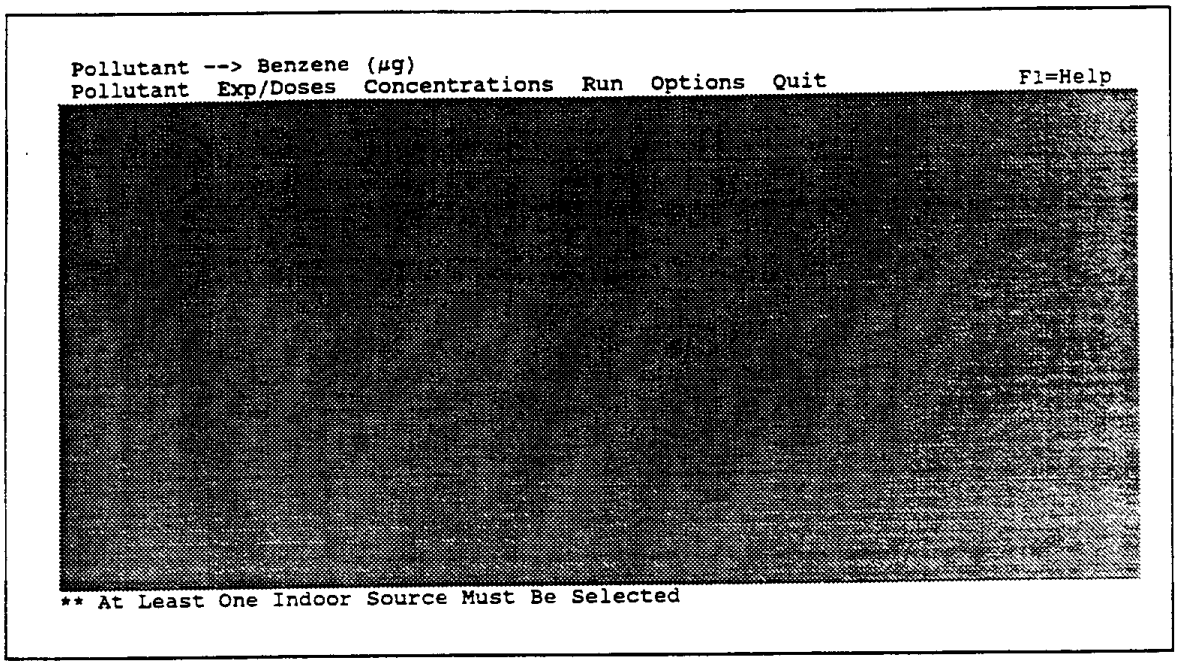
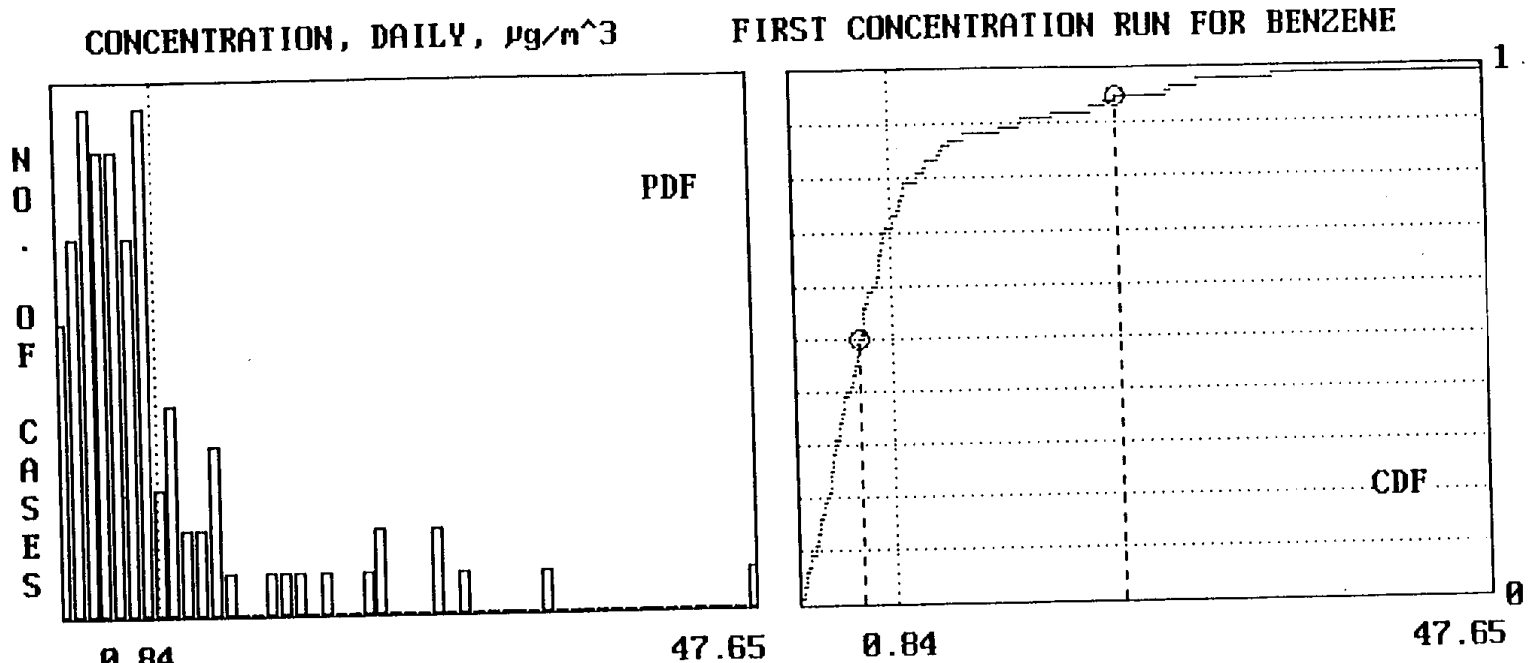


Figure 5-7. Warning for Concentration Calculations When No Indoor Source Has Been Selected

An example of the graphical output for daily concentrations is given in Figure 5-8. The output format is like that for exposure or dose, with a PDF and CDF at the top and summary statistics at the bottom. The daily-concentration graph can be printed or saved (file-name extension of .GCD). The hourly-concentration graph (Figure 5-9) is smoother than that for daily concentrations because it is based on 24 times the number of observations (replicates). If saved, the file containing this graph will have an extension of .GCH.

Buttons beneath the graphs and summary statistics for daily/hourly concentrations function identically to those for exposures or doses. These buttons allow the user to save or print graphical outputs, to move back and forth between daily and hourly concentration plots, or to exit this part of the run sequence, thereby gaining access to options for saving statistics and/or saving a file with detailed results for each trial. The statistics file (Figure 5-10), with a extension of .STC, contains the statistics displayed in Figures 5-8 and 5-9. As indicated by the format file (.FMT extension) in Figure 5-11, the detailed file (.ASC extension) contains the index (trial) number, average concentrations for each of 24 hours,



Pollutant: Benzene (µg)
Date: 04-10-1997
RN seed: 7777
Replicates: 100

Arith Mean:	7.29
Arith Std Dev:	7.53
Geo Mean:	5.09
Geo Std Dev:	2.29
Minimum:	0.84
Maximum:	47.65

Percentiles

0.05	1.19	0.55	5.43
0.10	1.75	0.60	6.03
0.15	2.18	0.65	6.49
0.20	2.65	0.70	6.82
0.25	3.01	0.75	7.96
0.30	3.24	0.80	9.15
0.35	3.69	0.85	10.84
0.40	4.25	0.90	16.13
0.45	4.77	0.95	22.76
0.50	4.96	1.00	47.65

Figure 5-8. Example of Daily Output from Concentration Calculations

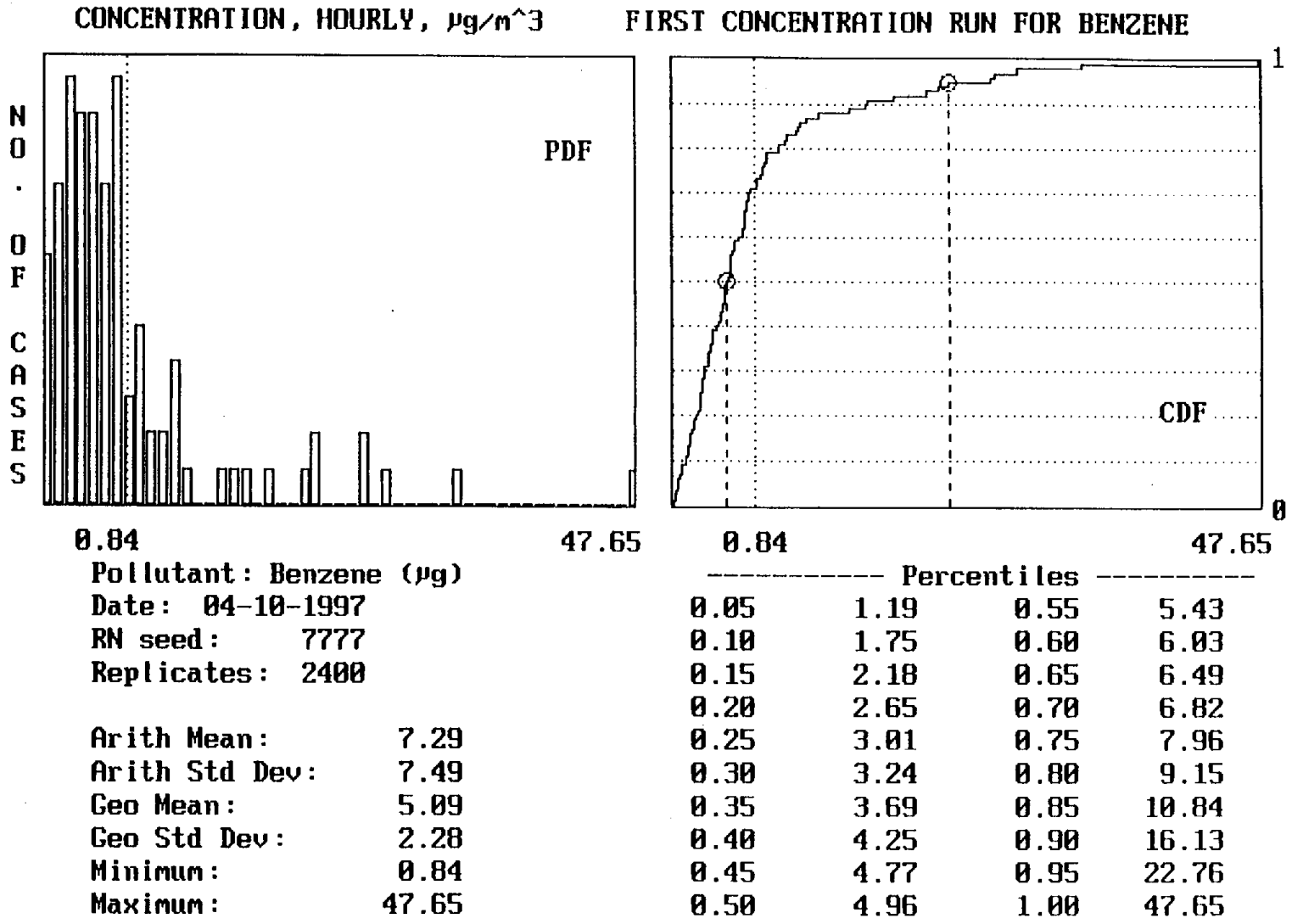


Figure 5-9. Example of Hourly Output from Concentration Calculations

Title: FIRST CONCENTRATION RUN FOR BENZENE
Pollutant: Benzene (ug/m^3)
Trials: 100
Random seed: 7777

	DAILY	HOURLY
Arith Mean	7.29	7.29
Arith Std Dev	7.53	7.49
Geo Mean	5.09	5.09
Geo Std Dev	2.29	2.28
Minimum	0.84	0.84
Maximum	47.65	47.65
5%	1.19	1.19
10%	1.75	1.75
15%	2.18	2.18
20%	2.65	2.65
25%	3.01	3.01
30%	3.24	3.24
35%	3.69	3.69
40%	4.25	4.25
45%	4.77	4.77
50%	4.96	4.96
55%	5.43	5.43
60%	6.03	6.03
65%	6.49	6.49
70%	6.82	6.82
75%	7.96	7.96
80%	9.15	9.15
85%	10.84	10.84
90%	16.13	16.13
95%	22.76	22.76
100%	47.65	47.65

Figure 5-10. Example of Statistics File for Concentrations

FIELD NAME	COLUMNS
Index Number	1 - 8
Hour 1	10 - 17
Hour 2	19 - 26
Hour 3	28 - 35
Hour 4	37 - 44
Hour 5	46 - 53
Hour 6	55 - 62
Hour 7	64 - 71
Hour 8	73 - 80
Hour 9	82 - 89
Hour 10	91 - 99
Hour 11	101 - 107
Hour 12	109 - 116
Hour 13	118 - 125
Hour 14	127 - 134
Hour 15	136 - 143
Hour 16	145 - 152
Hour 17	154 - 161
Hour 18	163 - 170
Hour 19	172 - 179
Hour 20	181 - 188
Hour 21	190 - 197
Hour 22	199 - 206
Hour 23	208 - 215
Hour 24	217 - 224
Average	226 - 234

Figure 5-11. Example of Format File for Concentrations

and the daily-average concentration. Figure 5-12 shows a part of the detailed file, consisting of the index number followed by concentrations for the first six hours. The concentrations are identical across hours for each trial because a constant, long-term indoor source was chosen.

1	3.93	3.93	3.93	3.93	3.93	3.93
2	3.69	3.69	3.69	3.69	3.69	3.69
3	22.76	22.76	22.76	22.76	22.76	22.76
4	2.99	2.99	2.99	2.99	2.99	2.99
5	5.43	5.43	5.43	5.43	5.43	5.43
6	6.49	6.49	6.49	6.49	6.49	6.49
7	5.76	5.76	5.76	5.76	5.76	5.76
8	6.66	6.66	6.66	6.66	6.66	6.66
9	5.38	5.38	5.38	5.38	5.38	5.38
10	3.83	3.83	3.83	3.83	3.83	3.83
11	21.03	21.03	21.03	21.03	21.03	21.03
12	3.00	3.00	3.00	3.00	3.00	3.00
13	8.27	8.27	8.27	8.27	8.27	8.27
14	1.24	1.24	1.24	1.24	1.24	1.24
15	2.04	2.04	2.04	2.04	2.04	2.04
16	6.90	6.90	6.90	6.90	6.90	6.90
17	1.98	1.98	1.98	1.98	1.98	1.98
18	4.25	4.25	4.25	4.25	4.25	4.25
19	6.03	6.03	6.03	6.03	6.03	6.03
20	28.23	28.23	28.23	28.23	28.23	28.23
21	1.17	1.17	1.17	1.17	1.17	1.17
22	8.21	8.21	8.21	8.21	8.21	8.21
23	6.42	6.42	6.42	6.42	6.42	6.42
24	3.07	3.07	3.07	3.07	3.07	3.07
25	2.81	2.81	2.81	2.81	2.81	2.81
26	4.52	4.52	4.52	4.52	4.52	4.52
27	2.36	2.36	2.36	2.36	2.36	2.36
28	0.94	0.94	0.94	0.94	0.94	0.94
29	7.77	7.77	7.77	7.77	7.77	7.77
30	3.65	3.65	3.65	3.65	3.65	3.65
31	9.15	9.15	9.15	9.15	9.15	9.15
32	2.87	2.87	2.87	2.87	2.87	2.87
33	14.95	14.95	14.95	14.95	14.95	14.95
34	2.65	2.65	2.65	2.65	2.65	2.65
35	6.55	6.55	6.55	6.55	6.55	6.55
36	8.07	8.07	8.07	8.07	8.07	8.07
37	6.82	6.82	6.82	6.82	6.82	6.82
38	2.21	2.21	2.21	2.21	2.21	2.21
39	7.96	7.96	7.96	7.96	7.96	7.96
40	10.84	10.84	10.84	10.84	10.84	10.84
41	3.01	3.01	3.01	3.01	3.01	3.01
42	3.18	3.18	3.18	3.18	3.18	3.18
43	3.71	3.71	3.71	3.71	3.71	3.71
44	4.47	4.47	4.47	4.47	4.47	4.47
45	2.06	2.06	2.06	2.06	2.06	2.06
46	7.40	7.40	7.40	7.40	7.40	7.40
47	5.43	5.43	5.43	5.43	5.43	5.43
48	6.36	6.36	6.36	6.36	6.36	6.36
49	4.55	4.55	4.55	4.55	4.55	4.55
50	9.77	9.77	9.77	9.77	9.77	9.77

Figure 5-12. Example of Detailed Results File for Concentrations

Section 6.0

EXAMPLE APPLICATIONS

6.1 EXPOSURE/DOSE DISTRIBUTIONS

The example applications below involve runs with inputs (concentration distributions) for one environment and for two environments. Options related to population subgroup, number of trials, random number seed, and multiple concentration inputs for one environment are demonstrated.

6.1.1 Model Runs for One Environment

For the first run [Example 6.1.1(a)], formaldehyde was selected as the pollutant and an integration period of 24 hours was chosen. No population subgroup was specified; with this choice, a total of 2,962 activity profiles for adults, adolescents and children were available. A sample of 500 activity profiles was specified through the "Number of Trials" submenu. Concentration inputs were provided for one environment--residential. As shown in Figure 6-1, a lognormal distribution was chosen, for which the arithmetic mean and standard deviation were specified. A random number seed of 7777 was chosen.

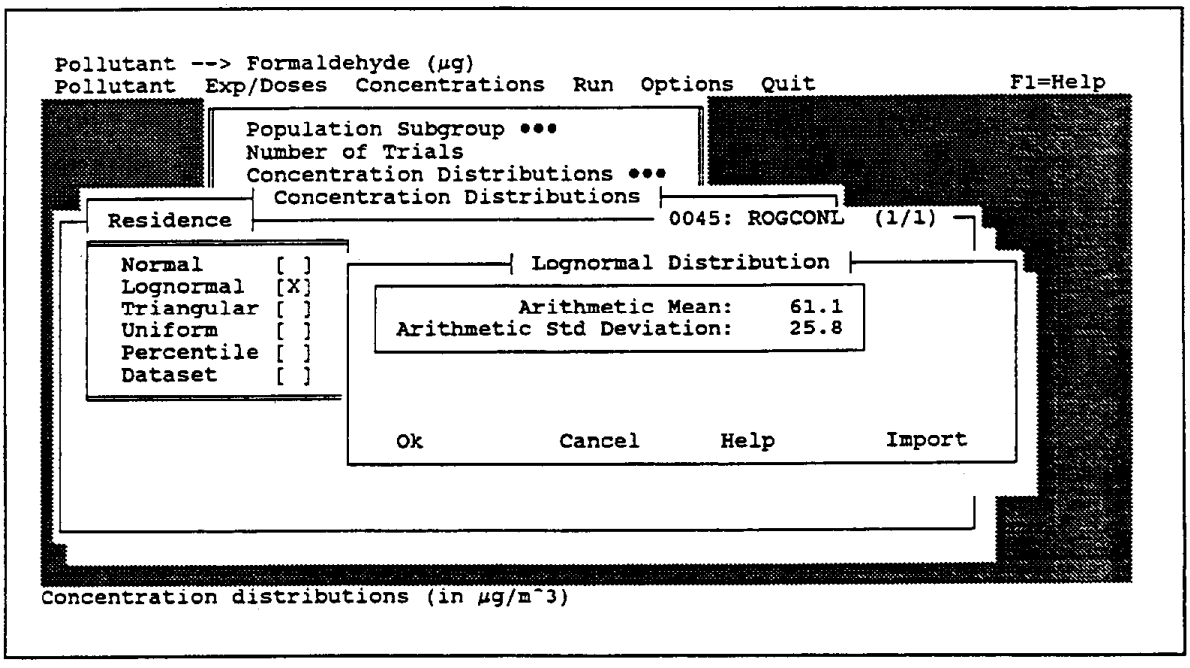


Figure 6-1. Inputs for Concentration Distribution for Example 6.1.1(a)

Through the "Run" menu (Figure 6-2), options were chosen to calculate dose and to compute results for each environment (one in this case) and in total. A title for the run and an output filename were also specified.

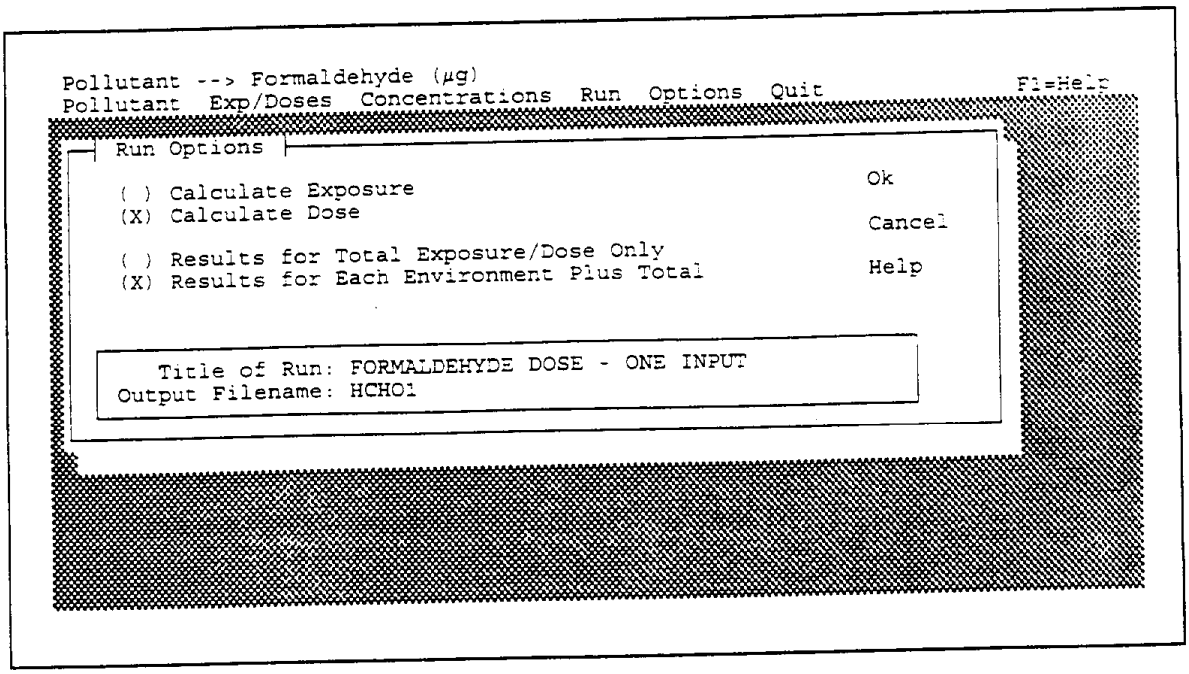


Figure 6-2. Run Options for Example 6.1.1(a)

The results of the model run are shown in Figure 6-3. The upper left title indicates the environment to which the results pertain and the units for dose. The upper right title is that provided through the "Run" menu. The information below the PDF plot indicates the pollutant, the date of the run, the random number (RN) seed, that 500 trials (replicates) were run, and that these trials involved sampling 500 activity profiles from the 2,962 that were available. The results include an arithmetic mean dose of 707.6 μg and a geometric mean dose of 469.1 μg. The shape of the PDF is consistent with that deriving from a lognormal distribution.

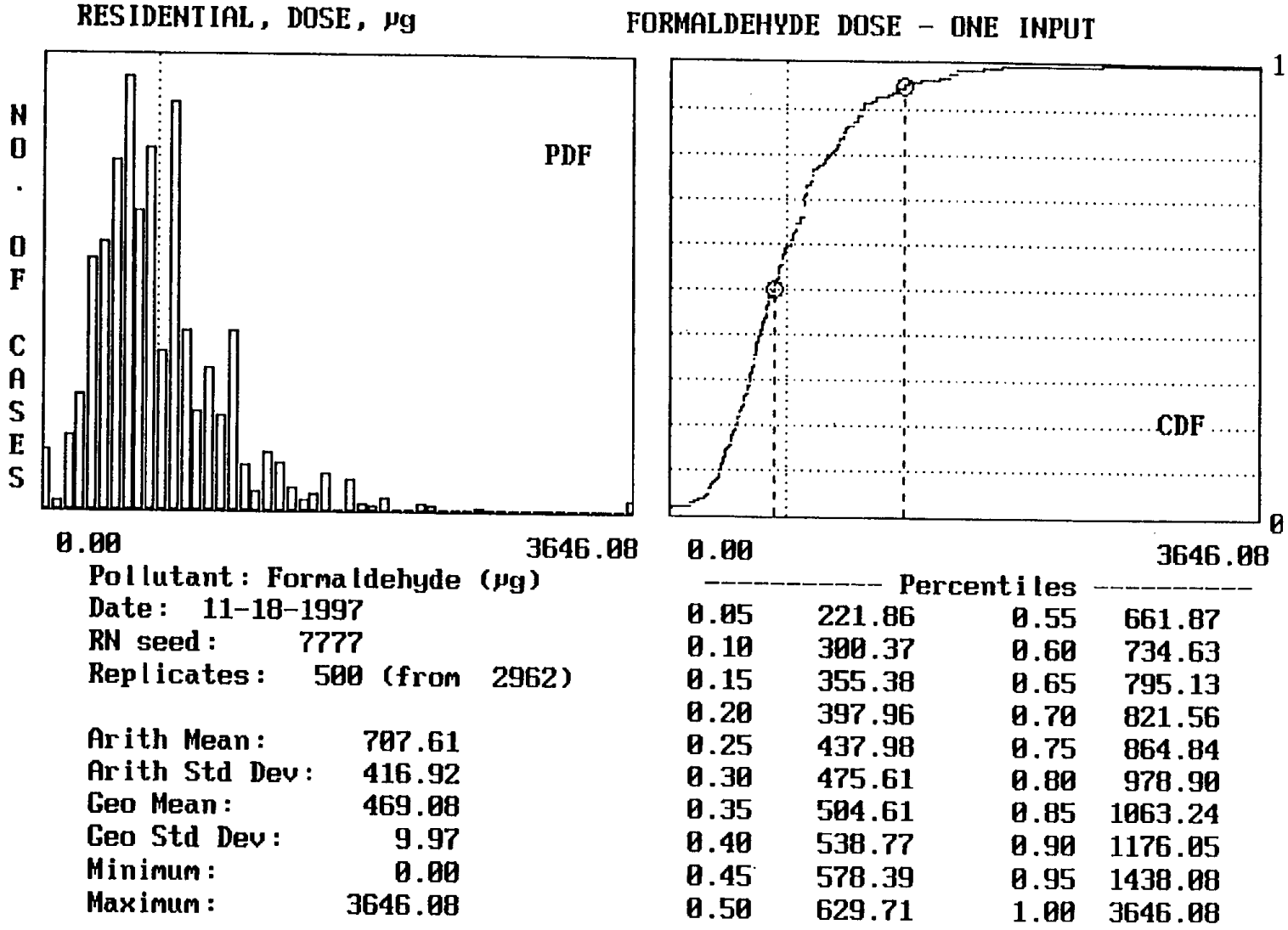


Figure 6-3. Results for Residential Dose for Example 6.1.1(a)

The detailed results file (HCHO1.PRN) from this run was imported into a Lotus 1-2-3 spreadsheet, from which the average residential concentration (right-hand column of Figure 6-4) to which each individual was exposed was calculated by dividing the exposure (concentration times the time spent in the residence) by the time. For four of the 500 cases (trials), the time spent in the residence was zero and the concentration could not be calculated. Based on the remaining 496 cases, the residential concentration averaged 63.7 $\mu g/m^3$ with a standard deviation of 26.7, consistent with the inputs (61.1 $\mu g/m^3$ ± 25.8) previously shown in Figure 6-1. Next, 50 dose bins were created with equal widths of 73 $\mu g/m^3$ (based on division of the maximum dose, 3646 $\mu g/m^3$, by 50), and these bins were used with the Lotus "Data Distribution" function to create the dose histogram shown in Figure 6-5, which is similar to the model's PDF plot previously displayed in Figure 6-3.

For the second run [Example 6.1.1(b)], residential was again selected as the only environment. In this case, however, four concentration distributions were loaded, with each described as lognormal. The weights assigned to the four distributions are shown in Figure 6-6. The last two distributions pertain to conventional houses, which account for about 96 percent of the California population. The fourth distribution (ROGCONL) was considered the most reliable and was given twice the weight (64 percent) of the third (SEXCONWL, 32 percent). The weights for the mobile-home distributions were set equal, at 2 percent each, because they reflect results for two different seasons (summer and winter) from the same study. The random number seed of 7777 was again used.

H3: (F2) [W9] +F3/E3 READY

	A	B	C	D	E	F	G	H
1	TRIAL	CASEID	AGE/SEX	TIMEWT	TIME	EXPO-	DOSE	CONCEN-
2						SURE		TRATION
3	1	35035	3	0.134	20.58	932.96	485.74	45.33
4	2	24745	3	0.174	16.75	873.96	416.55	52.18
5	3	64175	3	0.189	24	1377.05	732.99	57.38
6	4	68985	3	0.1	22.58	3139.93	1527.09	139.06
7	5	42505	3	0.234	12.75	534.89	228.64	41.95
8	6	28525	3	0.067	15.75	611.42	309.59	38.82
9	7	5861	1	0.294	9.75	560.91	359.56	57.53
10	8	63901	2	0.626	11.75	1063.26	524.84	90.49
11	9	29791	1	0.669	18.12	1872.3	1381.4	103.33
12	10	66695	3	0.1	22.17	1023.89	457.29	46.18
13	11	32591	2	2.723	15.25	740.29	398.06	48.54
14	12	41	1	1.178	19.75	1613.99	1184.96	81.72
15	13	28805	3	0.221	20	1413.3	832.08	70.66
16	14	64001	1	0.626	22.33	820.33	691.77	36.74
17	15	24255	3	0.458	23.5	1970.95	1652.24	83.87
18	16	21663	1	0.73	16.67	1278.53	933.33	76.70
19	17	64361	1	0.94	9.67	646.34	378.89	66.84
20	18	32725	3	0.458	16.5	597.13	372.15	36.19

12-May-94 08:04 AM

Figure 6-4. Calculation of Residential Concentration from Example 6.1.1(a) Outputs Imported Into a Spreadsheet

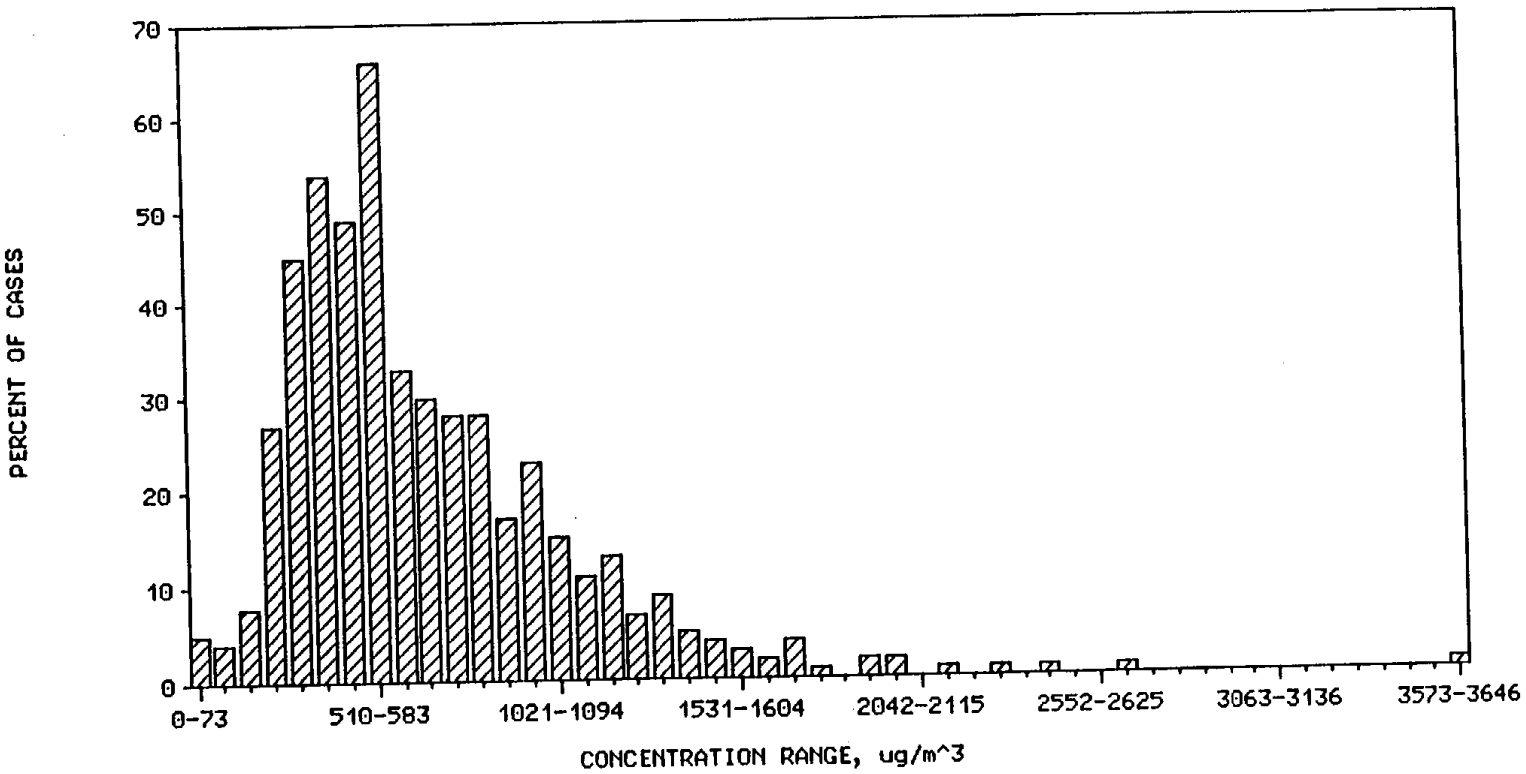


Figure 6-5. Histogram of Residential Dose Distribution for Example 6.1.1(a) Developed with Spreadsheet Software

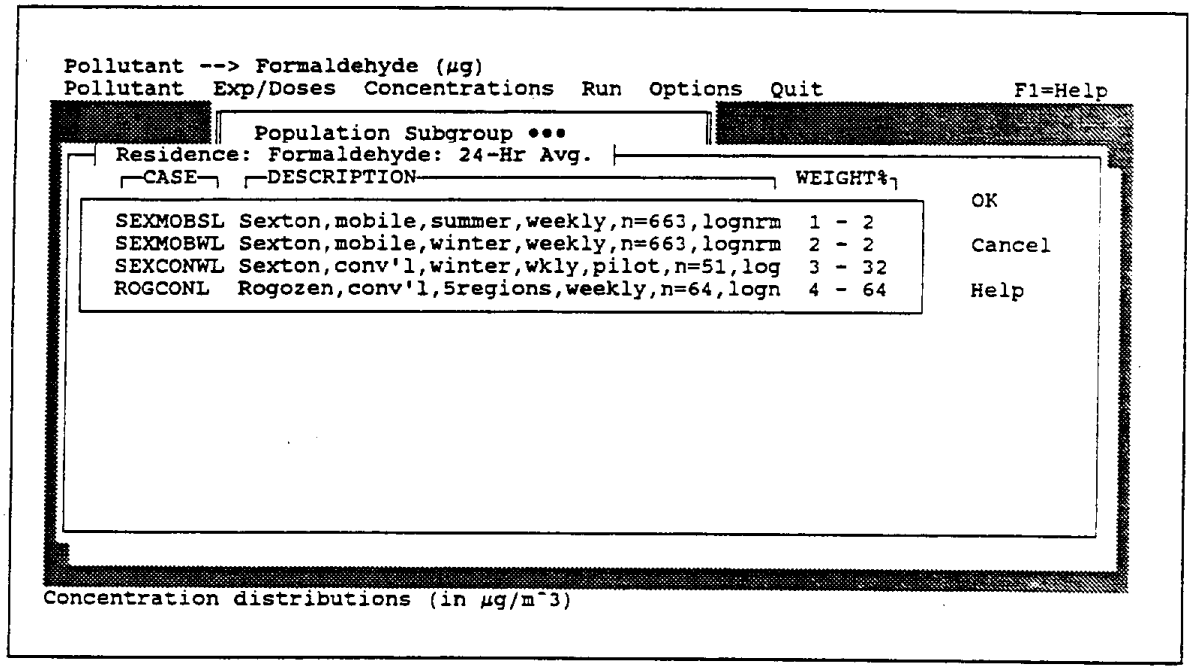
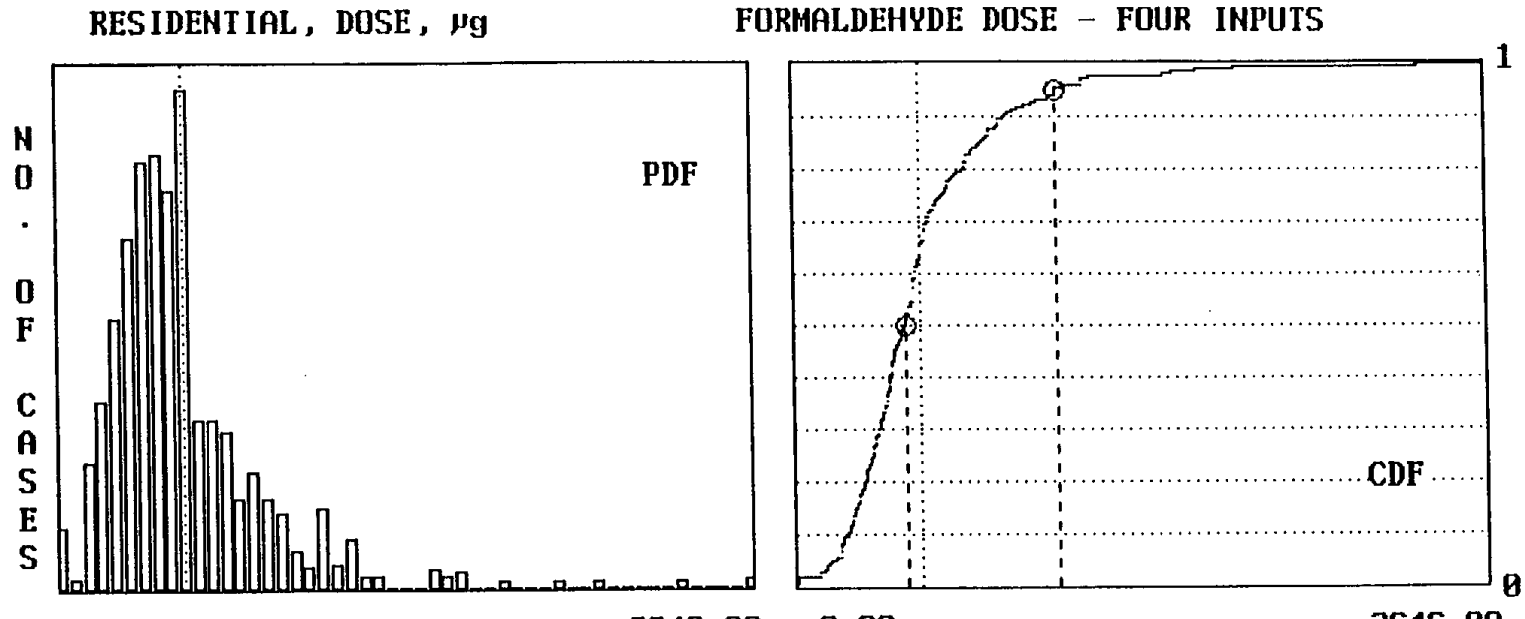


Figure 6-6. Assignment of Weights to Four Residential Concentration Distributions for Example 6.1.1(b)

Results of the second run are shown in Figure 6-7. The arithmetic and geometric means for the second run are similar to, but somewhat smaller than, those from the first run. The arithmetic standard deviation is slightly larger for the second run, whereas the geometric standard deviation is slightly smaller. The maximum dose for the second run (3646 μg) is the same as that for the first run.



Pollutant: Formaldehyde (µg)
Date: 11-18-1997
RN seed: 7777
Replicates: 500 (from 2962)

Arith Mean:	649.93
Arith Std Dev:	426.62
Geo Mean:	424.82
Geo Std Dev:	9.89
Minimum:	0.00
Maximum:	3646.08

Percentiles

0.05	183.20	0.55	616.45
0.10	268.05	0.60	629.94
0.15	309.87	0.65	657.23
0.20	359.00	0.70	692.73
0.25	398.86	0.75	776.52
0.30	430.09	0.80	884.79
0.35	472.16	0.85	986.28
0.40	495.83	0.90	1122.41
0.45	521.69	0.95	1385.16
0.50	572.45	1.00	3646.08

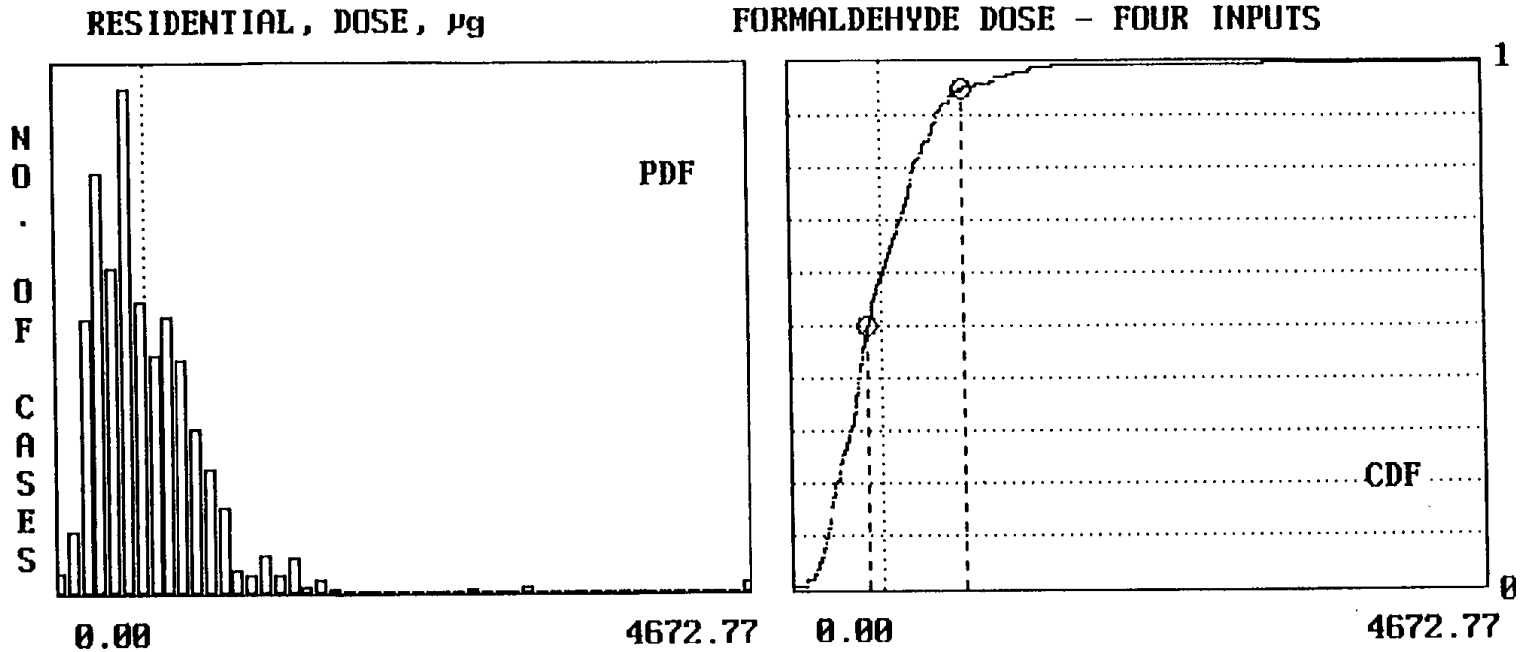
Figure 6-7. Results for Residential Dose for Example 6.1.1(b)

For the third run [Example 6.1.1(c)], all inputs were the same as for the second run, except the random number seed. In this case, a seed from the clock (2417) was chosen. The results in Figure 6-8 indicate that estimated distribution from the simulation is shifted left relative to that from the second run, with smaller values for the arithmetic mean and percentiles of the dose distribution through the 60th. The maximum dose (4673 μg), however, was higher for the third run than the second. As noted previously, making multiple runs with all inputs the same, except the random number seed, will allow the user to assess the stability of estimates for various parameters of the distribution.

6.1.2 Model Run for Two Environments

For this run [Example 6.1.2(a)], the selections of formaldehyde as the pollutant and 24 hours as the integration period were retained. The population subgroup was chosen to be all workers in the South Coast region; this choice was saved using the case name "SCWORK" (Figure 6-9). There were 209 activity profiles that met these criteria for population subgroup; all were used in the simulation, once each, by choosing the "Use All" option in the "Number of Trials" submenu. The two environments chosen were residence and office. For residence, the weights for four concentration distributions used in the previous example were retained. For office, two concentration distributions were used, with weights as shown in Figure 6-10. A random number seed of 9113 was chosen.

Output graphs were viewed for residential dose, office dose, and total dose; the graph for total dose is shown in Figure 6-11. Summary dose statistics from the .STD file are shown in Figure 6-12. On average, the dose received while in the residence accounted for nearly 90 percent (524 μg/591 μg) of the total dose. The office component of total dose was relatively small because more than 60 percent of the workers spent no time in office settings; this is indicated by zero-dose values for the office environment up through the 60th percentile. The maximum value (3146 μg) was identical for residential and total dose, indicating that the individual who received the highest residential dose spent no time in an office. The model was rerun [Example 6.1.2(b)] with all inputs the same but with the option to calculate exposure rather than dose. Summary exposure statistics from the .STE file (Figure 6-13) indicate that, on average, the residential exposure (765 μg-h/m^3) accounted for slightly more than 90 percent of the total exposure (839 μg-h/m^3).



Pollutant: Formaldehyde (µg)
Date: 11-18-1997
RN seed: 2417
Replicates: 500 (from 2962)

Arith Mean:	596.89
Arith Std Dev:	412.64
Geo Mean:	460.75
Geo Std Dev:	3.88
Minimum:	0.00
Maximum:	4672.77

Percentiles

0.05	169.35	0.55	546.47
0.10	230.95	0.60	608.81
0.15	249.99	0.65	672.99
0.20	290.05	0.70	743.40
0.25	328.80	0.75	785.53
0.30	377.90	0.80	821.05
0.35	421.89	0.85	900.52
0.40	445.87	0.90	989.88
0.45	469.99	0.95	1155.42
0.50	506.72	1.00	4672.77

Figure 6-8. Results for Residential Dose for Example 6.1.1(c)

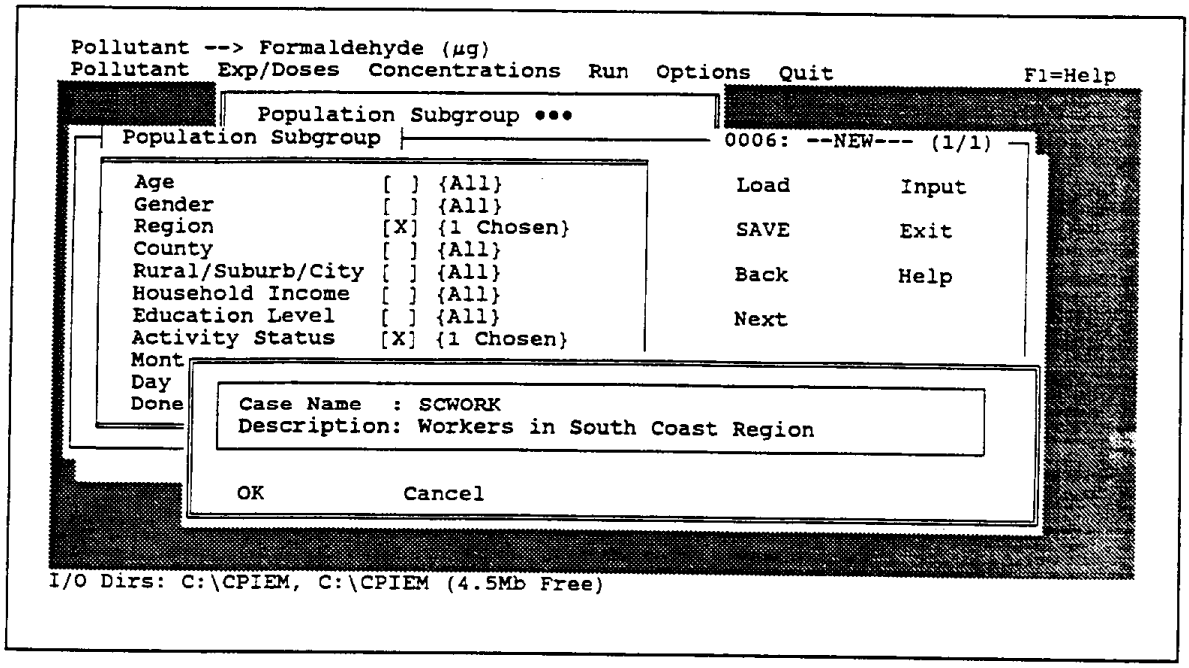


Figure 6-9. Inputs for Population Subgroup for Example 6.1.2(a)

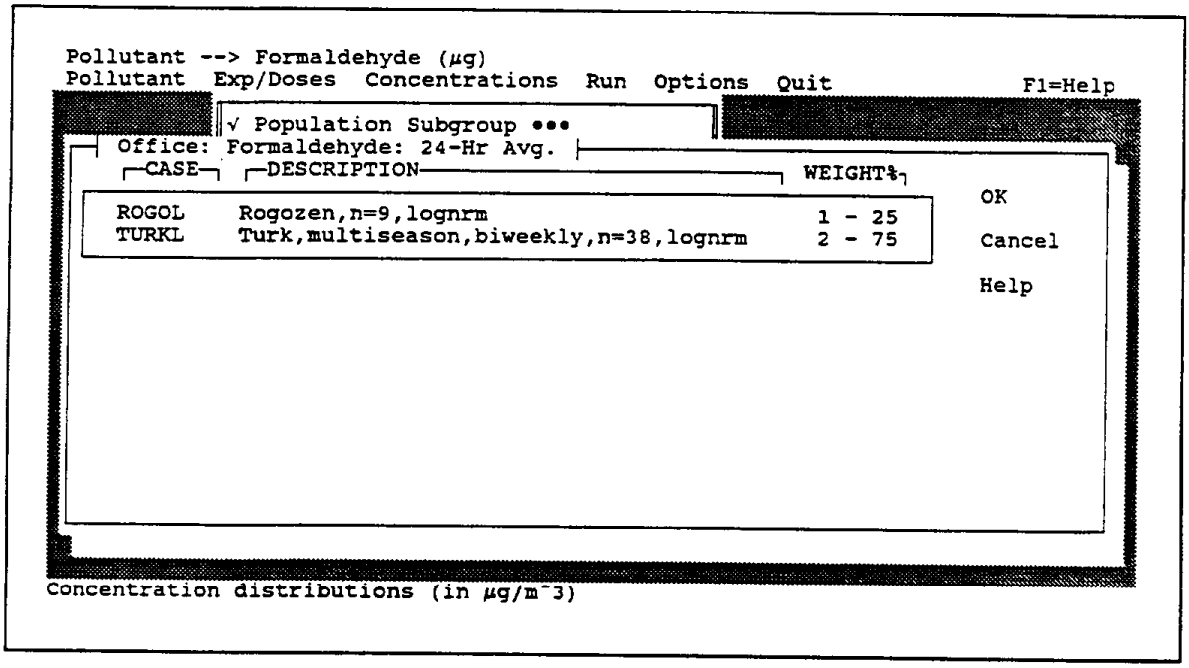
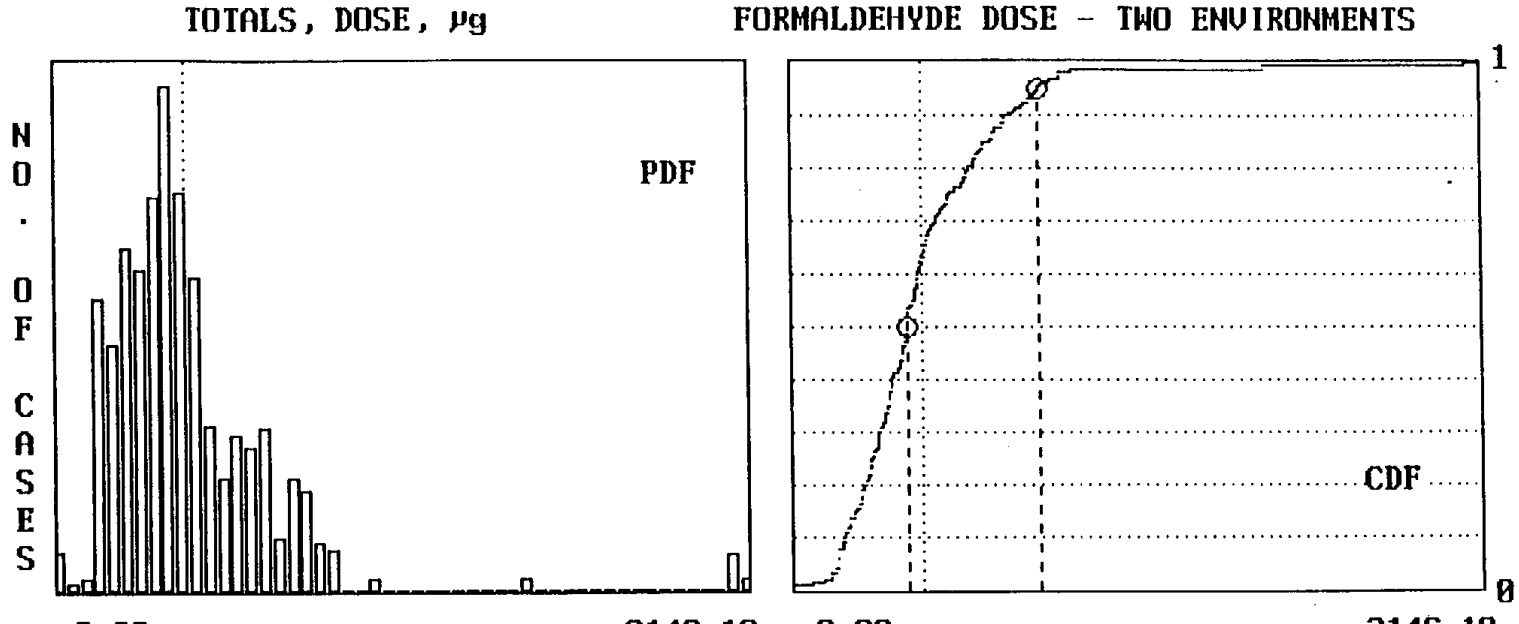


Figure 6-10. Assignment of Weights to Two Office Concentration Distributions for Example 6.1.2(a)



Pollutant: Formaldehyde (µg)
Date: 11-18-1997
RN seed: 9113
Replicates: 209 (all)

Arith Mean:	591.24
Arith Std Dev:	392.29
Geo Mean:	435.16
Geo Std Dev:	5.98
Minimum:	0.00
Maximum:	3146.19

Percentiles

0.05	196.05	0.55	548.43
0.10	231.79	0.60	568.96
0.15	282.13	0.65	605.92
0.20	327.70	0.70	650.14
0.25	358.75	0.75	721.71
0.30	388.78	0.80	805.95
0.35	430.67	0.85	899.13
0.40	449.56	0.90	983.80
0.45	497.56	0.95	1115.05
0.50	519.19	1.00	3146.19

Figure 6-11. Results for Total Dose for Example 6.1.2(a)

Title: FORMALDEHYDE DOSE - TWO ENVIRONMENTS
Pollutant: Formaldehyde (ug)
Trials: 209 (all)
Random seed: 9113

	ENV1	ENV2	TOTALS
Arith Mean	524.08	67.16	591.24
Arith Std Dev	388.35	125.41	392.29
Geo Mean	379.74	0.00	435.16
Geo Std Dev	5.94	2554.44	5.98
Minimum	0.00	0.00	0.00
Maximum	3146.19	550.35	3146.19
5%	187.45	0.00	196.05
10%	221.51	0.00	231.79
15%	238.30	0.00	282.13
20%	271.79	0.00	327.70
25%	302.74	0.00	358.75
30%	336.53	0.00	388.78
35%	359.07	0.00	430.67
40%	375.51	0.00	449.56
45%	395.19	0.00	497.56
50%	427.42	0.00	519.19
55%	450.91	0.00	548.43
60%	517.63	0.00	568.96
65%	549.71	5.08	605.92
70%	587.33	45.13	650.14
75%	625.86	86.99	721.71
80%	698.99	126.31	805.95
85%	774.54	189.75	899.13
90%	881.95	255.98	983.80
95%	1112.16	329.84	1115.05
100%	3146.19	550.35	3146.19

LEGEND:

ENV1 = RESIDENTIAL
ENV2 = OFFICE
ENV3 = INDUSTRIAL PLANT
ENV4 = SCHOOL
ENV5 = TRAVEL IN VEHICLE
ENV6 = PUBLIC ACCESS BLDG.
ENV7 = RESTAURANT/LOUNGE
ENV8 = OTHER INDOOR
ENV9 = OUTDOORS

Figure 6-12. Summary Dose Statistics for Example 6.1.2(a)

Title: FORMALDEHYDE EXPOSURE - TWO ENVIRONMENTS
Pollutant: Formaldehyde (ug-h/m^3)
Trials: 209 (all)
Random seed: 9113

	ENV1	ENV2	TOTALS
Arith Mean	765.50	73.74	839.25
Arith Std Dev	509.63	135.49	512.42
Geo Mean	569.46	0.00	631.37
Geo Std Dev	6.07	2676.40	6.11
Minimum	0.00	0.00	0.00
Maximum	5355.21	657.04	5355.21
5%	275.17	0.00	299.10
10%	354.84	0.00	380.91
15%	396.54	0.00	437.25
20%	427.92	0.00	507.90
25%	473.66	0.00	555.94
30%	518.83	0.00	590.54
35%	543.68	0.00	646.06
40%	590.31	0.00	676.95
45%	640.77	0.00	733.41
50%	671.47	0.00	755.30
55%	709.81	0.00	778.87
60%	756.34	0.00	830.30
65%	797.73	6.35	862.42
70%	845.32	45.13	914.65
75%	909.18	95.93	954.81
80%	946.65	153.01	1041.52
85%	1030.36	191.21	1158.92
90%	1218.34	307.33	1416.10
95%	1485.97	386.52	1560.15
100%	5355.21	657.04	5355.21

LEGEND:

ENV1 = RESIDENTIAL
ENV2 = OFFICE
ENV3 = INDUSTRIAL PLANT
ENV4 = SCHOOL
ENV5 = TRAVEL IN VEHICLE
ENV6 = PUBLIC ACCESS BLDG.
ENV7 = RESTAURANT/LOUNGE
ENV8 = OTHER INDOOR
ENV9 = OUTDOORS

Figure 6-13. Summary Exposure Statistics for Example 6.1.2(b)

6.2 CONCENTRATION DISTRIBUTIONS

The example applications below involve runs to estimate residential concentration distributions. Options related to indoor sources, outdoor concentrations, penetration factors, indoor sinks, volumes, and air exchange rates are demonstrated. The focus, however, is on indoor sources.

6.2.1 Model Run with Long-term Source

Potential indoor sources of benzo[a]pyrene (BaP) include combustion processes such as wood burning and tobacco smoking. Although such sources are not used continuously, the primary information on emission rates (from the PTEAM study sponsored by EPA and ARB) assumes steady-state conditions (i.e., sources operating continuously). Given this type of information, it is appropriate to treat the BaP source as a long-term source that is not related to the indoor volume (i.e., no loading). Information from the PTEAM study indicates that a BaP source was present in 28 percent of the study homes with an average emission rate of 390 hg/h and a standard deviation of 1285. This information ("Initial Emission Rate") was input to the model (Example 6.2.1) as a log-normal distribution (Figure 6-14). The "Percent of Cases" with the source was input as 28 (not shown).

Because the emission rate represents all indoor sources of BaP combined, it was input as a single source for each house using a normal distribution with a mean of one and a standard deviation of zero (Figure 6-15) for the "Quantity Present." Since the emission rate was assumed to be constant over time, the "Decline of Rate" was set uniformly to zero by inputting a normal distribution with values of zero for both the mean and standard deviation. Because the emission rate does not decline over time, the distribution for "When Installed" does not apply; a normal distribution with a mean of 12 months and a standard deviation of zero was arbitrarily chosen.

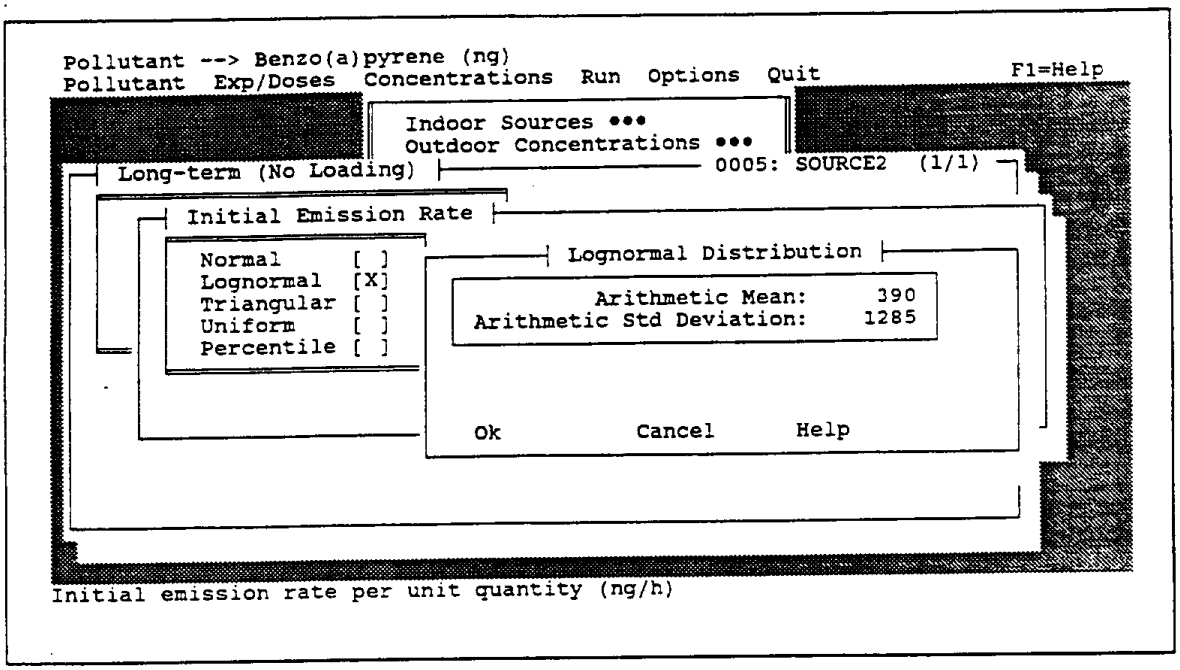


Figure 6-14. Inputs for Initial Emission Rate for Example 6.2.1

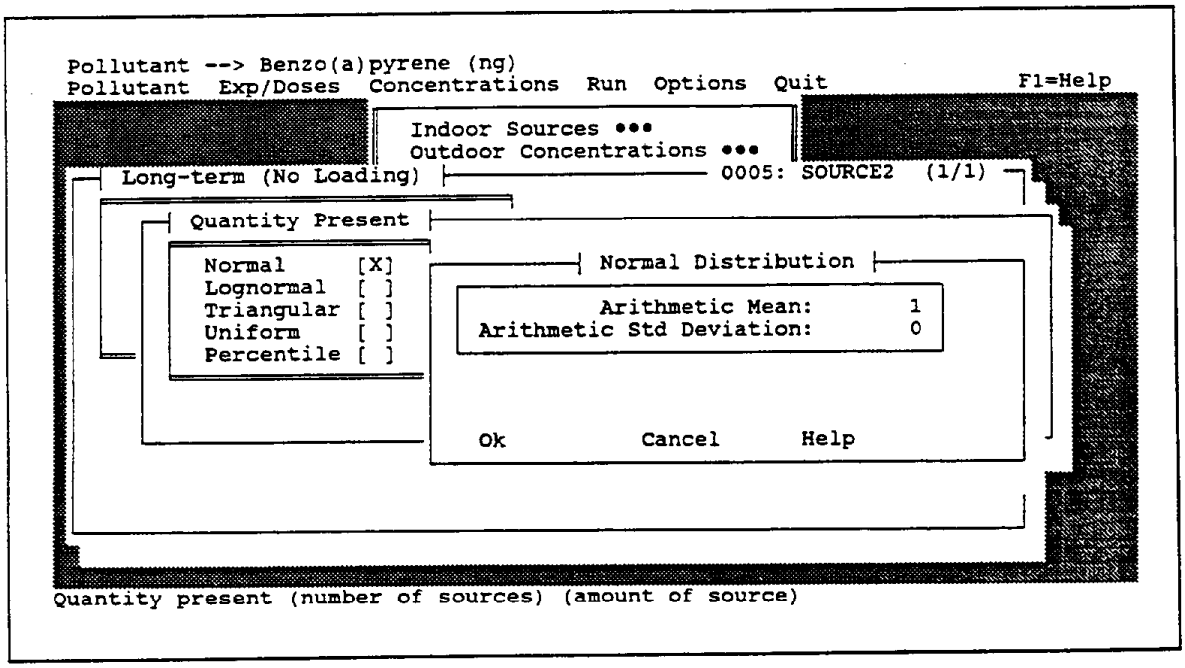


Figure 6-15. Inputs for Quantity Present for Example 6.2.1

Inputs for other model parameters, summarized in Table 6-1, were expressed as either normal or lognormal distributions. Daily-average outdoor concentrations, volumes, and air exchange rates were input as lognormal distributions. The values for outdoor concentrations and air exchange rates were taken from the PTEAM study from which the emission rates were estimated. This study did not report the house volumes; instead, distributions form three other studies (Figure 6-16) in the same geographic area were given equal weights. The penetration factor estimated from the study, 0.6, was input as a constant value using a normal distribution with a standard duration of zero, and no pollutant decay was assumed (i.e., indoor sinks were set uniformly to zero.)

Table 6-1. Inputs for Other Mass-Balance Parameters for Example 6.2.1

Input Parameter	Distribution/Values
Outdoor Concentrations	Daily, Lognormal (0.30, 0.36)
Penetration Factors	Normal (0.6, 0)
Indoor Sinks	Normal (0, 0)
Volumes*	Lognormal (274.9, 110.6) Lognormal (309.5, 159.8) Lognormal (354, 101)
Air Exchange Rates	Lognormal (1.25, 1.02)

* Three different distributions given virtually equal weights (34% for first case, 33% each for second and third cases).

The graphical outputs for daily-average concentrations from this model run are shown in Figure 6-17. As illustrated in the PDF plot on the left of the figure, the modeled distribution has a rather broad tail; this outcome, also evidenced by a standard deviation that is more than twice the mean, is largely due to the broad distribution for the emission rate, with a standard deviation more than three times the mean. The summary statistics for daily- and hourly-average concentrations shown in Figure 6-18 are virtually identical, with a minor difference only in the standard deviations due to different sample sizes (100 for daily, 2400 for hourly), because a constant indoor source and daily-average outdoor concentrations were used as inputs.

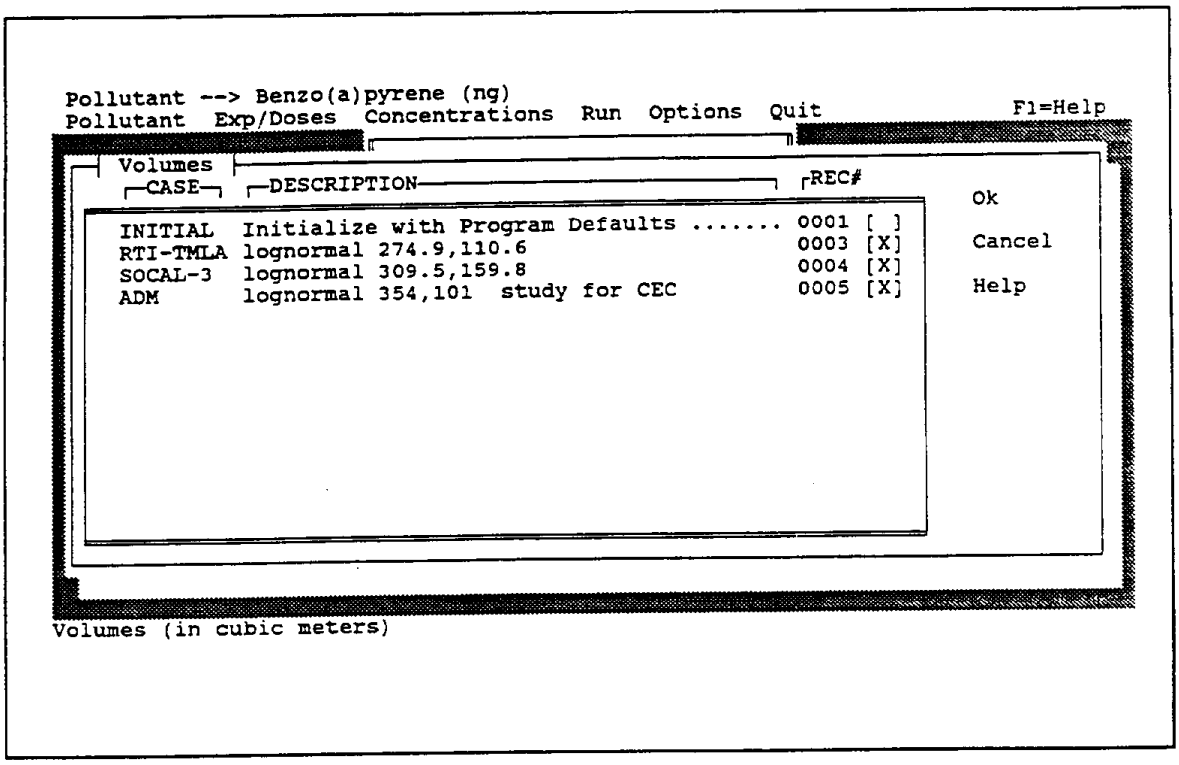


Figure 6-16. Volume Distributions Used for Example 6.2.1

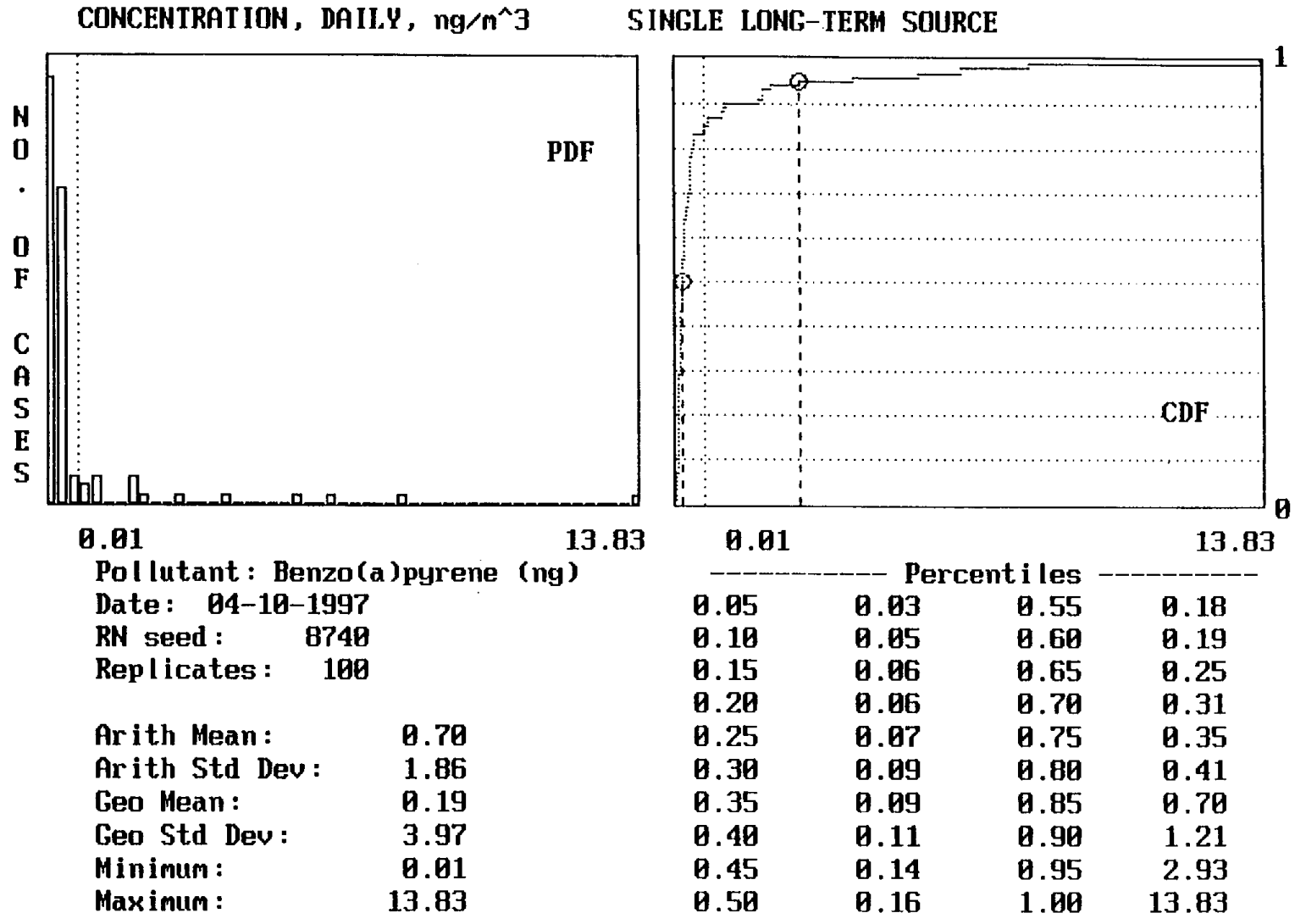


Figure 6-17. Results for Daily-Average Concentrations for Example 6.2.1

Title: SINGLE LONG-TERM SOURCE
Pollutant: Benzo(a)pyrene (ng/m^3)
Trials: 100
Random seed: 8740

	DAILY	HOURLY
Arith Mean	0.70	0.70
Arith Std Dev	1.86	1.85
Geo Mean	0.19	0.19
Geo Std Dev	3.97	3.95
Minimum	0.01	0.01
Maximum	13.83	13.83
5%	0.03	0.03
10%	0.05	0.05
15%	0.06	0.06
20%	0.06	0.06
25%	0.07	0.07
30%	0.09	0.09
35%	0.09	0.09
40%	0.11	0.11
45%	0.14	0.14
50%	0.16	0.16
55%	0.18	0.18
60%	0.19	0.19
65%	0.25	0.25
70%	0.31	0.31
75%	0.35	0.35
80%	0.41	0.41
85%	0.70	0.70
90%	1.21	1.21
95%	2.93	2.93
100%	13.83	13.83

Figure 6-18. Summary Concentration Statistics for Example 6.2.1

6.2.2 Model Run with Episodic Source

This run (Example 6.2.2) was made for a hypothetical pollutant unique to latex paint, an indoor source that is used sporadically in households. Data from an EPA-sponsored survey (WESTAT, Inc., Household Solvent Products: A National Usage Survey, Report No. EPA-OTS 560/5-87-005, July 1987) indicated that 55.2 percent of households had ever used latex paint at the time of the survey and that the mean time since last use was 16.7 months (500 days). Thus, the "Percent of Cases" with this source was entered as 55.2; the percentile distribution for "Time Since Use" reported from the survey was input as shown in Figure 6-19 (1st percentile is 1 day since last use, 5th percentile is 4 days since last use, etc.).

Assuming that a gallon of paint weighing 3629 g will paint a room of 40 m^3 volume, the load factor for painting is 90.72 g/m^3. This input for load factor (Figure 6-20) was provided as a lognormal distribution with a standard deviation arbitrarily set at half the mean. The emission rate for a chemical tends to exponentially decline over time as the reservoir of volatile material is gradually depleted. Based on an assumed emission half-life of 12 hours (0.5 days), the rate constant for exponential decline in the emission rate was calculated to be 0.693 $days^{-1}$ using the procedure described in Section 4.1 (page 4-8). The initial emission rate (E_o) per unit quantity (1 g) of paint used can be calculated from the relationship

$$\int_o^t E_o e^{-0.693} dt = E_o/0.693 = 1g$$

from which E_o is calculated to be 0.693 g/h. Assuming that the hypothetical pollutant constitutes 1 percent of the paint's total weight, the initial emission rate for the pollutant is 0.00693 g/h, or 6930 μg/h. Both the "Initial Emission Rate" and the "Decline in Rate" were input as constants using a normal distribution with a standard deviation of zero. The duration of use was arbitrarily assigned a mean value of 3 hours with standard deviation of 1.5 and input as a lognormal distribution.

The hypothetical pollutant was assumed to be unique to the indoor environment; thus, the outdoor concentration was uniformly set to zero. Other inputs included a

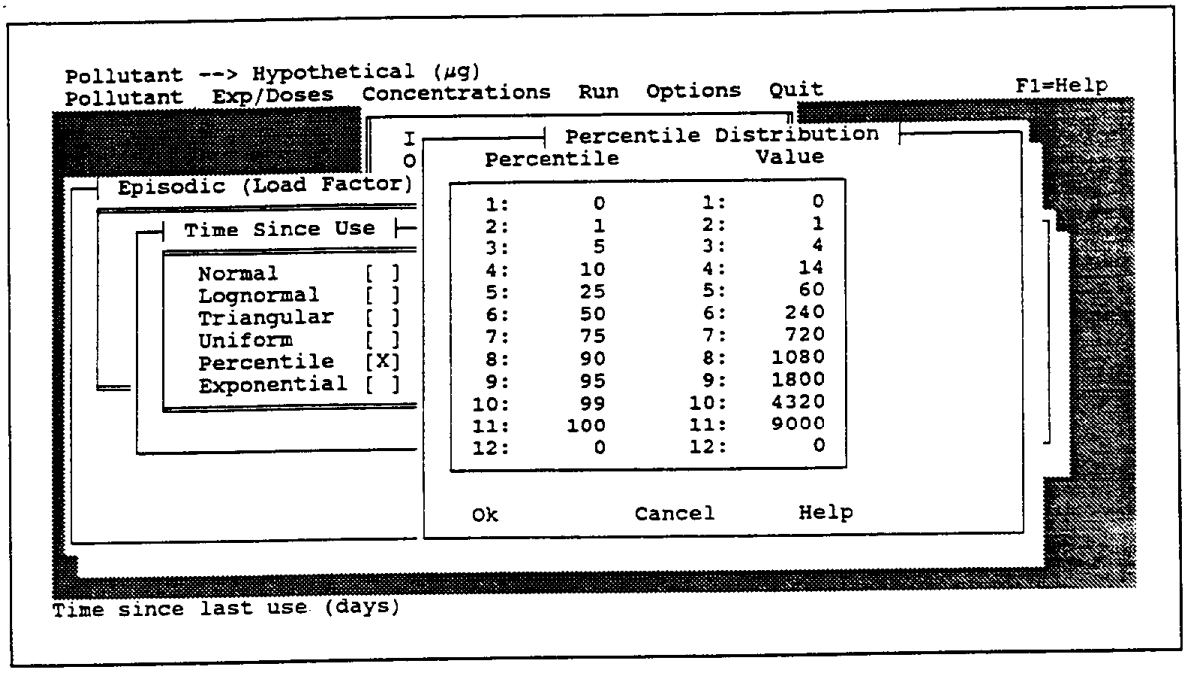


Figure 6-19. Inputs for Time Since Use for Example 6.2.2

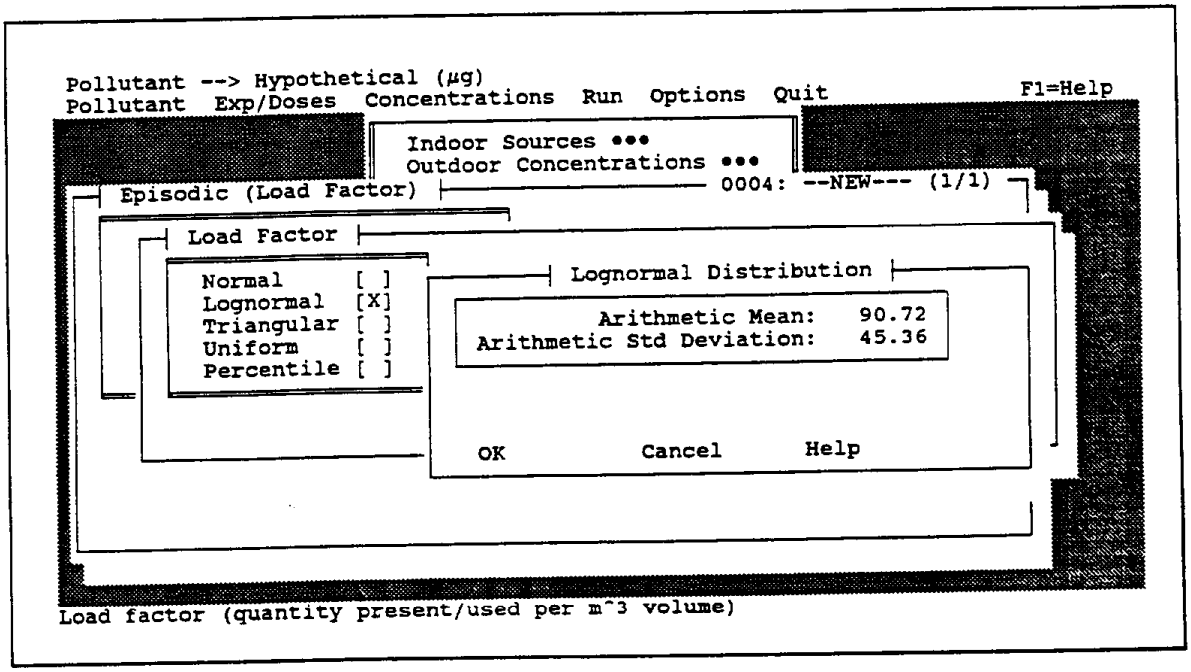


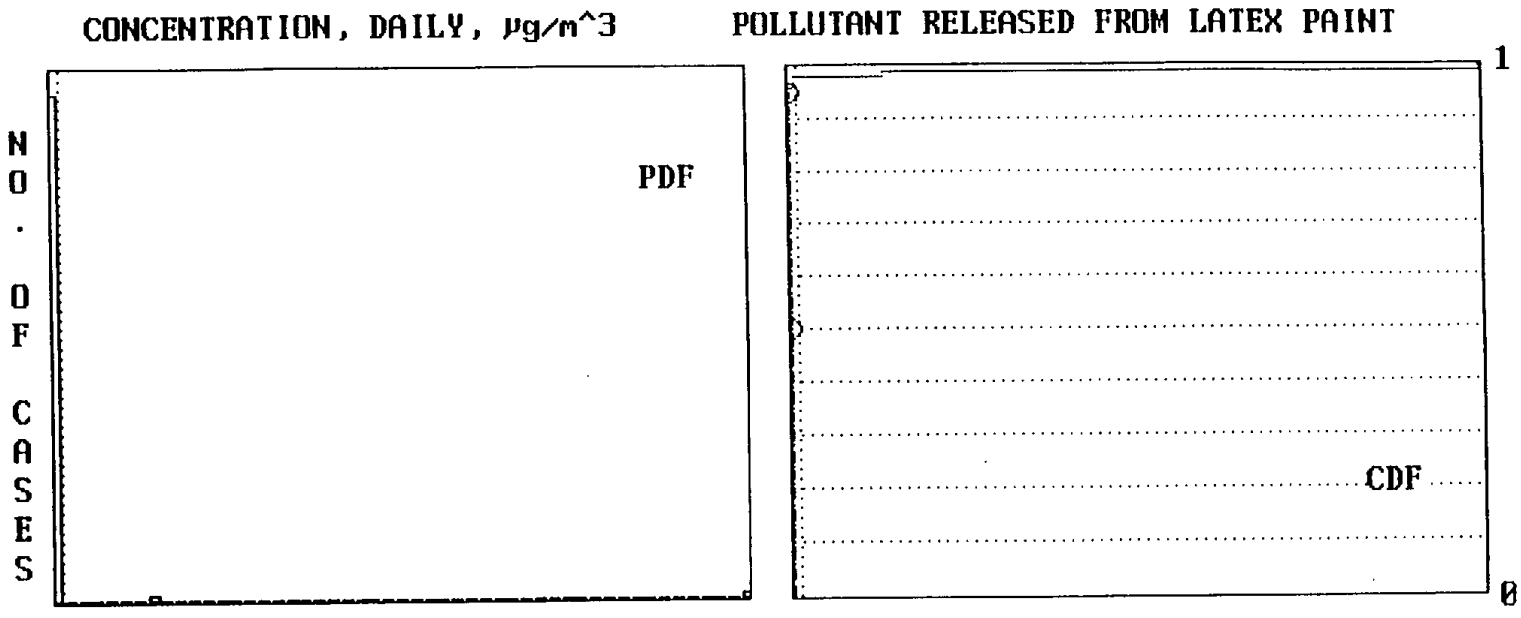
Figure 6-20. Inputs for Load Factor for Example 6.2.2

constant penetration factor of 1, a constant decay rate (indoor sink) of 0, and lognormal distributions for volume (320 ± 160 cubic meters) and air exchange (1.0 ± 0.5 air changes per hour). The graphical outputs from this model run are shown in Figure 6-21. In most cases the concentration is zero, as one would find in the residential population because only a few households have painted recently enough for traces of the pollutant to remain. The output is in scientific notation because the maximum (181,000 $\mu g/m^3$) is fairly large. This example, although hypothetical, illustrates how limited data could be used to estimate a concentration distribution for a specific type of indoor source of a pollutant.

6.2.3 Model Run with Frequent Source

The primary indoor source of chloroform is volatilization from public water supplies during indoor uses. Information for households in Southern California ("Urban Water Use Characteristics in the Metropolitan Water District of Southern California," draft document dated August 1991) indicates that the average daily indoor water use (for toilets, faucets, bath/showers, dishwashers, and clothes washers) is 262 gallons, or 992 liters. For this run (Example 6.2.3), the water use was modeled as a frequent source, occurring multiple times daily in 100 percent of households.

The average household use (992 liters) was treated as an average of 10 episodes per day at a rate of 99.2 liters per use. To account for variability across households in daily use, both uses per day (10 ± 5) and liters per use (99.2 ± 24.8) were input as lognormal distributions. The liters per use was input by specifying 99.2 ± 24.8 for "Quantity Present" (units of liters per minute) and a fixed "Duration" of 1 minute (i.e., 1 ± 0) with normal distribution. The "Start Time" distribution shown in Figure 6-22 was chosen so as to give higher weight to morning and evening hours when water use might be greatest. Overlapping episodes were allowed, consistent with the notion that multiple episodes of water use can occur within an hour. Based on measurements from the TEAM study and published volatilization coefficients for chloroform for various types of indoor water use, a lognormal distribution of 5.2 ± 3.0 liters per minute was specified for the "Initial Emission Rate." Because the emission rate can be expected to be nearly constant when water is used, the "Decline in Rate" was set to zero.



Pollutant: Hypothetical (µg)
Date: 04-10-1997
RN seed: 8891
Replicates: 100

Arith Mean:	2.07E+03
Arith Std Dev:	1.82E+04
Geo Mean:	1.69E-06
Geo Std Dev:	1.75E+05
Minimum:	0.00E+00
Maximum:	1.81E+05

Percentiles

0.05	0.00E+00	0.55	0.00E+00
0.10	0.00E+00	0.60	0.00E+00
0.15	0.00E+00	0.65	0.00E+00
0.20	0.00E+00	0.70	0.00E+00
0.25	0.00E+00	0.75	0.00E+00
0.30	0.00E+00	0.80	0.00E+00
0.35	0.00E+00	0.85	1.08E-35
0.40	0.00E+00	0.90	8.57E-21
0.45	0.00E+00	0.95	3.42E-02
0.50	0.00E+00	1.00	1.81E+05

Figure 6-21. Results for Daily-Average Concentration for Example 6.2.2

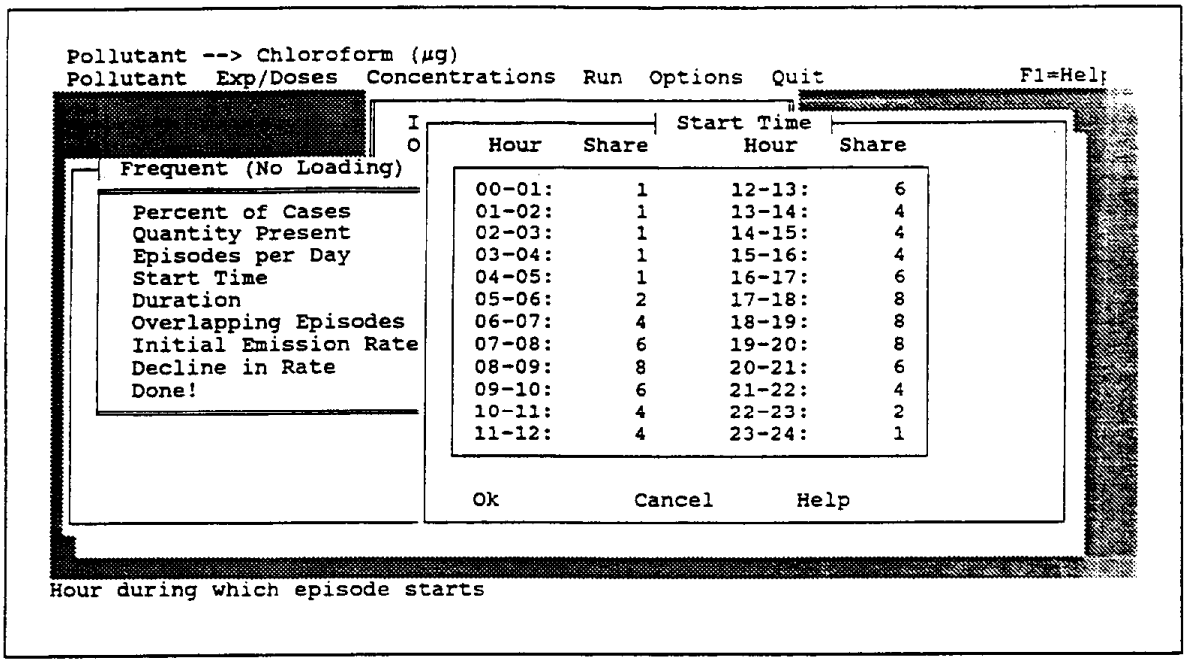
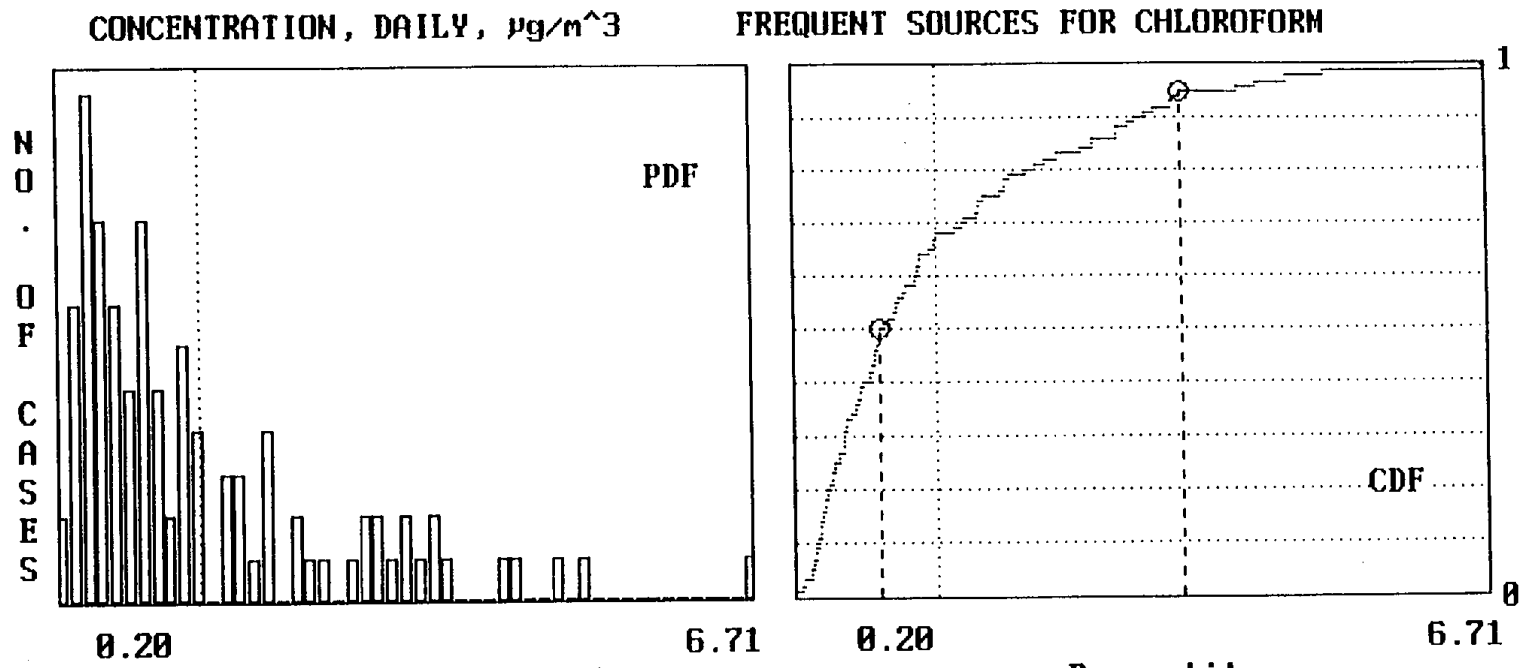


Figure 6-22. Inputs for Start Time for Example 6.2.3

Lognormal distributions were assumed for the outdoor concentration (0.49 ± 0.80 $\mu g/m^3$), volume (274.9 ± 110.6 cubic meters), and air exchange rate (0.94 ± 0.82 air changes per hour). Values for these distributions were all based on results of the 1987 TEAM study in which the indoor chloroform concentrations were measured. The penetration factor and indoor sink rate were modeled as constant values of one and zero, respectively. The modeled daily indoor concentration distribution (Figure 6-23) has a fairly wide spread, with a standard deviation almost the same magnitude as the mean. The modeled hourly concentration distribution (Figure 6-24) has an even greater spread. The lognormal shape of the hourly distribution is readily apparent from its PDF plot, and the smoother CDF plot for hourly than for daily concentrations is due to the greater number of hourly values (2400 versus 100).



Pollutant: Chloroform (µg)
Date: 04-10-1997
RN seed: 649
Replicates: 100

Arith Mean:	1.52
Arith Std Dev:	1.29
Geo Mean:	1.11
Geo Std Dev:	2.23
Minimum:	0.20
Maximum:	6.71

Percentiles

0.05	0.34	0.55	1.15
0.10	0.40	0.60	1.33
0.15	0.44	0.65	1.46
0.20	0.50	0.70	1.78
0.25	0.57	0.75	1.97
0.30	0.66	0.80	2.37
0.35	0.77	0.85	3.00
0.40	0.83	0.90	3.41
0.45	0.94	0.95	3.83
0.50	0.99	1.00	6.71

Figure 6-23. Results for Daily-Average Concentration for Example 6.2.3

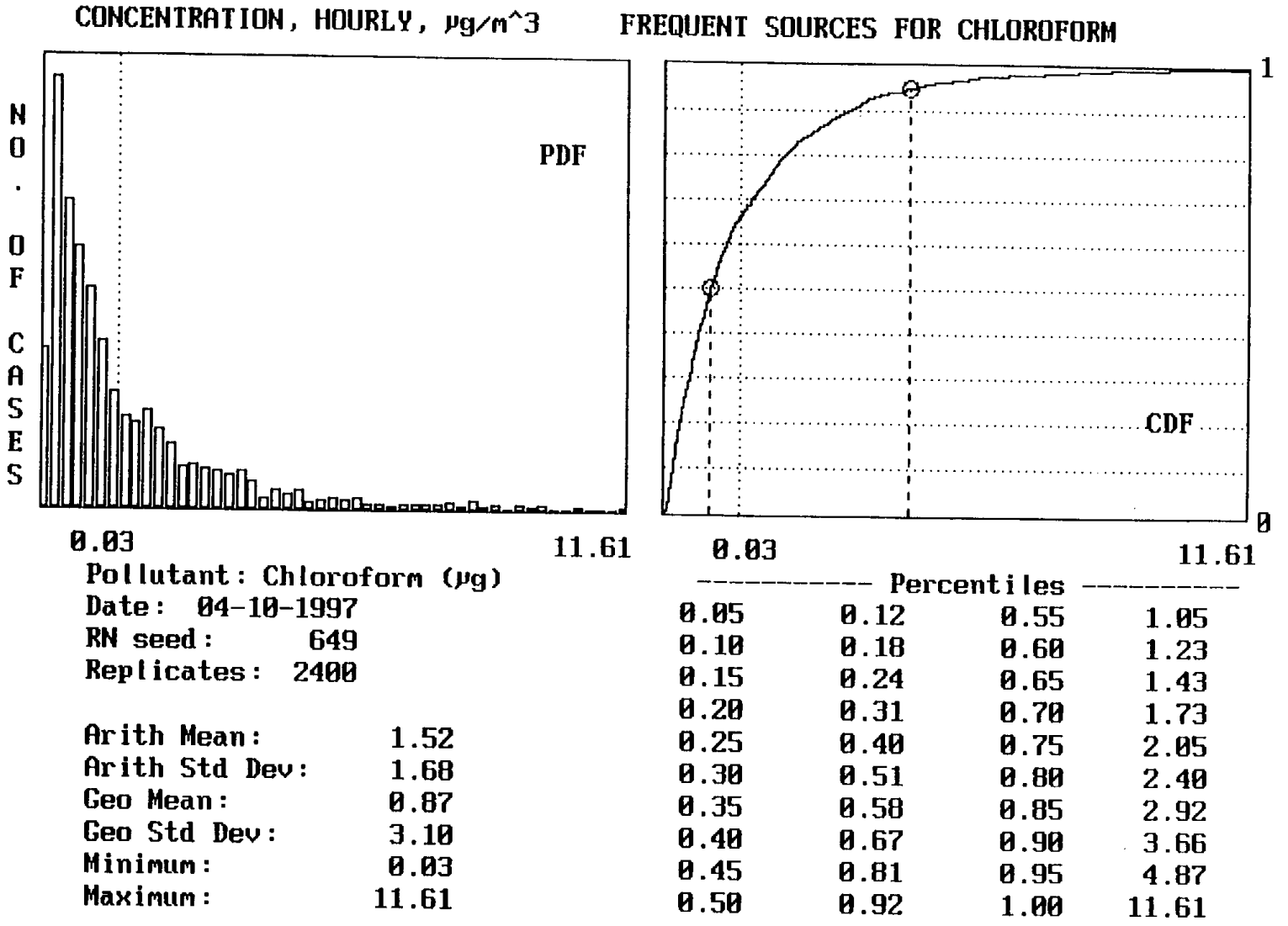


Figure 6-24. Results for Hourly-Average Concentration for Example 6.2.3

6.2.4 Model Run with Linked Sources

Nitrogen dioxide (NO_2) indoors is produced primarily as one of the combustion products from gas ranges. Although the gas range might initially be viewed as a single source, there are aspects of the range or its use that need to be treated as separate sources. These include cooking meals and use of the range for supplemental heating, which can be thought of as frequent sources that can occur at least once a day, and range pilot lights, which can be thought of as a long-term (constant) source. These sources are linked in the sense that some fraction of households have gas ranges that are used for cooking (73.3 percent of households in the Los Angeles area) and that pilot lights and use of the range for heating occur with a subset of the households that have gas ranges for cooking.

For this run (Example 6.2.4), range use for cooking was input as the primary indoor source, to which range use for heating and pilot lights were linked. Published NO_2 emission rates from gas ranges are in units of μg/Btu; thus, the quantity used per minute needs to be expressed in Btu/minute for compatibility. Estimates of gas use per meal are in units of cubic feet consumed, with an average of 4.85 cubic feet per meal. Based on a heating value of 1,030 Btu per cubic foot, this translates to an average of 4995 Btu per meal. Assuming an average fuel input rate of 150 Btu/minute, roughly equivalent to that of one range top burner at full input or a cycling oven, the 4995 Btu/meal translates to an average cooking duration of 33.3 minutes. Published estimates of cooking frequency indicate an average of 9.4 meals per week, or 1.34 meals per day. The distribution input for "Episodes per Day" (Figure 6-25) is consistent with this estimate. Other model inputs for range cooking, summarized in Table 6-2, are consistent with the figures given above and published NO_2 emission rates. The distribution for hour of day in the table was intended to proportionally represent the times when breakfast, lunch or dinner typically might be cooked.

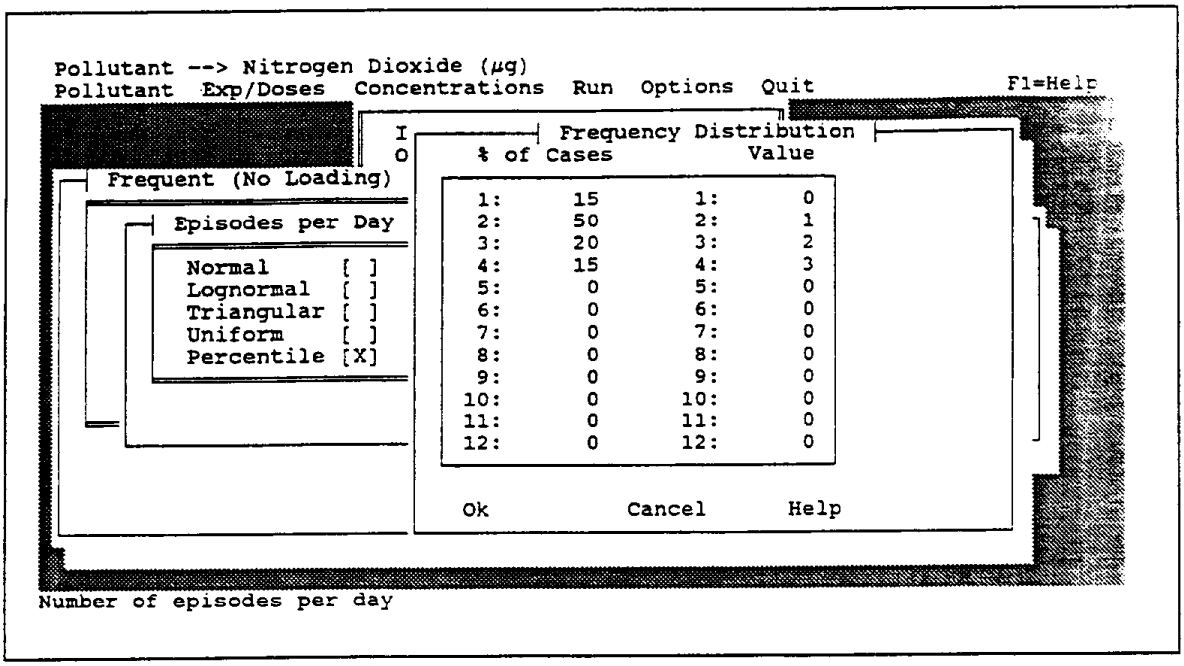


Figure 6-25. Inputs for Episodes per Day for Example 6.2.4

Table 6-2. Summary of Model Inputs for Range Cooking for Example 6.2.4

Input Parameter	Distribution/Value(s)
Percent of Residences with Indoor Source	73.3%
Quantity Used (Btu/min)	Lognormal (150, 50)
Episodes per Day 0 1 2 3	 15% 50% 20% 15%
Hour of Day 07-08 12-13 18-19	 26% 22% 52%
Duration (min)	Lognormal (33.3, 33.3)
Emission Rate (μg/Btu)	Normal (9.15, 2.3)
Decline in Rate	Normal (0,0)

The inputs concerning use of the range for cooking were saved with the case name "COOKING." The next source, use of the range for heating (case name "RANGEHT") was input as a frequent source and linked to cooking through the "Percent of Cases" input, as shown in Figure 6-26. Published data (see Section 7.2.3 of the final report, page 7-24) indicate that the gas range is used for heating by slightly more than 11 percent of households in the Los Angeles area. Because the example run was intended to represent the residential distribution of NO_2 concentrations throughout the year and use of the range for heating occurs primarily during winter, the percent of cases was reduced by a factor of four to 2.8.

The linkage was accomplished by specifying source type "F." As shown in Figure 6-27, a list of "Frequent (No Loading)" sources, corresponding to source type "F," was then presented, from which "COOKING" was selected. When linking to another source, the model indicates the number of cases currently marked (with an X) for each source type (A and B are long-term sources, C and D are episodic sources, and E and F are frequent sources), from which the user can select one. For the example in Figure 6-26, one type-B long-term source (PILOT) was marked and two type-F frequent sources (COOKING and RANGEHT) were marked at the time when the linkage was established.

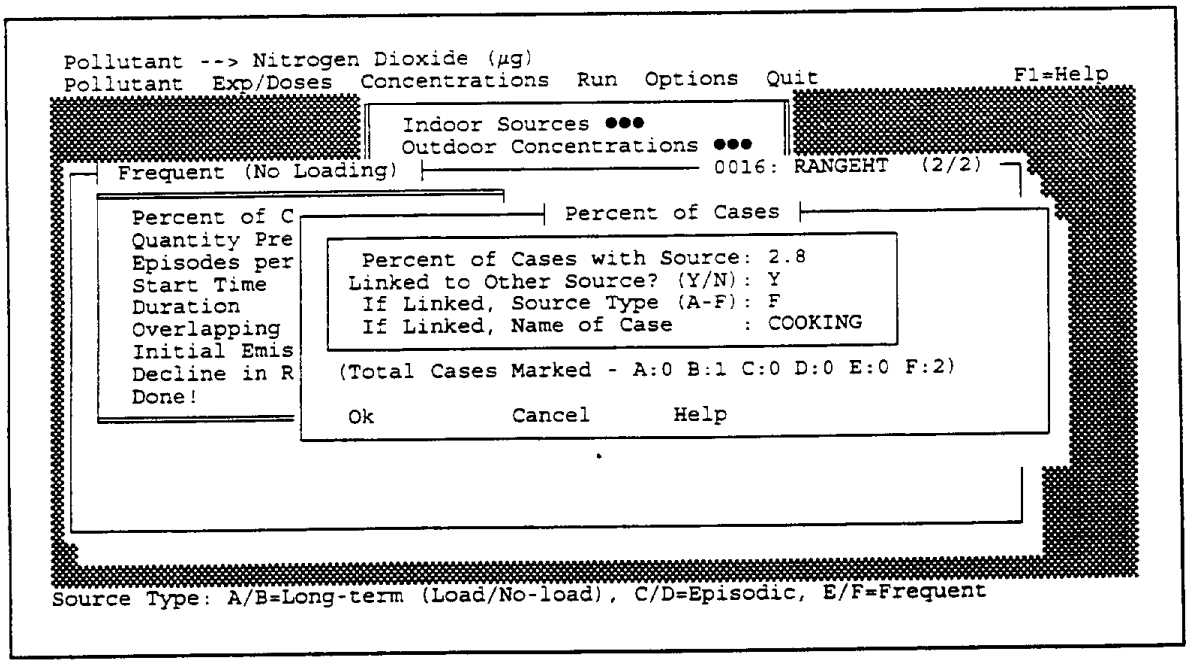


Figure 6-26. Linkage of Range Heating Source to Range Cooking Source for Example 6.2.4

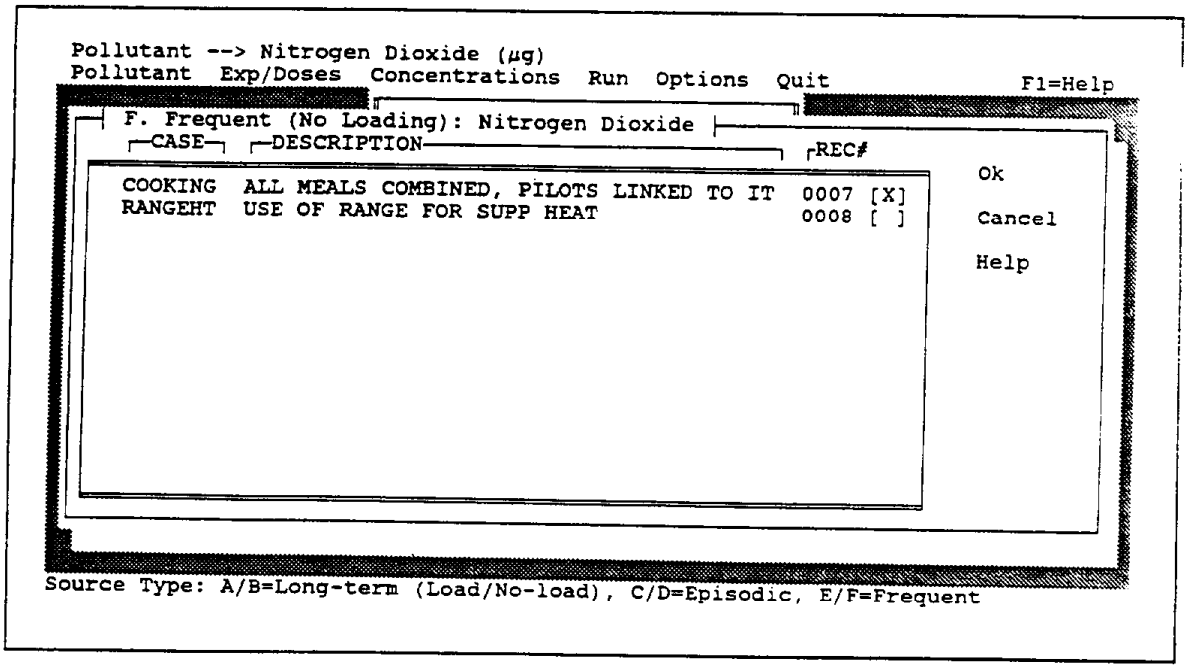


Figure 6-27. Choice of Cases for Linking After Specifying Linkage to Source Type "F"

Published estimates on the frequency of range use for heating, in households where this type of range use occurs, indicate an average of 2.4 days per week. Consistent with this estimate, the number of episodes per day was input as a frequency (percentile) distribution with one episode on 34 percent of days and zero episodes on 66 percent of days. A fuel-input rate of 300 Btu per minute was input as a constant (i.e., standard deviation of zero) for the "Quantity Present." The "Duration" of the episode was input as a lognormal distribution with a mean of 144 minutes and a standard duration of 72, consistent with published estimates of 2.4 hours per day as the average duration of range use for heating. The time of use ("Start Time") was assumed to be late evening (hours 8-9 and 9-10) or early morning (hours 5-6 and 6-7). The emission rate was assured to be the same as that for range cooking.

Pilot lights (case name "PILOT") were input as a long-term (no loading) source and linked to "COOKING" as shown in Figure 6-28, based on published estimates that 68.1 percent of gas ranges in the Los Angeles area have pilot lights. The "Quantity Present" was input as a percentile distribution for hourly fuel input rate, with a minimum value of

128.8 Btu/hour (3 cubic feet per day), a maximum value of 643.8 Btu/hour (15 cubic feet per day), and intermediate values of 257.5, 343.3 and 429.2 Btu/hour for the 25th, 50th nd 75th percentiles, respectively. The "Initial Emission Rate" distribution for pilot lights was assumed to be the same as that for range cooking. The emission rate was treated as constant in each household, by inputting a normal distribution with mean and standard deviation both equal to zero for "Decline in Rate." With a constant emission rate per household, the input for "When Installed" is not used for model calculations; a normal distribution with a mean of 12 months and a standard deviation of zero was arbitrarily input.

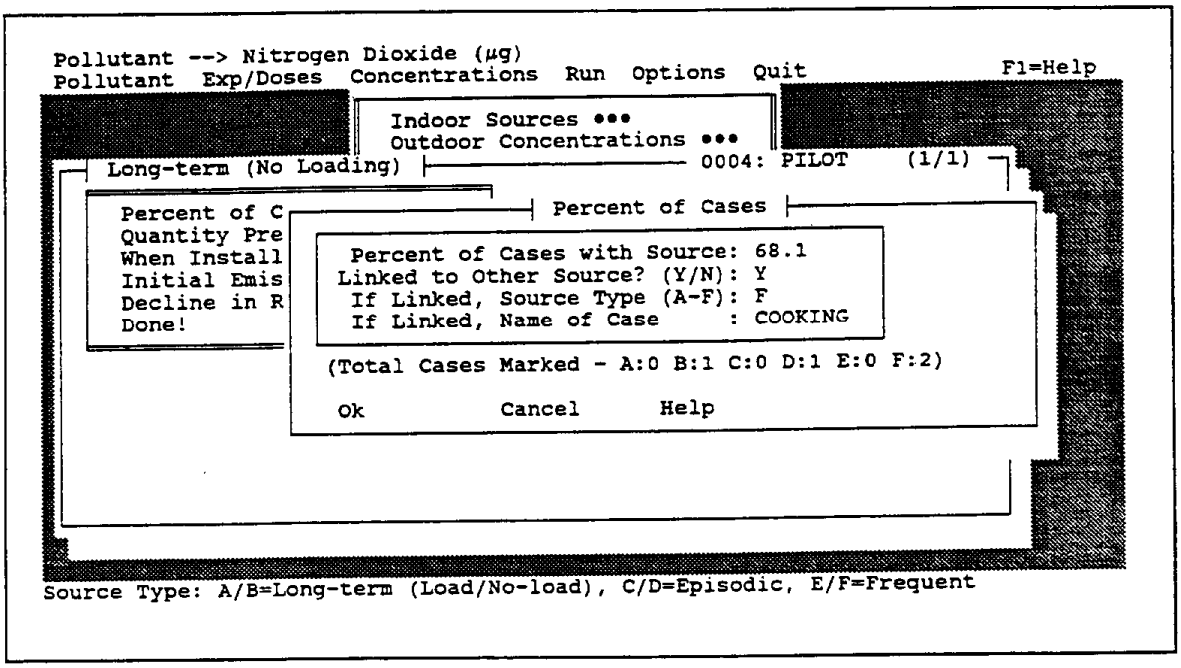


Figure 6-28. Linkage of Pilot Light Source to Range Cooking Source for Example 6.2.4

Values for the other model inputs, all based on published estimates, are summarized in Table 6-3. All parameters except the penetration factor, for which a value of one was assumed to apply to all residences, were input as lognormal distributions. Inputs for volumes were based on two separate estimates, equally weighted, and inputs for air exchange rates were based on six separate estimates at various times of the year for residences in the Los Angeles area, again equally weighted.

Table 6-3. Inputs for Other Model Parameters for Example 6.2.4

Input Parameter	Type of Distribution	Mean	Standard Deviation
Outdoor Concentrations, $\mu g/m^3$	Lognormal	72.0	39.3
Penetration Factors	Normal	1	0
Indoor Sinks, 1/h	Lognormal	0.8	0.3
Volumes, m^3*			
TEAM Study	Lognormal	274.9	110.6
SoCal Study	Lognormal	309.5	159.8
Air Exchange Rates, 1/h**			
TEAM Study (Feb.)	Lognormal	0.94	0.82
TEAM Study (July)	Lognormal	2.83	2.54
SoCal Study (Mar.)	Lognormal	0.78	0.63
SoCal Study (July)	Lognormal	1.51	1.47
SoCal Study (Jan.)	Lognormal	0.58	0.47
Cal IAQ Study	Lognormal	0.77	0.57

* Two different distributions given equal weights (50% for each case).

** Six different distributions given virtually equal weights (17% each for the first three cases, 16% for the fourth case, 17% for the fifth case, and 16% for the sixth case).

Daily and hourly summary statistics for the results of the example run are displayed in Figure 6-29. The two distributions have the same mean but the hourly distribution has a larger standard deviation. Values for various percentiles of the distribution are larger for the daily averaging period through the 80th percentile, but the hourly averaging period has a considerably larger maximum value. The file of detailed results from this run was imported into Lotus 1-2-3 and the hourly time series was plotted for three of the 100 trials (residences) as shown in Figure 6-30. Trial 44 is the residence in which the maximum hourly value (880 $\mu g/m^3$) occurred. It can be deduced from the plot that this high a value was due to range heating, because it occurred in late evening hours following a cooking event that started in hour 18. This residence also had some residual NO_2 elevation, above the "background" due to outdoor NO_2 and pilot lights, from a range cooking/heating event the day before. The trial 25 residence had both lunch and dinner range cooking events, whereas the trial 6 residence had either an electric range or no cooking events with a gas range.

Title: LINKED SOURCES FOR NITROGEN DIOXIDE
Pollutant: Nitrogen Dioxide (ug/m^3)
Trials: 2400
Random seed: 1096

	DAILY	HOURLY
Arith Mean	48.61	48.61
Arith Std Dev	28.35	38.75
Geo Mean	42.49	40.75
Geo Std Dev	1.66	1.76
Minimum	13.38	9.77
Maximum	154.06	880.03
5%	19.93	17.42
10%	22.73	20.90
15%	24.49	22.93
20%	26.53	25.32
25%	28.68	27.18
30%	31.32	28.68
35%	35.23	32.36
40%	37.20	35.82
45%	38.36	38.70
50%	40.39	40.39
55%	42.19	41.69
60%	45.61	44.02
65%	49.92	48.44
70%	54.06	51.88
75%	60.69	56.98
80%	63.72	60.31
85%	68.99	70.31
90%	79.10	88.25
95%	105.71	110.85
100%	154.06	880.03

Figure 6-29. Summary Statistics on Daily and Hourly Average Concentrations for Example 6.2.4

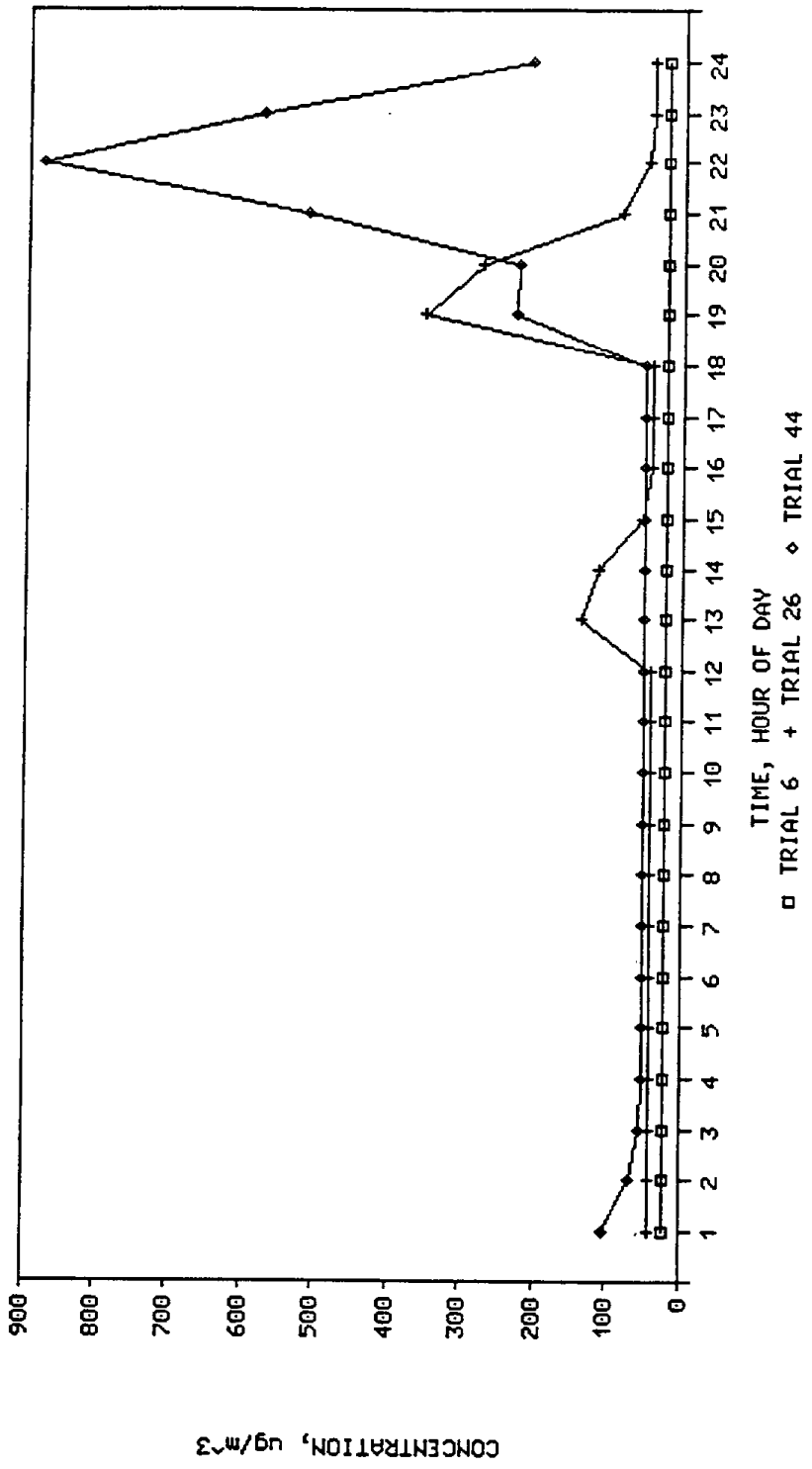


Figure 6-30. Plot of Hourly Average Concentrations for Selected Trials from Example 6.2.4

6.3 MODELED CONCENTRATIONS AS INPUTS TO EXPOSURE/DOSE DISTRIBUTIONS

A modeled concentration distribution from Level 3 can be accessed within the "Concentration Distributions" submenu in Level 1-2. An example of this feature is given in Figure 6-31. Through the "Run" menu, the eighth example run was given the output filename NO1, causing the model to assign NO1.STC as the name of the summary statistics file. After accessing the "Residence" item in the "Concentration Distributions" submenu, choosing "Lognormal" as the type of distribution, and activating the "Import" button, the prompt for the name of the data file was completed as shown in the figure.

The inputs supplied by the model after activating the "Ok" button following entry of the file name are shown in Figure 6-32. The mean and standard deviation from the daily-average distribution are supplied by the model if either normal or lognormal is selected as the type of distribution. For a triangular distribution (Figure 6-33), the model supplies the geometric mean as the value for the mode. For a percentile distribution (Figure 6-34), the model supplies the 5th, 10th, 25th, 50th, 75th, 90th and 95th percentiles of the distribution in addition to the minimum and maximum values.

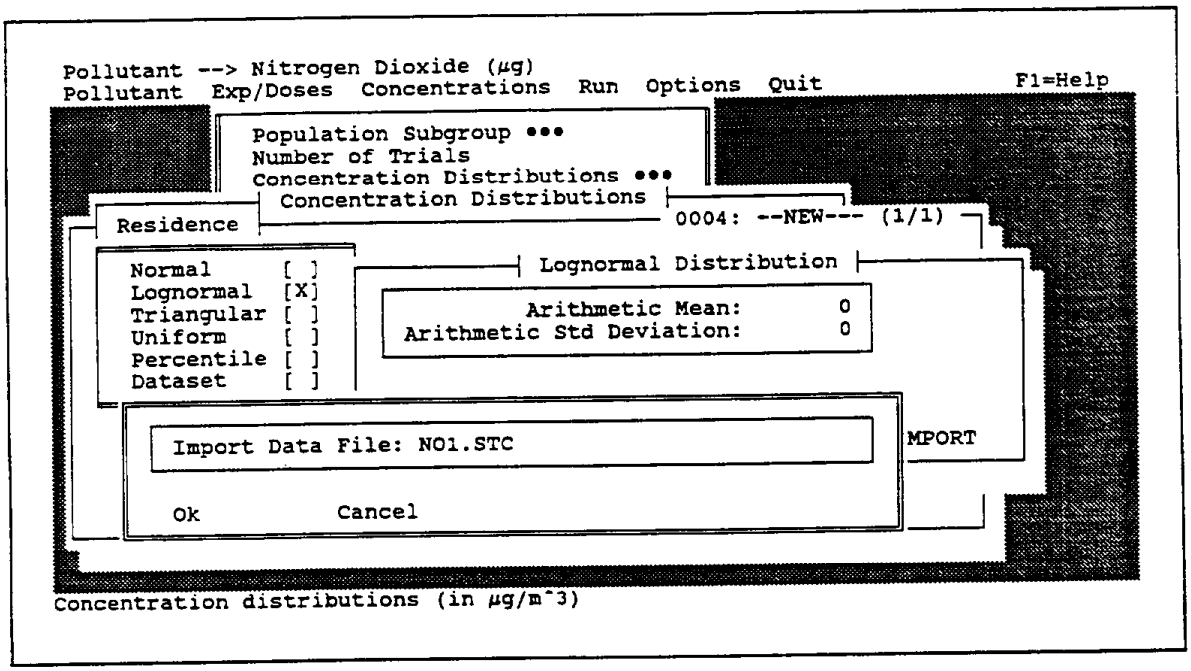


Figure 6-31. Response to Prompt for Name of Data File When Importing Concentration Results from Example 6.2.4

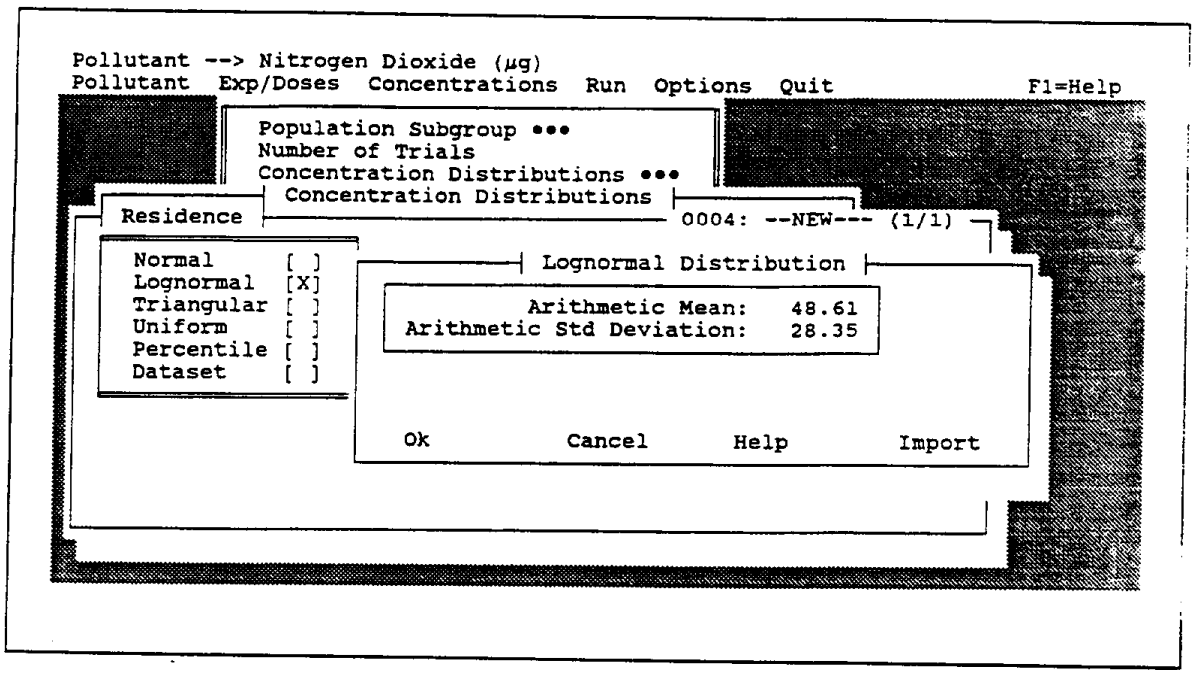


Figure 6-32. Inputs Supplied by the Model When Importing a Lognormal Distribution

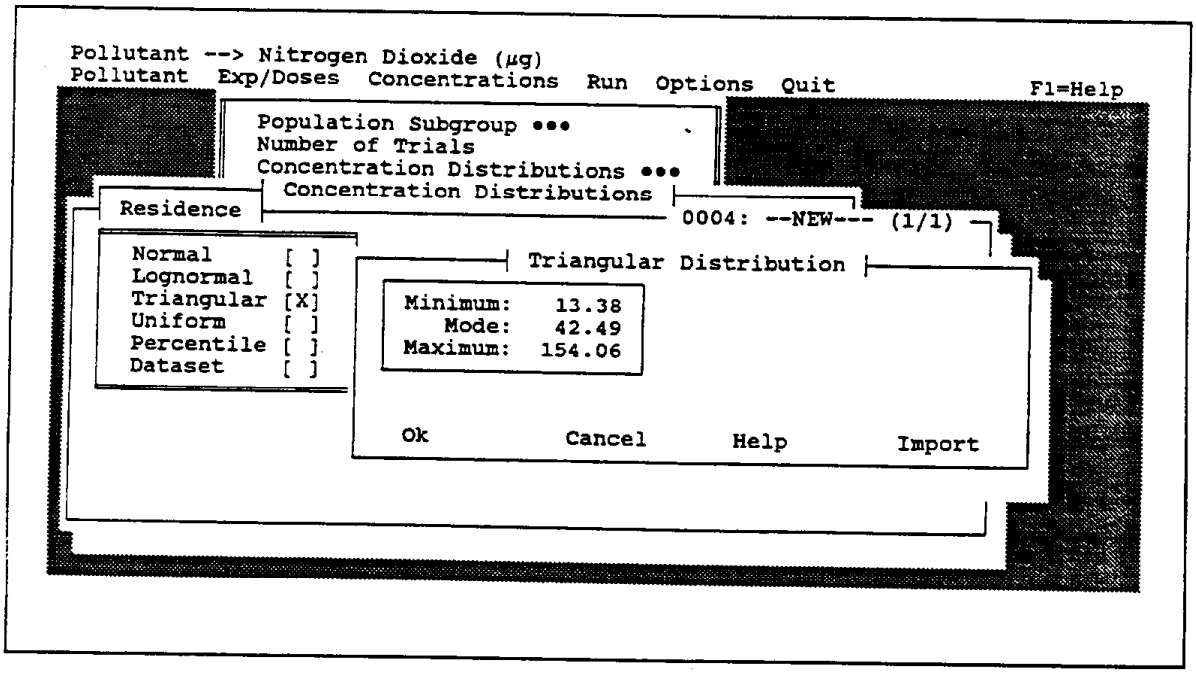


Figure 6-33. Inputs Supplied by the Model When Importing a Triangular Distribution

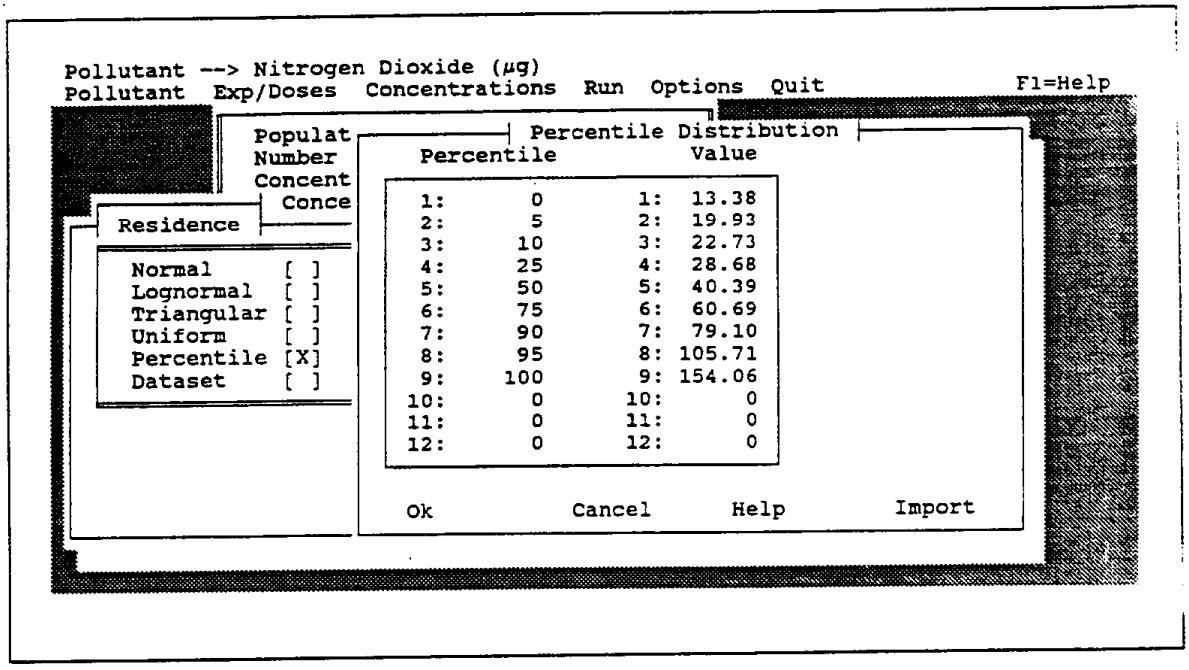


Figure 6-34. Inputs Supplied by the Model When Importing a Percentile Distribution

Section 7.0

FILES AND SETUP OPTIONS

7.1 FILES

The types of files used by the model include executable files, common files, input files, and output files. Each of these types is described below in Sections 7.1.1 to 7.1.4. Procedures for using dBASE/compatible software to create a data set for model input are given in Section 7.1.5.

7.1.1 Executable Files

These files (Table 7-1) execute all procedures for the modeling software. The file CPIEM.EXE handles the overall program flow and user interface, and temporarily passes control to other executable files for (1) determining cases that match user criteria for population subgroup, (2) executing Level 1-2 sampling/calculation routines, or (3) executing Level 3 sampling/calculation routines.

Table 7-1. Executable Files and Associated Functions

File Name	Function
CPIEM.EXE	Handles overall program flow and user interface.
POPMATCH.EXE	Determines cases that match user criteria for population subgroup and creates a file of activity patterns (WC__ACT1.DAT) for those cases.
LEVEL1-2.EXE	Executes routines for Level 1-2 sampling and calculations.
LEVEL3.EXE	Executes routines for Level 3 sampling and calculations.

7.1.2 Common Files

These files (Table 7-2) commonly serve both Level 1-2 and Level 3 of the model. The functions of these files include providing information used to construct screens, passing user inputs to sampling/calculation routines, saving names of pollutants and their measurement units, and creating a data set as input to Level 1-2 or Level 3 (see Section 7.1.5). Because of the critical roles of these files, they should not be deleted or edited. The POLLUT.DBF file, for example, assigns an index number to each pollutant. All inputs saved by users for Level 1-2 concentration distributions and Level 3 indoor sources, outdoor concentrations, penetration factors, and indoor sinks are linked to the pollutant through this index number. The file initially contains 10 pollutants, indexed from 1 to 10. If the user added a pollutant (e.g, ozone), then this pollutant would be assigned index number 11. If the user later deleted POLLUT.DBF, the model would initialize the file with the original 10 pollutants. If the user then added styrene as the 11th pollutant, then all user inputs previously identified with ozone would now be identified with styrene.

Table 7-2. Common Files and Associated Functions

File Name	Function
CPIEM.SCR	Provides information used to construct screens (menus).
CPIEM.SET	Passes user choices/options to calculation modules.
POLLUT.DBF*	Saves list of pollutants and associated measurement units.
DATASET.DBF**	Creates data set as input for Level 1-2 (concentration distributions) or Level 3 (indoor sources, outdoor concentrations, penetration factors, indoor sinks, volumes, air exchange rates).

* Critical file for linkages (should never be deleted); see text.
** See Section 7.1.5 for procedures to create an input data set.

7.1.3 Input Files

Input files are summarized for Level 1-2 in Table 7-3 and for Level 3 in Table 7-4. Most of these files are used to store user inputs for items such as population subgroup, concentration distributions and indoor sources. Additional files for Level 1-2 relate to storing and matching activity profiles for various integration periods. There is one file for each of the nine environments in Level 1-2. There are two files for each of the six types of indoor sources in Level 3; two files are needed because the inputs are relatively complex.

Although many of the input files are based directly on published data, in some instances calculations were required to convert the data to a form consistent with input requirements for the model. Such calculations are documented in Appendix C.

Table 7-3. Level 1-2 Input Files and Associated Contents

File Name	Content
WC_ACT[ ].DBF*	Activity profiles for various integration periods
WC_ACT[ ].NDX*	Pointers (index numbers) to files containing activity profiles
RESIDNT2.DBF	Characteristics of individuals to determine index numbers for activity profiles that match user criteria for population subgroup
POPGRP.DBF	Current criteria for population subgroup
CL_POP.DBF	Case names and associated criteria for population subgroups
CL_BRT.DBF	Case names and associated inputs for breathing rates
CL_ENV[ ].DBF**	Case names and associated inputs for concentration distributions for each of 9 environments

* [ ] refers to 24 for 24-hour profiles, AM for 12-hour daytime profiles, PM for 12-hour nighttime profiles, 8H for 8-hour profiles, or 1H for 1-hour profiles.

** [ ] refers to 1 for residence, 2 for office, 3 for industrial plant, 4 for school, 5 for travel in vehicle, 6 for public access building, 7 for restaurant/lounge, 8 for other indoor, or 9 for outdoors.

Table 7-4. Level 3 Input Files and Associated Contents

File Name	Content
CL_SRC1(D).DBF*	Case names and associated inputs for long-term (load factor) indoor sources
CL_SRC2(D).DBF*	Case names and associated inputs for long-term (no loading) indoor sources
CL_SRC3(D).DBF*	Case names and associated inputs for episodic (load factor) indoor sources
CL_SRC4(D).DBF*	Case names and associated inputs for episodic (no load) indoor sources
CL_SRC5(D).DBF*	Case names and associated inputs for frequent (load factor) indoor sources
CL_SRC6(D).DBF*	Case names and associated inputs for frequent (no load) indoor sources
CL_OUT1.DBF	Case names and associated inputs for daily outdoor concentrations
CL_OUT2.DBF	Case names and associated inputs for hourly outdoor concentrations
CL_PEN.DBF	Case names and associated inputs for penetration factors
CL_SNK.DBF	Case names and associated inputs for indoor sinks
CL_VOL.DBF	Case names and associated inputs for volumes
CL_ACH.DBF	Case names and associated inputs for air exchange rates

* CL_SRC1.DBF contains the case names and indicates the record numbers in CL_SRC1D.DBF that contain the inputs for each case name.

7.1.4 Output Files

Output files are summarized for Level 1-2 in Table 7-5 and for Level 3 in Table 7-6. The files are generally of three types--graphical outputs, summary statistics, and detailed (trial-by-trial) results. One file that is specific to Level 1-2--WC_ACT1.DAT--provides a random-access format for sampling of activity profiles within the Level 1-2 execution module.

Table 7-5. Level 1-2 Output Files and Associated Contents

File Name	Content
WC_ACT1.DAT	Random-access file with activity profiles for individuals that match user criteria for population subgroup
NONAME.GE[ ]*	Graphical outputs and summary statistics for exposure distributions
NONAME.GD[ ]*	Graphical outputs and summary statistics for dose distributions
NONAME.STE	Summary statistics for exposure distributions for each environment and total across environments
NONAME.STD	Summary statistics for dose distributions for each environment and total across environments
NONAME.FMT	Format for NONAME.PRN file
NONAME.PRN	Detailed (trial-by-trial) results for exposure and dose for each environment and total across environments

* NONAME is the default file-name prefix, which the user can override through the "Run" menu; [ ] refers to 1 for residence, ..., 9 for outdoors, and T for total across environments.

Table 7-6. Level 3 Output Files and Associated Contents

File Name	Content
NONAME.GCD*	Graphical outputs and summary statistics for daily-average concentrations
NONAME.GCH	Graphical outputs and summary statistics for hourly-average concentrations
NONAME.STC	Summary statistics for hourly-average and daily-average concentrations
NONAME.FMT	Format for NONAME.ASC file
NONAME.ASC	Detailed (trial-by-trial) results for hourly-average and daily-average concentrations

* NONAME is the default file-name prefix, which the user can override through the "Run" menu.

7.1.5 Procedures for Creating a Data Set

Although most inputs to the model are in the form of parameters that describe distributions (e.g., normal, lognormal), data sets can also be provided for concentration inputs. A data set used by the model must be in a prescribed format. Two files--DATASET.DBF and DATASET.NDX--provide this format. After choosing a name for the input data set (e.g., INPUT), the following DOS commands are executed:

- COPY DATASET.DBF INPUT.DBF
- COPY DATASET.NDX INPUT.NDX

This preserves the files with the DATASET prefix for future use.

The first field is an index number with the format F9.0; all remaining fields (1 field for daily concentrations or other mass-balance parameters; 24 fields for hourly concentrations) have a format of F9.2. This format can be developed easily in a spreadsheet environment (e.g., Lotus, Quattro Pro) by creating an index field using the "DATA FILL" command (an analogous command is also available in Excel) and then importing the ASCII file containing concentration (or other) data. The "GLOBAL COLUMN WIDTH" command can be used to set all column widths to nine. The first (index) field must then be changed to a width of ten. The "RANGE FORMAT" command can then be used to format all fields but the index field with two decimal places. The file can then be created using the "PRINT" command with the left margin set to zero and the right margin set to 240. It should then be verified through a file editor that the first field ends in column 9 and that the second field ends in column 18 (or that the last field ends in column 225, if hourly concentrations are used).

The file created (e.g., DATA.PRN) can then be read into dBASE with the following command sequence (within dBASE):

- USE INPUT INDEX INPUT
- APPEND FROM DATA.PRN SDF

The user can then exit dBASE (QUIT command), and the file INPUT.DBF will contain the data set to be input to the model.

7.2 SETUP OPTIONS

Figure 7-1 displays the setup options. By default, the software assumes an HP Laserjet Printer or compatible and printer port LPT1. Other printers indicated in the figure are directly supported; additional printers can be accommodated, provided they are set to emulate one of the four types shown in the figure. A directory (e.g., C:\MODEL\INPUT) can be specified for both input and output files. The bottom line of the screen displays current choices for input/output directories. The input directory should contain all the case list (CL) files listed in Section 7.1.3, along with the files POLLUT.DBF and POPGRP.DBF. Executable files and activity files (e.g., WC_ACT24.DBF, RESIDNT2.DBF) should remain in the directory (e.g., CPIEM) from which the model is being executed. If the program cannot find any of the required files in the user-defined input directory, it will then search the directory from which the user invoked the model (by entering CPIEM).

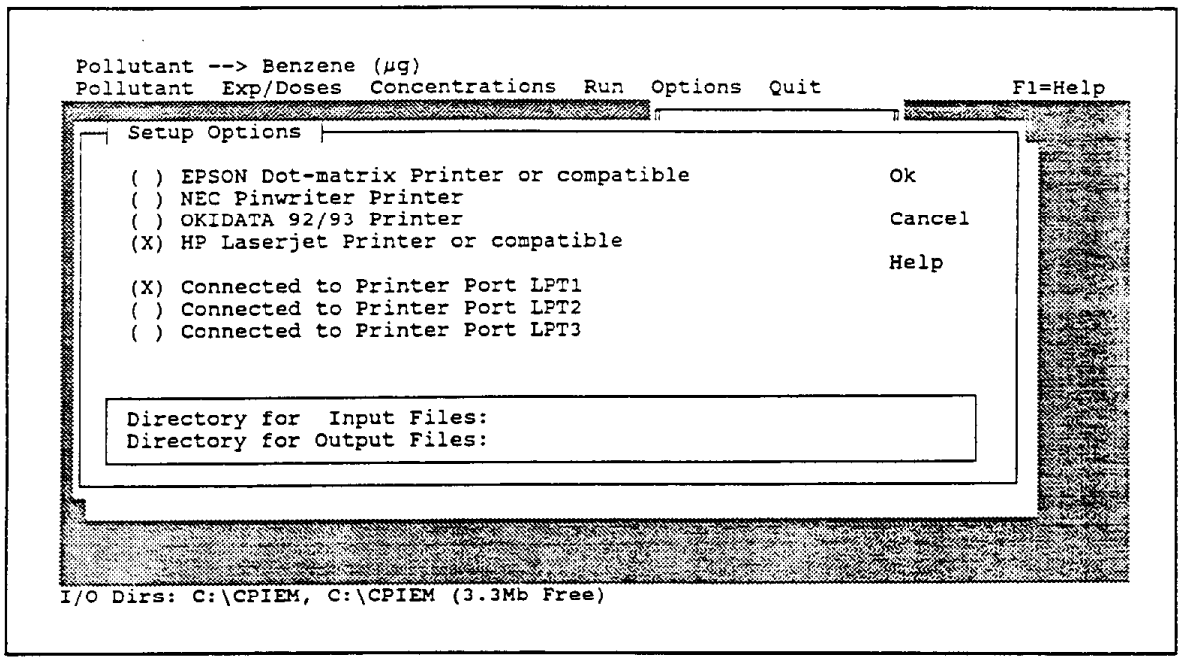


Figure 7-1. Setup Options (Initial Default Setting)

APPENDIX A
SOFTWARE INSTALLATION AND HARDWARE REQUIREMENTS

Installation of the CPIEM software is initiated by creating a subdirectory on the hard-disk drive and copying key files to that subdirectory. For example, a subdirectory called CPIEM can be created on the C drive by entering the command MD\CPIEM. The subdirectory can then be entered by using the command CD\CPIEM. When in the subdirectory, the following files must be copied from the diskettes containing the original software and supporting data:

- All executable files
  - CPIEM.EXE
  - LEVEL12.EXE
  - LEVEL3.EXE
  - POPMATCH.EXE

- The file containing information used to construct screens (menus)
  - CPIEM.SCR

- The file containing information used to select location/activity profiles that match the user's selection criteria
  - RESIDNT2.DBF

- One or more pairs of files (.DBF and .NDX) containing location/activity information
  - WC_ACT24.DBF and .NDX (24-hour profiles)
  - WC_ACTAM.DBF and .NDX (12-hour daytime profiles)
  - WC_ACTPM.DBF and .NDX (12-hour nighttime profiles)
  - WC_ACT1H.DBF and .NDX (1-hour profiles)
  - WC_ACT8H.DBF and .NDX (8-hour profiles)

Other files with a .DBF extension--POLLUT, POPGRP, and files that begin with CL (See Section 7.1.3)--are not absolutely necessary but can be copied to take advantage of inputs that have been provided with the model. If these files are not provided, then the model will create all such files (initially empty) when it is first accessed. The files provided with the model collectively require about 30 megabytes of disk space. However, certain files containing location and activity information, particularly those containing 1-hour and 8-hour profiles, are quite large (12-13 megabytes) and are not expected to be used

frequently. Consequently, these files need not be copied unless the user is planning a run that requires them. After such a run, the files can be removed to increase available disk space. A minimum of 10 megabytes of free disk space should be available when running the model, to allow for scratch files written while the model is executing and output files saved at the user's request. Double that amount (20 megabytes) should be available if the user is working with 1-hour or 8-hour activity files.

The model software is a DOS application that runs on the PC-compatible family of microcomputers. The software also can be run from a Windows environment. In Windows 3.1, for example, the software can be accessed by selecting File, then Run, in the Program Manager, and then browsing to the subdirectory containing the CPEIM software and selecting CPIEM.EXE. The following are recommended minimum hardware requirements:

- 386-generation (or higher) computer with a microprocessor speed of 25 mHz or higher
- 640K of conventional memory
- Hard disk with capacity of 100 mB or greater
- VGA monitor.

The requirements for memory and type of monitor are absolute. Some memory-resident programs may cause a conflict with the software and need to be temporarily disabled. Although machines with slower microprocessors or less disk capacity could conceivably be utilized, performance of the software may suffer accordingly. A math coprocessor and disk-caching hardware/software are highly recommended as tools that will enhance the performance (speed) of the software. The following printers are supported by the model software: Epson dot-matrix printer or compatible; NEC pinwriter printer; Okidata 92/93 printer; and HP laserjet printer or compatible.

The model has no software requirements per se. All modules are provided as executable programs that were developed and compiled using Microsoft QuickBASIC (Version 4.5) software and several add-on products (Quick Windows Advanced Version 2.10 for design of screens, db/LIB for database management, and GRAFLIB for saving and

printing graphical outputs). Many of the user inputs to the model are stored in dBASE-compatible (.DBF) files, which can be browsed "outside" the model using dBASE/compatible software. Detailed output files provided by the model are in an ASCII format that can be readily analyzed using commercially available spreadsheet or statistical software packages.

APPENDIX B

INPUT DATA PROVIDED WITH THE MODEL

LEVEL 1-2 INPUTS

Inputs provided for Level 1-2 of the model describe concentration distributions for four types of environments--residence, office, travel in vehicle, and outdoors. Five other types of environments in the model--industrial plant, school, public access building, restaurant/lounge, and other indoor--currently have no inputs. The pollutants and integration periods for which input data are available are summarized in Table B-1. Some data are available for all pollutants in the model except total PAHs. The greatest amount of data is available for residences, followed by outdoors and travel in vehicle. Concentrations in offices are available for one pollutant (formaldehyde).

The concentration inputs for each type of environment are listed in Table B-2 for residences, B-4 for offices, B-5 for travel in vehicle, and B-6 for outdoors. Each listing indicates the case name by which the data are accessed in the model together with the pollutant, averaging period, and distribution type. Distributions for which data are provided are of two types: (1) lognormal, for which the mean concentration and standard deviation are listed, and (2) percentile, for which various percentiles of the cumulative frequency distribution are listed together with associated concentration values. Tables B-3 and B-7 provide recommended weights for the default cases for residences and outdoors, respectively.

Table B-1. Summary of Concentration Data Available for Model Level 1-2

Pollutant	Residence (Environment 1)	Office (Environment 2)	Travel in Vehicle (Environment 5)	Outdoors (Environment 9)
Benzene	24AP*	--	24AP	24AP
Benzo(a)pyrene	24AP	--	--	24AP
Carbon Monoxide	24	--	24	24
Chloroform	24AP	--	24AP	24AP
Formaldehyde	24	24	24	24
Nitrogen Dioxide	24	--	--	24
PM10	24AP	--	--	24AP
Perchlorethylene	24AP	--	24AP	24AP
Total PAHs	--	--	--	--
Trichloroethylene	24AP	--	--	24AP

* 24 refers to 24-hour integration period, A refers to 12-hour daytime period, and P refers to 12-hour nighttime period.

Table B-2. Concentration Distributions for Residences (Level 1-2)

Residences					
Case Number	Case Name	Ref	Pollutant	Averaging Period	Distribution Type (data)
3	WOODSL[a]	1	Benzene	24	Lognormal(4.50,10.24)
4	WOODSP	1	Benzene	24	Percentile(0,0; 10,0.84; 25,1.50; 50,2.20; 75,4.80; 90,9.40; 100,130.00)
5	TM87B24L	2	Benzene	24	Lognormal(8.95,10.44)
6	TM87B24P	2	Benzene	24	Percentile(0,1.47; 5,1.64; 10,2.08; 25,3.41; 50,5.84; 75,9.84; 90,16.10; 95,31.70; 100,68.60)
7	TM87W24L[a]	2	Benzene	24	Lognormal(12.12,12.98)
8	TM87W24P	2	Benzene	24	Percentile(0,1.47; 5,1.72; 10,2.20; 25,4.56; 50,9.00; 75,14.25; 90,26.19; 95,48.56; 100,68.60)
9	TM87S24L[a]	2	Benzene	24	Lognormal(5.95,6.10)
10	TM87S24P	2	Benzene	24	Percentile(0,1.51; 5,1.55; 10,1.76; 25,2.72; 50,4.58; 75,7.56; 90,9.37; 95,20.93; 100,36.03)
11	TM87BDYL[a]	2	Benzene	AM	Lognormal(8.23,11.84)
12	TM87WDYL	2	Benzene	AM	Lognormal(10.97,15.70)
13	TM87SDYL	2	Benzene	AM	Lognormal(5.50,4.73)
14	TM87BNTL[a]	2	Benzene	PM	Lognormal(10.49,11.46)
15	TM87WNTL	2	Benzene	PM	Lognormal(14.56,13.31)
16	TM87SNTL	2	Benzene	PM	Lognormal(6.54,7.61)
17	TM84LAWL[a]	3	Benzene	PM	Lognormal(16.50,13.80)
18	TM84LASL[a]	3	Benzene	PM	Lognormal(7.78,9.26)
19	TM84CCSL[a]	3	Benzene	PM	Lognormal(6.47,8.31)
20	PTM24L	4	Benzo(a)Pyrene	24	Lognormal(.70,4.00)
21	PTMDYL	4	Benzo(a)Pyrene	AM	Lognormal(.52,2.52)
22	PTMNTL	4	Benzo(a)Pyrene	PM	Lognormal(.77,4.76)
23	WOODSP[a]	1	Chloroform	24	Percentile(0,0; 10,0; 25,0.20; 50,0.40; 75,1.20; 90,2.70; 100,4.00)
24	TM87B24L	2	Chloroform	24	Lognormal(1.31,1.58)
25	TM87B24P	2	Chloroform	24	Percentile(0,0.07; 5,0.07; 10,0.08; 25,0.34; 50,0.76; 75,1.70; 90,2.99; 95,5.44; 100,7.79)
26	TM87W24L[a]	2	Chloroform	24	Lognormal(1.41,1.52)
27	TM87W24P	2	Chloroform	24	Percentile(0,0.07; 5,0.08; 10,0.11; 25,0.34; 50,0.97; 75,1.79; 90,3.64; 95,5.10; 100,7.23)
28	TM87S24L[a]	2	Chloroform	24	Lognormal(1.20,1.65)

Table B-2. Concentration Distributions for Residences (Level 1-2)

Residences					
Case Number	Case Name	Ref	Pollutant	Averaging Period	Distribution Type (data)
29	TM87S24P	2	Chloroform	24	Percentile(0,0.07; 5,0.07; 10,0.07; 25,0.34; 50,0.65; 75,1.28; 90,2.47; 95,6.75; 100,7.79)
30	TM87BDYL[a]	2	Chloroform	AM	Lognormal(1.27,1.45)
31	TM87WDYL	2	Chloroform	AM	Lognormal(1.38,1.48)
32	TM87SDYL	2	Chloroform	AM	Lognormal(1.13,1.41)
33	TM87BNTL[a]	2	Chloroform	PM	Lognormal(1.43,2.33)
34	TM87WNTL	2	Chloroform	PM	Lognormal(1.46,2.04)
35	TM87SNTL	2	Chloroform	PM	Lognormal(1.39,2.64)
36	TM84LAWL[a]	3	Chloroform	PM	Lognormal(2.17,2.01)
37	TM84LASL[a]	3	Chloroform	PM	Lognormal(1.57,3.39)
38	TM84CCSL[a]	3	Chloroform	PM	Lognormal(.80,1.58)
39	SEXMOBSL[b]	5a	Formaldehyde	24	Lognormal(111.70,84.70)
40	SEXMOBSP[b]	5a	Formaldehyde	24	Percentile(0,6.14; 6,30.70; 30,61.40; 53,92.00; 69,122.70; 84,184.10; 91,245.40; 96,368.10; 100,569.30)
41	SEXMOBWL[b]	5a	Formaldehyde	24	Lognormal(111.70,63.80)
42	SEXMOBWP[b]	5a	Formaldehyde	24	Percentile(0,20.90; 1,30.70; 20,61.40; 44,92.00; 69,122.70; 89,184.10; 96,245.40; 99,368.10; 100,385.30)
43	SEXCONWL[b]	5b	Formaldehyde	24	Lognormal(46.60,20.90)
44	SEXCONWP[b]	5b	Formaldehyde	24	Percentile(0,16.00; 10,24.50; 44,36.80; 57,49.10; 77,61.40; 91,73.60; 93,85.90; 99,98.20; 100,104.30)
45	ROGCONL[b]	6	Formaldehyde	24	Lognormal(61.10,25.80)
46	ROGCONP[b]	6	Formaldehyde	24	Percentile(0,22.10; 3,24.50; 13,36.80; 36,49.10; 63,61.40; 77,73.60; 86,85.90; 91,98.20; 94,110.40; 97,122.70; 100,147.20)
47	HARVLAL[c]	7	Nitrogen Dioxide	24	Lognormal(51.20,30.40)
48	HARVLAP[c]	7	Nitrogen Dioxide	24	Percentile(0,6.60; 5,13.40; 10,18.70; 25,31.30; 50,46.40; 75,65.80; 90,84.30; 95,100.90; 99,167.80; 100,289.40)
49	SOCLJNKL[b]	8	Nitrogen Dioxide	24	Lognormal(114.60,67.20)
50	SOCLJNKP[b]	8	Nitrogen Dioxide	24	Percentile(0,3.00; 5,34.50; 10,43.60; 25,65.20; 50,100.70; 75,147.90; 90,212.90; 95,244.70; 99,325.90; 100,390.80)
51	SOCLJNBL[b]	8	Nitrogen Dioxide	24	Lognormal(82.30,53.10)

Table B-2. Concentration Distributions for Residences (Level 1-2)

Residences					
Case Number	Case Name	Ref	Pollutant	Averaging Period	Distribution Type (data)
52	SOCLJNBP[b]	8	Nitrogen Dioxide	24	Percentile(0,1.60; 5,23.30; 10,31.00; 25,47.80; 50,70.40; 75,104.50; 90,138.40; 95,168.60; 99,312.40; 100,390.80)
53	SOCLMRKL[b]	8	Nitrogen Dioxide	24	Lognormal(81.10,48.70)
54	SOCLMRKP[b]	8	Nitrogen Dioxide	24	Percentile(0,0; 5,21.00; 10,26.00; 25,40.00; 50,73.00; 75,110.00; 90,146.00; 95,167.00; 99,223.00; 100,330.00)
55	SOCLMRBL[b]	8	Nitrogen Dioxide	24	Lognormal(55.70,34.40)
56	SOCLMRBP[b]	8	Nitrogen Dioxide	24	Percentile(0,0; 5,15.00; 10,21.00; 25,31.00; 50,48.50; 75,72.00; 90,97.00; 95,121.00; 99,170.00; 100,247.00)
57	SOCLJLKL[b]	8	Nitrogen Dioxide	24	Lognormal(93.40,46.30)
58	SOCLJLKP[b]	8	Nitrogen Dioxide	24	Percentile(0,0.40; 5,26.90; 10,38.00; 25,60.80; 50,88.80; 75,122.60; 90,152.90; 95,171.20; 99,210.70; 100,260.60)
59	SOCLJLBL[b]	8	Nitrogen Dioxide	24	Lognormal(71.60,33.70)
60	SOCLJLBP[b]	8	Nitrogen Dioxide	24	Percentile(0,0.60; 5,23.30; 10,30.60; 25,47.30; 50,69.20; 75,91.80; 90,114.10; 95,127.50; 99,159.00; 100,203.00)
61	PTEAMFL[a]	4	Inhalable Particles (PM10)	24	Lognormal(79.00,51.40)
62	PTEAMFP	4	Inhalable Particles (PM10)	24	Percentile(0,19.90; 10,32.90; 25,45.10; 50,65.30; 75,106.40; 90,143.60; 100,324.80)
63	COLOMFL	9	Inhalable Particles (PM10)	24	Lognormal(42.50,21.90)
64	PTEAMFL[a]	4	Inhalable Particles (PM10)	AM	Lognormal(94.70,74.10)
65	PTEAMFL[a]	4	Inhalable Particles (PM10)	PM	Lognormal(62.70,40.90)
66	WOODSL[a]	1	Perchloroethylene	24	Lognormal(1.44,6.12)
67	WOODSP	1	Perchloroethylene	24	Percentile(0,0; 10,0; 25,0.12; 50,0.24; 75,0.73; 90,2.30; 100,30.00)
68	TM87B24L	2	Perchloroethylene	24	Lognormal(4.93,6.20)
69	TM87B24P	2	Perchloroethylene	24	Percentile(0,0.60; 5,0.69; 10,1.46; 25,2.24; 50,3.12; 75,4.95; 90,8.20; 95,17.67; 100,44.22)
70	TM87W24L[a]	2	Perchloroethylene	24	Lognormal(6.74,7.66)
71	TM87W24P	2	Perchloroethylene	24	Percentile(0,0.66; 5,1.19; 10,2.09; 25,2.99; 50,4.42; 75,7.12; 90,17.27; 95,21.90; 100,44.22)

Table B-2. Concentration Distributions for Residences (Level 1-2)

Residences					
Case Number	Case Name	Ref	Pollutant	Averaging Period	Distribution Type (data)
72	TM87S24L[a]	2	Perchloroethylene	24	Lognormal(2.46,1.10)
73	TM87S24P	2	Perchloroethylene	24	Percentile(0,0.60; 5,0.62; 10,0.74; 25,1.84; 50,2.48; 75,2.88; 90,4.57; 95,4.71; 100,4.78)
74	TM87BDYL[a]	2	Perchloroethylene	AM	Lognormal(4.56,6.28)
75	TM87WDYL	2	Perchloroethylene	AM	Lognormal(5.86,7.96)
76	TM87SDYL	2	Perchloroethylene	AM	Lognormal(2.80,1.68)
77	TM87BNTL[a]	2	Perchloroethylene	PM	Lognormal(5.03,6.52)
78	TM87WNTL	2	Perchloroethylene	PM	Lognormal(7.71,7.72)
79	TM87SNTL	2	Perchloroethylene	PM	Lognormal(1.70,1.30)
80	TM84LAWL[a]	3	Perchloroethylene	PM	Lognormal(13.50,17.40)
81	TM84LASL[a]	3	Perchloroethylene	PM	Lognormal(3.99,11.20)
82	TM84CCSL[a]	3	Perchloroethylene	PM	Lognormal(3.36,5.57)
83	WOODSL[a]	1	Trichloroethylene	24	Lognormal(.65,1.57)
84	WOODSP	1	Trichloroethylene	24	Percentile(0,0; 10,0; 25,0.09; 50,0.19; 75,0.56; 90,1.90; 100,9.30)
85	TM87B24L	2	Trichloroethylene	24	Lognormal(1.01,1.49)
86	TM87B24P	2	Trichloroethylene	24	Percentile(0,0.06; 5,0.08; 10,0.16; 25,0.18; 50,0.39; 75,1.08; 90,3.38; 95,4.75; 100,7.27)
87	TM87W24L[a]	2	Trichloroethylene	24	Lognormal(.93,1.20)
88	TM87W24P	2	Trichloroethylene	24	Percentile(0,0.06; 5,0.06; 10,0.15; 25,0.18; 50,0.47; 75,1.24; 90,2.25; 95,4.60; 100,5.02)
89	TM87S24L[a]	2	Trichloroethylene	24	Lognormal(1.10,1.77)
90	TM87S24P	2	Trichloroethylene	24	Percentile(0,0.06; 5,0.13; 10,0.16; 25,0.18; 50,0.34; 75,0.90; 90,4.21; 95,6.55; 100,7.27)
91	TM87BDYL[a]	2	Trichloroethylene	AM	Lognormal(.87,1.31)
92	TM87WDYL	2	Trichloroethylene	AM	Lognormal(.99,1.35)
93	TM87SDYL	2	Trichloroethylene	AM	Lognormal(.72,1.27)
94	TM87BNTL[a]	2	Trichloroethylene	PM	Lognormal(1.37,2.65)
95	TM87WNTL	2	Trichloroethylene	PM	Lognormal(1.38,2.55)
96	TM87SNTL	2	Trichloroethylene	PM	Lognormal(1.35,2.80)
97	TM84LAWL[a]	3	Trichloroethylene	PM	Lognormal(3.97,8.15)
98	TM84LASL[a]	3	Trichloroethylene	PM	Lognormal(2.02,7.64)
99	TM84CCSL[a]	3	Trichloroethylene	PM	Lognormal(.76,1.00)
100	CRIAQALL[c]	10	Benzene	24	Lognormal(10.86,7.99)
101	CRIAQPGL[c]	10	Benzene	24	Lognormal(8.63,5.43)
102	CRIAQSCL[c]	10	Benzene	24	Lognormal(15.66,8.95)
103	CRIAQSDL[c]	10	Benzene	24	Lognormal(8.63,8.95)

Table B-2. Concentration Distributions for Residences (Level 1-2)

Residences					
Case Number	Case Name	Ref	Pollutant	Averaging Period	Distribution Type (data)
104	CRIAQALL[c]	10	Nitrogen Dioxide	24	Lognormal(47.00,50.80)
105	CRIAQALP[c]	10	Nitrogen Dioxide	24	Percentile(0,0; 5,3.80; 25,16.90; 50,30.10; 75,60.20; 95,139.20; 100,332.90)
106	CRIAQPGL[c]	10	Nitrogen Dioxide	24	Lognormal(35.70,48.90)
107	CRIAQPGP[c]	10	Nitrogen Dioxide	24	Percentile(0,0; 5,0; 25,11.29; 50,20.69; 75,43.26; 95,142.96; 100,312.25)
108	CRIAQSCL[c]	10	Nitrogen Dioxide	24	Lognormal(64.00,58.30)
109	CRIAQSCP[c]	10	Nitrogen Dioxide	24	Percentile(0,0; 5,3.80; 25,28.20; 50,54.60; 75,82.80; 95,159.90; 100,332.90)
110	CRIAQSDL[c]	10	Nitrogen Dioxide	24	Lognormal(47.00,39.50)
111	CRIAQSDP[c]	10	Nitrogen Dioxide	24	Percentile(0,7.50; 5,11.30; 25,22.60; 50,30.10; 75,64.00; 95,118.50; 100,212.60)
112	CRIAQALL[c]	10	Carbon Monoxide	24	Lognormal(1.80,1.90)
113	CRIAQALP[c]	10	Carbon Monoxide	24	Percentile(0,0; 5,0.10; 25,0.80; 50,1.40; 75,2.10; 95,4.90; 100,14.80)
114	CRIAQPGL[c]	10	Carbon Monoxide	24	Lognormal(1.50,1.60)
115	CRIAQPGP[c]	10	Carbon Monoxide	24	Percentile(0,0; 5,0.10; 25,0.70; 50,1.00; 75,1.60; 95,3.80; 100,13.60)
116	CRIAQSCL[c]	10	Carbon Monoxide	24	Lognormal(3.10,2.70)
117	CRIAQSCP[c]	10	Carbon Monoxide	24	Percentile(0,0.30; 5,0.70; 25,1.40; 50,2.10; 75,3.70; 95,8.40; 100,14.80)
118	CRIAQSDL[c]	10	Carbon Monoxide	24	Lognormal(1.30,.90)
119	CRIAQSDP[c]	10	Carbon Monoxide	24	Percentile(0,0.10; 5,0.20; 25,0.70; 50,1.30; 75,1.60; 95,3.20; 100,4.90)

[a] Indicates case marked as default; see Table B-3 for recommended weights for default cases.

[b] Data for these cases are based on week-long measurements. Although they are included among model inputs for the 24-hour averaging period, they are best treated as "practice" data sets.

[c] Data for these cases are based on 48-hour measurements. Although they are included among model inputs for the 24-hour averaging period, they are best treated as "practice" data sets.

Table B-3. Recommended Weights (in Percents) for Default Cases for Residences

	24-Hour		Daytime		Nighttime	
	Case Name (#)	Weight	Case Name (#)	Weight	Case Name (#)	Weight
Benzene	WOODSL (3)	34	TM87BDYL (11)	100	TM87BNTL (14)	70
	TM87W24L (7)	33			TM84LAWL (17)	10
	TM87S24L (9)	33			TM84LASL (18)	10
					TM84CCSL (19)	10
Benzo(a)pyrene	PTM24L (20)	100	PTMDYL (21)	100	PTMNTL (22)	100
Carbon Monoxide	CRIAQALL (112)	100				
Chloroform	WOODSP (23)	34	TM87BDYL (30)	100	TM87BNTL (33)	70
	TM87W24L (26)	33			TM84LAWL (36)	10
	TM87S24L (28)	33			TM84LASL (37)	10
					TM84CCSL (38)	10
Formaldehyde	SEXMOBSL (39)	100				
Nitrogen Dioxide	HARVLAL (47)	100				
PM10	PTEAMFL (61)	100	PTEAMFL (64)	100	PTEAMFL (65)	100
Perchloroethylene	WOODSL (66)	34	TM87BDYL (74)	100	TM87BNTL (77)	70
	TM87W24L (70)	33			TM84LAWL (80)	10
	TM87S24L (72)	33			TM84LASL (81)	10
					TM84CCSL (82)	10
Trichloroethylene	WOODSL (83)	34	TM87BDYL (91)	100	TM87BNTL (94)	70
	TM87W24L (87)	33			TM84LAWL (97)	10
	TM87S24L (89)	33			TM84LASL (98)	10
					TM84CCSL (99)	10

Table B-4. Concentration Distributions for Offices (Level 1-2)

Offices					
Case Number	Case Name	Ref	Pollutant	Averaging Period	Distribution Type (Data)
4	ROGOL[a,b]	6	Formaldehyde	24	Lognormal (41.20,15.60)
5	TURKL[c]	11	Formaldehyde	24	Lognormal (28.20,12.40)

[a] Indicates case marked as default.

[b] Data for these cases are based on week-long measurements. Although they are included among model inputs for the 24-hour averaging period, they are best treated as "practice" data sets.

[c] Data for these cases are based on biweekly measurements. Although they are included among model inputs for the 24-hour averaging period, they are best treated as "practice" data sets.

Table B-5. Concentration Distributions for Travel in Vehicle (Level 1-2)

Travel in Vehicle					
Case Number	Case Name	Ref	Pollutant	Averaging Period	Distribution Type (Data)
3	SHIKL[a]	12	Benzene	24	Lognormal (42.50,30.70)
4	SHIKL[a]	12	Benzene	AM	Lognormal (42.50,30.70)
5	SHIKL[a]	12	Benzene	PM	Lognormal (42.50,30.70)
6	SHIKL[a]	12	Chloroform	24	Lognormal (0.44,0.15)
7	SHIKL[a]	12	Chloroform	AM	Lognormal (0.44,0.15)
8	SHIKL[a]	12	Chloroform	PM	Lognormal (0.44,0.15)
9	SHIKL[a]	12	Formaldehyde	24	Lognormal (15.30,6.40)
10	SHIKL[a]	12	Perchloroethylene	24	Lognormal (37.30,32.60)
11	SHIKL[a]	12	Perchloroethylene	AM	Lognormal (37.30,32.60)
12	SHIKL[a]	12	Perchloroethylene	PM	Lognormal (37.30,32.60)
14	SHIKL[a]	12	Carbon monoxide	24	Lognormal (9.90,5.70)

[a] All cases included in this table are defaults and are based on trips averaging 33 minutes in duration.

Table B-6. Concentration Distributions for Outdoors (Level 1-2)

Outdoors					
Case Number	Case Name	Ref	Pollutant	Averaging Period	Distribution Type (Data)
3	TXNETALL[a]	13	Benzene	24	Lognormal (8.04,6.78)
4	TXNETSCL	13	Benzene	24	Lognormal (10.20,7.07)
5	TXNETSFL	13	Benzene	24	Lognormal (7.27,6.48)
6	TXNETRSL	13	Benzene	24	Lognormal (7.46,5.83)
7	WOODOUTL[a]	1	Benzene	24	Lognormal (1.20,0.62)
8	TM87B24L[a]	2	Benzene	24	Lognormal (5.10,3.46)
9	TM87W24L	2	Benzene	24	Lognormal (6.41,3.83)
10	TM87S24L	2	Benzene	24	Lognormal (3.75,2.41)
11	TM84LAWL[a]	3	Benzene	PM	Lognormal (18.90,9.11)
12	TM84LASL[a]	3	Benzene	PM	Lognormal (3.07,2.16)
13	TM84CCSL[a]	3	Benzene	PM	Lognormal (1.82,1.01)
14	TM87BDYL	2	Benzene	AM	Lognormal (4.10,2.81)
15	PTM24L	4	Benzo(a)Pyrene	24	Lognormal (0.30,0.36)
16	PTMDYL	4	Benzo(a)Pyrene	AM	Lognormal (0.17,0.26)
17	PTMNTL	4	Benzo(a)Pyrene	PM	Lognormal (0.44,0.51)
18	TXNETALL[a]	13	Chloroform	24	Lognormal (0.19,0.59)
19	TXNETSCL	13	Chloroform	24	Lognormal (0.18,0.16)
20	TXNETSFL	13	Chloroform	24	Lognormal (0.17, 0.14)
21	TXNETRSL	13	Chloroform	24	Lognormal (0.21,0.86)
22	TM87B24L[a]	2	Chloroform	24	Lognormal (0.64,1.11)
23	TM87W24L	2	Chloroform	24	Lognormal (0.49,0.80)
24	TM87S24L	2	Chloroform	24	Lognormal (0.79,1.36)
25	TM84LAWL[a]	3	Chloroform	PM	Lognormal (1.14,1.86)
26	TM84LASL[a]	3	Chloroform	PM	Lognormal (0.35,0.58)
27	TM84CCSL[a]	3	Chloroform	PM	Lognormal (0.59,0.47)
28	TXNETALL	13	Benzo(a)Pyrene	24	Lognormal (0.84,1.87)
29	TXNETSCL	13	Benzo(a)Pyrene	24	Lognormal (0.42,0.74)
30	TXNETSFL	13	Benzo(a)Pyrene	24	Lognormal (0.54,0.88)
31	TXNETRSL	13	Benzo(a)Pyrene	24	Lognormal (1.03,2.02)
32	TOXALL	13	Formaldehyde	24	Lognormal (4.00,3.20)
33	TOXSCL	13	Formaldehyde	24	Lognormal (4.60,3.70)
34	TOXSFL	13	Formaldehyde	24	Lognormal (3.20,2.40)
35	TOXRSL	13	Formaldehyde	24	Lognormal (3.60,2.70)
36	HARVLAL[c]	7	Nitrogen Dioxide	24	Lognormal (72.00,39.30)
37	SOCLJANL[b]	8	Nitrogen Dioxide	24	Lognormal (107.00,42.50)
38	SOCLMARL[b]	8	Nitrogen Dioxide	24	Lognormal (53.70,22.60)
39	SOCLJULL[b]	8	Nitrogen Dioxide	24	Lognormal (77.20,34.20)
40	TXNETALL[a]	13	Inhalable Particles (PM10)	24	Lognormal (38.60,34.60)
41	TXNETSCL	13	Inhalable Particles (PM10)	24	Lognormal (51.60,37.20)
42	TXNETSFL	13	Inhalable Particles (PM10)	24	Lognormal (30.70,24.80)
43	TXNETRSL	13	Inhalable Particles (PM10)	24	Lognormal (37.00,34.90)
44	PTEAMFL[a]	4	Inhalable Particles (PM10)	24	Lognormal (91.20,50.70)
45	PTEAMFL[a]	4	Inhalable Particles (PM10)	AM	Lognormal (94.90,70.60)
46	PTEAMFL[a]	4	Inhalable Particles (PM10)	PM	Lognormal (86.30,56.00)
47	TXNETALL[a]	13	Perchloroethylene	24	Lognormal (2.18,3.89)

Table B-6. Concentration Distributions for Outdoors (Level 1-2)

Outdoors					
Case Number	Case Name	Ref	Pollutant	Averaging Period	Distribution Type (Data)
48	TXNETSCL	13	Perchloroethylene	24	Lognormal (3.78,7.08)
49	TXNETSFL	13	Perchloroethylene	24	Lognormal (2.14,2.14)
50	TXNETRSL	13	Perchloroethylene	24	Lognormal (1.40,1.65)
51	WOODOUTL[a]	1	Perchloroethylene	24	Lognormal (0.53,1.99)
52	TM87B24L[a]	2	Perchloroethylene	24	Lognormal (2.90,2.55)
53	TM87W24L	2	Perchloroethylene	24	Lognormal (4.06,3.08)
54	TM87S24L	2	Perchloroethylene	24	Lognormal (1.75,0.99)
55	TM84LAWL[a]	3	Perchloroethylene	PM	Lognormal (11.20,9.80)
56	TM84LASL[a]	3	Perchloroethylene	PM	Lognormal (1.86,1.34)
57	TM84CCSL[a]	3	Perchloroethylene	PM	Lognormal (0.62,1.26)
58	TXNETALL[a]	13	Trichloroethylene	24	Lognormal (0.87,2.02)
59	TXNETSCL	13	Trichloroethylene	24	Lognormal (0.96,1.07)
60	TXNETSFL	13	Trichloroethylene	24	Lognormal (1.01,3.08)
61	TXNETRSL	13	Trichloroethylene	24	Lognormal (0.70,1.39)
62	TM87B24L[a]	2	Trichloroethylene	24	Lognormal (0.16,0.14)
63	TM87W24L	2	Trichloroethylene	24	Lognormal (0.21,0.18)
64	TM87S24L	2	Trichloroethylene	24	Lognormal (0.11,0.05)
65	TM84LAWL[a]	3	Trichloroethylene	PM	Lognormal (0.95,0.78)
66	TM84LASL[a]	3	Trichloroethylene	PM	Lognormal (0.14,0.34)
67	TM84CCSL[a]	3	Trichloroethylene	PM	Lognormal (0.12, 0.06)
68	CRIAQALL[c]	10	Benzene	24	Lognormal (8.63,7.99)
69	CRIAQPGL[c]	10	Benzene	24	Lognormal (5.43,3.20)
70	CRIAQSCL[c]	10	Benzene	24	Lognormal (15.02,11.18)
71	CRIAQSDL[c]	10	Benzene	24	Lognormal (6.07,2.56)
72	CRIAQALL[c]	10	Nitrogen Dioxide	24	Lognormal (43.30,32.00)
73	CRIAQPGL[c]	10	Nitrogen Dioxide	24	Lognormal (33.90,24.50)
74	CRIAQSCL[c]	10	Nitrogen Dioxide	24	Lognormal (65.80,41.40)
75	CRIAQSDL[c]	10	Nitrogen Dioxide	24	Lognormal (39.50,22.60)
76	CRIAQALL[c]	10	Carbon Monoxide	24	Lognormal (1.10,1.40)
77	CRIAQPGL[c]	10	Carbon Monoxide	24	Lognormal (0.80,0.60)
78	CRIAQSCL[c]	10	Carbon Monoxide	24	Lognormal (2.20,2.30)
79	CRIAQSDL[c]	10	Carbon Monoxide	24	Lognormal (0.80,0.60)
80	TM87WDYL	2	Benzene	AM	Lognormal (4.69,3.07)
81	TM87SDYL	2	Benzene	AM	Lognormal (3.45,2.38)
82	TM87BNTL	2	Benzene	PM	Lognormal (6.97,6.06)
83	TM87WNTL	2	Benzene	PM	Lognormal (9.58,6.83)
84	TM87SNTL	2	Benzene	PM	Lognormal (3.96,2.98)
85	TM87BDYL	2	Chloroform	AM	Lognormal (0.63,1.57)
86	TM87WDYL	2	Chloroform	AM	Lognormal (0.48,0.77)
87	TM87SDYL	2	Chloroform	AM	Lognormal (0.80,2.12)
88	TM87BNTL	2	Chloroform	PM	Lognormal (0.74,1.83)
89	TM87WNTL	2	Chloroform	PM	Lognormal (0.47,1.10)
90	TM87SNTL	2	Chloroform	PM	Lognormal (1.05,2.39)
91	TM87BDYL	2	Perchloroethylene	AM	Lognormal (2.61,1.83)
92	TM87WDYL	2	Perchloroethylene	AM	Lognormal (2.94,1.84)

Table B-6. Concentration Distributions for Outdoors (Level 1-2)

Outdoors					
Case Number	Case Name	Ref	Pollutant	Averaging Period	Distribution Type (Data)
93	TM87SDYL	2	Perchloroethylene	AM	Lognormal (2.26,1.77)
94	TM87BNTL	2	Perchloroethylene	PM	Lognormal (3.64,4.39)
95	TM87WNTL	2	Perchloroethylene	PM	Lognormal (5.72,5.12)
96	TM87SNTL	2	Perchloroethylene	PM	Lognormal (1.24,0.87)
97	TM87BDYL	2	Trichloroethylene	AM	Lognormal (0.13,0.12)
98	TM87WDYL	2	Trichloroethylene	AM	Lognormal (0.16,0.15)
99	TM87SDYL	2	Trichloroethylene	AM	Lognormal (0.11,0.07)
100	TM87BNTL	2	Trichloroethylene	PM	Lognormal (0.20,0.23)
101	TM87WNTL	2	Trichloroethylene	PM	Lognormal (0.28,0.29)
102	TM87SNTL	2	Trichloroethylene	PM	Lognormal (0.12,0.10)

[a] Indicates case marked as default; see Table B-7 for recommended weights for default cases.

[b] Data for these cases are based on week-long measurements. Although they are included among model inputs for the 24-hour averaging period, they are best treated as "practice" data sets.

[c] Data for these cases are based on 48-hour measurements. Although they are included among model inputs for the 24-hour averaging period, they are best treated as "practice" data sets.

Table B-7. Recommended Weights (in Percents) for Default Cases for Outdoors

	24-Hour		Daytime		Nighttime	
	Case Name (#)	Weight	Case Name (#)	Weight	Case Name (#)	Weight
Benzene	TXNETALL (3)	50	TM87BDYL (14)	100	TM84LAWL (11)	10
	WOODOUTL (7)	25			TM84LASL (12)	10
	TM87B24L (8)	25			TM84CCSL (13)	10
					TM87BNTL (82)	70
Benzo(a)pyrene	PTM24 (15)	100	PTMDYL (16)	100	PTMNTL (17)	100
Carbon Monoxide	CRIAQALL (76)	100				
Chloroform	TXNETALL (18)	70	TM87BDYL (85)	100	TM84LAWL (25)	10
	TM87B24L (22)	30			TM84LASL (26)	10
					TM84CCSL (27)	10
					TM87BNTL (88)	70
Formaldehyde	TOXALL (32)	100				
Nitrogen Dioxide	HARVLAL (36)	100				
PM10	TXNETALL (40)	50	PTEAMFL (45)	100	PTEAMFL (46)	100
	PTEAMFL (44)	50				
Perchloroethylene	TXNETALL (47)	50	TM87BDYL (91)	100	TM84LAWL (55)	10
	WOODOUTL (51)	25			TM84LASL (56)	10
	TM87B24L (52)	25			TM84CCSL (57)	10
					TM87BNTL (94)	70
Trichloroethylene	TXNETALL (58)	70	TM87BDYL (97)	100	TM84LAWL (65)	10
	TM87B24L (62)	30			TM84LASL (66)	10
					TM84CCSL (67)	10
					TM87BNTL (100	70

LEVEL 3 INPUTS

Pollutant-specific inputs available for Level 3 of the model are summarized in Table B-8. All inputs are specific to the residential environment. Indoor sources, penetration factors and indoor sinks are available for three pollutants--benzo(a)pyrene, chloroform and nitrogen dioxide. Outdoor concentration distributions (based on daily averages) are available for all pollutants in the model except total PAHs. As noted in a footnote to the table, inputs are also available for volumes and air exchange rates, but these are not pollutant-specific.

Of the six categories of indoor sources (see Section 4.1), model inputs are currently available for two types--long-term (no loading) sources (Table B-9) and frequent (no loading) sources (Table B-10). Each of the two tables lists all inputs for each case name associated with each pollutant. Outdoor concentrations (Table B-11) are summarized in a manner similar to that given previously for Level 1-2 concentration distributions. Distributional data on penetration factors, indoor sinks, volumes, and air exchange rates are summarized in Tables B-12 through B-15, respectively. Three distributions are provided for volumes and eight distributions for air exchange rates.

Table B-8. Summary of Pollutant-specific Inputs* Available for Model Level 3

Pollutant	Long-Term (No Loading) Sources	Frequent (No Loading) Sources	Outdoor Concentrations (Daily)	Penetration Factors	Indoor Sinks
Benzene			x		
Benzo(a)pyrene	x		x	x	x
Carbon Monoxide			x		
Chloroform		x	x	x	x
Formaldehyde			x		
Nitrogen Dioxide	x	x	x	x	x
PM10			x		
Perchloroethylene			x		
Trichloroethylene			x		
Total PAHs					

* Inputs for volumes and air exchange rates are also available, but these are not pollutant-specific

Table B-9. Inputs for Long Term (No Loading) Indoor Sources (Level 3)

Pollutant	Case Name	Ref	Input Parameter	Distribution/Value(s)
Benzo(a)pyrene	SOURCE1	4	Percent of Cases	28
		4	Quantity Present	Normal (1, 0)
		A1[b]	When Installed	Normal (12, 0)
		4	Initial Emission Rate	Lognormal (390, 390)
		A2[c]	Decline in Rate	Normal (0, 0)
	SOURCE2[a]	4	Initial Emission Rate	Lognormal (390, 1285)
	SOURCE3[a]	4	Initial Emission Rate	Percentile (0, 5; 50, 10; 75, 20; 80, 66; 85, 218; 90, 721; 95, 2383; 100, 8800)
Nitrogen Dioxide	PILOT	7	Percent of Cases	68.1 (Linked to COOKING)
		14	Quantity Present	Percentile (0, 128.8; 25, 257.5; 50, 343.3; 75, 429.2; 100, 643.8)
		A1[b]	When Installed	Normal (12, 0)
		15	Initial Emission Rate	Normal (9.15, 2.3)
		A2[c]	Decline in Rate	Normal (0, 0)

[a] Other inputs same as for SOURCE1.

[b] Arbitrary values; for a constant emission rate, as assumed in this case, the model does not use this input parameter.

[c] The appropriate value is zero when a constant emission rate is assumed within each modeled structure.

Table B-10. Inputs for Frequent (No Loading) Indoor Sources (Level 3)

Pollutant	Case Name	Ref	Input Parameter	Distribution/Value(s)
Chloroform	ALL	A1[a]	Percent of Cases	100
		16	Quantity Present	Lognormal (99.2, 24.8)
		A2[b]	Episodes per Day	Lognormal (10, 5)
		A1[a]	Start Time[c]	(1, 1, 1, 1, 1, 2, 4, 6, 8, 6, 4, 4, 6, 4, 4, 4, 6, 8, 8, 8, 6, 4, 2, 1)
		A2[b]	Duration	Normal (1, 0)
		A1[a]	Overlapping Episodes	Yes
		2	Initial Emission Rate	Lognormal (5.2, 3.0)
		A3[d]	Decline in Rate	Normal (0, 0)
	ALL2[e]	2	Initial Emission Rate	Lognormal (8.5, 2.6)
Nitrogen Dioxide	COOKING	7	Percent of Cases	73.3
		14	Quantity Present	Lognormal (150, 50)
		14	Episodes per Day	Frequency (15%-0; 50%-1, 20%-2; 15%-3)
		A1[a]	Start Time[c]	(0, 0, 0, 0, 0, 0, 0, 26, 0, 0, 0, 0, 22, 0, 0, 0, 0, 0, 52, 0, 0, 0, 0, 0)
		17	Duration	Lognormal (33.3, 33.3)
		A1[a]	Overlapping Episodes	No
		15	Initial Emission Rate	Normal (9.15, 2.3)
		A3[d]	Decline in Rate	Normal (0, 0)
	RANGEHT	17	Percent of Cases	2.8 (Linked to COOKING)
		A1[a]	Quantity Present	Normal (300, 0)
		17	Episodes per Day	Frequency (66%-0; 34%-1)
		A1[a]	Start Time[c]	(0, 0, 0, 0, 0, 25, 25, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 25, 25, 0, 0, 0)
		17	Duration	Lognormal (144, 72)
		A1[a]	Overlapping Episodes	No
		15	Initial Emission Rate	Normal (9.15, 2.3)
		A3[d]	Decline in Rate	Normal (0, 0)

[a] Assumed value based on professional judgement.

[b] Values were chosen such that the product of episodes per day times quantity present times duration of use was consistent with the average quantity used per day, as determined from reference 16.

[c] Percent share for each of 24 hourly periods, starting with midnight to 1:00 a.m.

[d] The appropriate value is zero when a constant emission rate is assumed within each modeled structure.

[e] Other inputs same as for ALL.

Table B-11. Inputs for Daily Outdoor Concentrations (Level 3)

Outdoor Concentration (Daily)				
Case Number	Case Name	Ref	Pollutant	Distribution Type (Data)
3	TXNETALL[a]	13	Benzene	Lognormal (8.04,6.78)
4	TXNETSCL	13	Benzene	Lognormal (10.20,7.07)
5	TXNETSFL	13	Benzene	Lognormal (7.27,6.48)
6	TXNETRSL	13	Benzene	Lognormal (7.46,5.83)
7	WOODOUTL[a]	1	Benzene	Lognormal (1.20,0.62)
8	TM87B24L[a]	2	Benzene	Lognormal (5.10,3.46)
9	TM87W24L	2	Benzene	Lognormal (6.41,3.83)
10	TM87S24L	2	Benzene	Lognormal (3.75,2.41)
11	PTM24L	4	Benzo(a)Pyrene	Lognormal (0.30,0.36)
12	TXNETALL[a]	13	Chloroform	Lognormal (0.19,0.59)
13	TXNETSCL	13	Chloroform	Lognormal (0.18,0.16)
14	TXNETSFL	13	Chloroform	Lognormal (0.17, 0.14)
15	TXNETRSL	13	Chloroform	Lognormal (0.21,0.86)
16	TM87B24L[a]	2	Chloroform	Lognormal (0.64,1.11)
17	TM87W24L	2	Chloroform	Lognormal (0.49,0.80)
18	TM87S24L	2	Chloroform	Lognormal (0.79,1.36)
19	TXNETALL	13	Benzo(a)Pyrene	Lognormal (0.84,1.87)
20	TXNETSCL	13	Benzo(a)Pyrene	Lognormal (0.42,0.74)
21	TXNETSFL	13	Benzo(a)Pyrene	Lognormal (0.54,0.88)
22	TXNETRSL	13	Benzo(a)Pyrene	Lognormal (1.03,2.02)
23	TOXALL	13	Formaldehyde	Lognormal (4.00,3.20)
24	TOXSCL	13	Formaldehyde	Lognormal (4.60,3.70)
25	TOXSFL	13	Formaldehyde	Lognormal (3.20,2.40)
26	TOXRSL	13	Formaldehyde	Lognormal (3.60,2.70)
27	HARVLAL[c]	7	Nitrogen Dioxide	Lognormal (72.00,39.30)
28	SOCLJANL[b]	8	Nitrogen Dioxide	Lognormal (107.00,42.50)
29	SOCLMARL[b]	8	Nitrogen Dioxide	Lognormal (53.70,22.60)
30	SOCLJULL[b]	8	Nitrogen Dioxide	Lognormal (77.20,34.20)
31	TXNETALL[a]	13	Inhalable Particles (PM10)	Lognormal (38.60,34.60)
32	TXNETSCL	13	Inhalable Particles (PM10)	Lognormal (51.60,37.20)
33	TXNETSFL	13	Inhalable Particles (PM10)	Lognormal (30.70,24.80)
34	TXNETRSL	13	Inhalable Particles (PM10)	Lognormal (37.00,34.90)
35	PTEAMFL[a]	4	Inhalable Particles (PM10)	Lognormal (91.20,50.70)
36	TXNETALL[a]	13	Perchloroethylene	Lognormal (2.18,3.89)
37	TXNETSCL	13	Perchloroethylene	Lognormal (3.78,7.08)
38	TXNETSFL	13	Perchloroethylene	Lognormal (2.14,2.14)
39	TXNETRSL	13	Perchloroethylene	Lognormal (1.40,1.65)
40	WOODOUTL[a]	1	Perchloroethylene	Lognormal (0.53,1.99)
41	TM87B24L[a]	2	Perchloroethylene	Lognormal (2.90,2.55)
42	TM87W24L	2	Perchloroethylene	Lognormal (4.06,3.08)
43	TM87S24L	2	Perchloroethylene	Lognormal (1.75,0.99)
44	TXNETALL[a]	13	Trichloroethylene	Lognormal (0.87,2.02)
45	TXNETSCL	13	Trichloroethylene	Lognormal (0.96,1.07)
46	TXNETSFL	13	Trichloroethylene	Lognormal (1.01,3.08)
47	TXNETRSL	13	Trichloroethylene	Lognormal (0.70,1.39)

Table B-11. Inputs for Daily Outdoor Concentrations (Level 3) (Concluded)

Outdoor Concentration (Daily)				
Case Number	Case Name	Ref	Pollutant	Distribution Type (Data)
48	TM87B24L[a]	2	Trichloroethylene	Lognormal (0.16,0.14)
49	TM87W24L	2	Trichloroethylene	Lognormal (0.21,0.18)
50	TM87S24L	2	Trichloroethylene	Lognormal (0.11,0.05)
51	CRIAQALL[c]	10	Benzene	Lognormal (8.63,7.99)
52	CRIAQPGL[c]	10	Benzene	Lognormal (5.43,3.20)
53	CRIAQSCL[c]	10	Benzene	Lognormal (15.02,11.18)
54	CRIAQSDL[c]	10	Benzene	Lognormal (6.07,2.56)
55	CRIAQALL[c]	10	Nitrogen Dioxide	Lognormal (43.30,32.00)
56	CRIAQPGL[c]	10	Nitrogen Dioxide	Lognormal (33.90,24.50)
57	CRIAQSCL[c]	10	Nitrogen Dioxide	Lognormal (65.80,41.40)
58	CRIAQSDL[c]	10	Nitrogen Dioxide	Lognormal (39.50,22.60)
59	CRIAQALL[c]	10	Carbon Monoxide	Lognormal (1.10,1.40)
60	CRIAQPGL[c]	10	Carbon Monoxide	Lognormal (0.80,0.60)
61	CRIAQSCL[c]	10	Carbon Monoxide	Lognormal (2.20,2.30)
62	CRIAQSDL[c]	10	Carbon Monoxide	Lognormal (0.80,0.60)

[a] Indicates case marked as default.

[b] Data for these cases are based on week-long measurements. Although they are included among model inputs for the 24-hour averaging period, they are best treated as "practice" data sets.

[c] Data for these cases are based on 48-hour measurements. Although they are included among model inputs for the 24-hour averaging period, they are best treated as "practice" data sets.

Table B-12. Inputs for Penetration Factors (Level 3)

Pollutant	Case Name	Ref	Distribution/Value(s)
Benzo(a)pyrene	PEN1	4	Normal (0.6, 0)
Chloroform	PEN1	A1[a]	Normal (1, 0)
Nitrogen Dioxide	PEN1	18	Normal (1, 0)

[a] Assumed value based on professional judgement.

Table B-13. Inputs for Indoor Sinks (Level 3)

Pollutant	Case Name	Ref	Distribution/Value(s)
Benzo(a)pyrene	SINK1	4	Normal (0, 0)
Chloroform	SINK1	A1[a]	Normal (0, 0)
Nitrogen Dioxide	SINK1	15	Lognormal (0.5, 0.3)
	SINK2	18, 19	Lognormal (0.8, 0.3)

[a] Assumed value based on professional judgement.

Table B-14. Inputs for Volumes (Level 3)

Case Name	Ref	Distribution/Value(s)
RTI-TMLA	2, 20	Lognormal (274.9, 110.6)
SOCAL-3	8, 20	Lognormal (309.5, 159.8)
ADM	21	Lognormal (354, 101)

Table B-15. Inputs for Air Exchange Rates (Level 3)

Case Name	Ref	Distribution/Value(s)
TEAMLA1	2, 20	Lognormal (0.94, 0.82)
TEAMLA2	2, 20	Lognormal (2.83, 2.54)
SOCAL1	8	Lognormal (0.78, 0.63)
SOCAL2	8	Lognormal (1.51, 1.47)
SOCAL3	8	Lognormal (0.58, 0.47)
CALIAQSC	10	Lognormal (0.77, 0.57)
ADM	21	Lognormal (0.70, 0.52)
PTEAM	4	Lognormal (1.25, 1.02)

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APPENDIX C

CALCULATIONS FOR DEVELOPMENT OF INPUT DATA SETS

GEOMET Technologies, Inc.

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MEMORANDUM IE-4405

TO: Susan Lum

FROM: Michael Koontz

DATE: October 23, 1995

SUBJECT: Calculations for Development of Input Data Sets

As you know, it was necessary for GEOMET to undertake a variety of data processing and calculation steps to develop some of the input data sets for the CPIEM software. The purpose of this memorandum is to document these steps, which are summarized below as they relate to indoor/outdoor concentrations, air exchange rates, volumes, and indoor sources.

Residential Indoor Concentrations

- For the 1984 TEAM study, the 1990 Woodland study, and the 1990 PTEAM study, the investigators reported the average concentration and the standard error for monitored VOCs (TEAM and Woodland) and PAHs (PTEAM). Because the model inputs require a mean and standard deviation, the standard deviation was obtained by multiplying the reported standard error by the square root of the reported sample size.

- For the 1987 TEAM study, 12-hour daytime and nighttime VOC samples were collected. The means and standard errors were reported for these data sets, but not for the 24-hour data. Consequently, files containing sampling results for each participating household were obtained through the EPA Environmental Monitoring Systems Laboratory in Las Vegas, and the daytime/nighttime values for each

household were averaged to develop a 24-hour average from which the mean and standard deviation were computed. For consistency, the means and standard deviations for the 12-hour samples were also computed from this set of data.

- For the 1984-85 study of formaldehyde concentrations in conventional and mobile homes, conducted by the California Department of Health Services, the means and standard deviations were reported in a journal article along with histograms. Information was extracted from the histograms to summarize percentiles of the cumulative frequency distribution for conventional homes during the winter and for mobile homes during the both the summer and the winter.

Concentrations for Travel in Vehicle

- Results were reported by the South Coast Air Quality Management District for a number of commuting trips during 1987-88 that averaged 33 minutes in duration. The results were reported on a volume/volume (parts per billion) basis. Because the model requires mass/volume (e.g., mg/m^3 or $\mu g/m^3$), the published results were converted using a formula based on the molecular weight of each compound.

Outdoor Concentrations

- For the 1984 TEAM study, the 1987 TEAM study, the 1990 Woodland study and the 1990 PTEAM study, the same processing and analysis steps were applied as described above for indoor concentrations.

- Data from the ARB air toxics monitoring network were acquired from ARB and processed and analyzed to developed distributional information (means and standard deviations) for selected VOCs (benzene, chloroform, formaldehyde, perchloroethylene, and trichloroethylene) and for benzo[a]pyrene. After eliminating sites with limited data, the records for each pollutant were statistically summarized across all monitoring sites. This procedure was followed for the state as a whole and for three regions (South Coast, San Francisco Bay area, and remainder of the state). A similar procedure was followed for inhalable particles (PM_{10}) using a separate file obtained from ARB. The VOC results, reported in volume/volume units, were converted to mass/volume units using a formula based on the molecular weight of each compound.

Residential Air Exchange Rates

- For the 1987 TEAM study, air exchange rates measured during February and July were processed and summarized separately, using a database of PFT measurements developed by Versar and GEOMET for the U.S. Environmental Protection Agency. Air exchange rates for the 1984-85 study for SoCal Gas were also available in this

database, but some errors were found in the portion of the database pertaining to this study; consequently, summaries reported by the investigators were used instead.

- For 1990 studies by ADM Associates and Berkeley Solar Group, the air exchange rates were not summarized by the investigators but the individual results were listed in their respective reports. The data listed in the reports were entered in a spreadsheet and then summarized statistically.

Residential Volumes

- For the 1987 TEAM study, house volumes were summarized statistically using a database of PFT measurements developed by Versar and GEOMET for the U.S. Environmental Protection Agency. Volumes for the 1984-85 study for SoCal Gas were also in this database. The SoCal study had three measurement periods (March 1984, July 1984, and January 1985) for largely the same set of houses. Because the 1984 data were found to have some errors, the summary statistics on house volumes were calculated using the 1985 data.

- For the 1990 study by ADM Associates, house volumes were not summarized by the investigators but were listed in their report. The listed data were entered in a spreadsheet and the summarized statistically.

Residential Indoor Sources

- Inputs for chloroform on indoor water uses were developed from a report by the Metropolitan Water District of Southern California, which summarized daily uses per household for toilets, faucets, baths/showers, dishwashers and clothes washers. From these individual sources, total household water use per day was computed and used in developing model inputs reflecting all water uses combined.

- Inputs for benzo[a]pyrene were largely taken from the report on the 1990 PTEAM study. The investigators reported the average source strength but not the standard deviation. The standard deviation was estimated using limited statistics on percentiles reported by the investigators coupled with assumptions for the percentiles that were not reported.

- Inputs for nitrogen dioxide were based on unpublished data from the gas industry, obtained from the Gas Research Institute, on daily and hourly gas consumption by gas ranges, including pilot light consumption. The data were analyzed to separate the pilot light consumption from the remainder of range consumption (i.e., for cooking or for supplemental heating). Fuel consumption summary statistics initially were developed separately for breakfast, lunch and dinner. The fuel-consumption

inputs were also used to develop inputs for duration of cooking for each meal. Subsequently, the three meals were combined to develop a single source for cooking; a Monte Carlo simulation was performed to develop an estimate of the standard deviation for duration of cooking for this combined source.

APPENDIX D
SCRIPTED EXAMPLES

Table D-1. Exposure/Dose Distributions (Example 6.1.2)

Keyboard Entries	Mouse Actions	Result
At DOS prompt, type CPIEM and press Enter key	N/A	Introductory Screen displayed
Press any key	N/A	Pollutant highlighted with menu displayed
Press Enter key	Click on Pollutant	Pollutant to be Modeled submenu displayed
Arrow to Formaldehyde, press Enter twice (or Enter and then Alt-O key combination)	Double-click on Formaldehyde (or click Formaldehyde and Ok)	Modeling Level submenu displayed
Arrow to Exposures/Doses, press Enter twice (or Enter then Alt-O)	Double-click on Exposures/Doses (or click Exposures/Doses then Ok)	Integration Period submenu displayed
Arrow to 24 hours, press Enter twice (or Enter then Alt-O)	Double-click on 24 hours (or click 24 hours then Ok)	Exp/Doses highlighted with menu displayed
Arrow to Population Subgroup, press Enter	Click on Population Subgroup	Population Subgroup submenu displayed
If {All} is not displayed for each criterion (age, etc.), then select the criterion (arrow then press Enter), arrow to All, press Enter then Alt-O	Click on each criterion (age, etc.), for which {All} is not displayed, click on All then Ok	{All} displayed for each criterion
Arrow to Region, press Enter twice	Double-click on Region	Region submenu displayed
Arrow to South Coast, press Enter then Alt-O	Click on South Coast then Ok	{1 Chosen} appears next to Region

Keyboard Entries	Mouse Actions	Result
Arrow to Activity Status, press Enter twice	Double-click on Activity Status	Activity Status submenu displayed
Arrow to Working, press Enter then Alt-O	Click on Working then Ok	{1 Chosen} appears next to Activity Status
Arrow to Done!, press Enter twice	Click twice (separately) on Done!	Message displayed -- Total 209 Cases Saved ...
Press any key	N/A (must use keyboard to continue)	Return to Exp/Doses menu with Population Subgroup highlighted
Arrow to Number of Trials, press Enter	Click on Number of Trials	Number of Trials submenu displayed
Arrow to Use All, press Enter or Alt-O	Click on Use All	Return to Exp/Doses menu with Number of Trials highlighted
Arrow to Concentration Distributions, press Enter	Click on Concentration Distributions	Concentration Distributions submenu displayed
Arrow to Residence, press Alt-I (for Input)	Click on Residence then Input	Residence submenu displayed
Press Alt-L	Click on Load	Cases and descriptions displayed
Unmark any selected cases by arrowing to the case/line and pressing Enter twice	Unmark any selected cases by clicking twice	No X's next to any cases
Arrow to SEXMOBSL, SEXMOBWL, SEXCONWL and ROGCONL, press Enter after each then Alt-O at end	Click on each case to be selected then Ok at end	ROGCONL (4/4) displayed with Lognormal highlighted
Press Enter	Click on Lognormal	Distribution Parameters displayed for ROGCONL (Mean = 61.1, Std Deviation = 25.8, see Fig. 6-1 in User's Guide)

Keyboard Entries	Mouse Actions	Result
Press Alt-O	Click on Ok	Return to Lognormal highlighted
Press Alt-N	Click on Next	SEXMOBSL (1/4) displayed
Press Alt-B	Click on Back	ROGCONL (4/4) displayed
Press Alt-W	Click on Weight	Case weights displayed with default of 100% for first case
Enter 2 for SEXMOBSL and press Enter, 2 for SEXMOBWL and Enter, 32 for SEXCONWL and Enter, 64 for ROGCONL and Enter (or 64 then Alt-O)	N/A	Weights of 2, 2, 32 and 64 assigned to the four respective cases (see Fig. 6-6 in User's Guide)
Press Alt-E	Click on Exit	Return to Residence submenu
Press Alt-E	Click on Exit	Return to Concentration Distributions submenu
Arrow to Office, press Alt-I (for Input)	Click on Office then Input	Office submenu displayed
Press Alt-L	Click on Load	Cases and descriptions displayed
Arrow to ROGOL, press Enter to select, arrow to TURKL and press Enter then Alt-O	Click on each case to be selected then Ok	TURKL (2/2) displayed
Press Alt-W	Click on Weight	Case weights displayed
Enter 25 for ROGOL and press Enter, then 75 for TURKL and Enter (or Alt-O)	N/A	Weights of 25 and 75 assigned to the two cases (see Fig. 6-10 in User's Guide)
Press Alt-O or Enter	Click on Ok	Return to Office submenu

Keyboard Entries	Mouse Actions	Result
Press Alt-E	Click on Exit	Return to Concentration Distributions submenu
If any environments other than Residence or Office have an [X], de-select by arrowing then pressing Enter (otherwise they will be included in the run)	Unmark environments with an [X], other than Residence or Office, by clicking on those environments	[X] appears next to Residential and Office only
Press Alt-E	Click on Exit	Return to Exp/Doses menu, Concentration Distribution highlighted
Arrow to Breathing Rates, press Enter	Click on Breathing Rates	--NEW--- displayed (default values)
Press Alt-O	Click on Ok	Return to Exp/Doses menu with Breathing Rate highlighted
Arrow to Random Number Seed, press Enter	Click on Random Number Seed	Random Number Seed submenu displayed
Arrow to Enter a Random Number, press Enter	Click on Enter a Random Number	Cursor blinking in box for Specify Random Number Seed
Enter 9113, press Enter twice (or Enter then Alt-O)	Enter 9113, click Ok	Return to Exp/Doses menu, Random Number Seed highlighted
Arrow to Done!, press Enter	Click on Done!	Run menu highlighted
Press Enter key	Click on Run	Run Options displayed

Keyboard Entries	Mouse Actions	Result
For Example 6.1.2a: Tab until "Calculate Dose" is highlighted, press space bar, Tab until "Results for Each Environment Plus Total" is highlighted, press space bar OR For Example 6.1.2b: Tab until "Calculate Exposure" is highlighted, press space bar, Tab until "Results for Each Environment Plus Total" is highlighted, press space bar	For Example 6.1.2a: Click on "Calculate Dose," then on "Results for Each Environment Plus Total" OR For Example 6.1.2b: Click on "Calculate Exposure," then on "Results for Each Environment Plus Total"	[X] appears next to choices
Tab to Title of Run	Click on Title of Run	Cursor blinking in box for Title of Run
For example 6.1.2a: Key in FORMALDEHYDE DOSE - TWO ENVIRONMENTS, press Enter OR For example 6.1.2b: Key in FORMALDEHYDE EXPOSURE - TWO ENVIRONMENTS, press Enter	N/A	Cursor blinking in box for Output Filename
Key in FORM2ENV, then press Enter	N/A	Ready to run model
Press Enter or Alt-O	Click on Ok	Model execution begins, % done displayed, then results for RESIDENTIAL
Press Alt-N	Click on Next	Results for OFFICE
Press Alt-N	Click on Next	Results for TOTALS (see Fig. 6-11 in User's Guide for Example 6.1.2a)
Press Alt-P (prints current screen display only)	Click on Print	Results for TOTALS to printer, beep when done

Keyboard Entries	Mouse Actions	Result
Press Alt-F (saves current screen display only)	Click on File	File saved (FORM2ENV.GDT for Example 6.1.2a, or FORM2ENV.GET for example 6.1.2b), beep when done
Press Alt-E	Click on Exit	Pop-up for Save Statistics and Save Detailed File
Tab to Save Detailed File, press space bar	Click on Save Detailed File	Both choices marked
Press Alt-E	Click on Exit	Statistics file (FORM2ENV.STD for Example 6.1.2a, or FORM2ENV.STE for Example 6.1.2b) and details file (FORM2ENV.PRN for both examples) saved, return to Exp/Doses menu
Press Esc twice, then Enter	Click on Quit	Exit the model
Type DIR at DOS prompt	N/A	For example 6.1.2a: Four files for FORM2ENV with extensions of GDT, STD, PRN and FMT OR For example 6.1.2b: Four files for FORM2ENV with extensions of GET, STE, PRN and FMT

Table D-2. Concentration Distributions (Example 6.2.4)

Keyboard Entries	Mouse Actions	Result
At DOS prompt, type CPIEM and press Enter key	N/A	Introductory Screen displayed
Press any key	N/A	Pollutant highlighted with menu displayed
Press Enter key	Click on Pollutant	Pollutant to be Modeled submenu displayed
Arrow to Nitrogen Dioxide, press Enter twice (or Enter then Alt-O key combination)	Double-click Nitrogen Dioxide (or Nitrogen Dioxide then Ok)	Modeling Level submenu displayed
Arrow to Concentrations, press Enter twice (or Enter then Alt-O)	Double-click Concentrations (or Concentrations then Ok)	Concentrations highlighted with menu displayed
Arrow to Indoor Sources, press Enter	Click on Indoor Sources	Indoor Sources submenu displayed
Arrow to Frequent (No Loading), Press Alt-I (for Input)	Click on Frequent (No Loading) then Input	Frequent (No Loading) submenu displayed
Press Alt-L	Click on Load	Cases and descriptions displayed
Unmark any selected cases by arrowing and pressing Enter twice	Unmark any selected cases by clicking twice	No X's next to any cases
Arrow to COOKING and RANGEHT, press Enter after each then Alt-O at end	Click on each case to be selected then Ok	RANGEHT (2/2) displayed with Percent of Cases highlighted
Press Enter	Click on Percent of Cases	Shows 2.8 for Percent of Cases, Y for Linked, F for Source Type and COOKING for Name of Case (see Fig. 6-26 in User's Guide)

Keyboard Entries	Mouse Actions	Result
Press Enter repeatedly until return to percent of cases (or press Alt-O or Esc)	Click on Ok	Return to Percent of Cases highlighted and marked [X]
Arrow to Quantity Present, press Enter	Click on Quantity Present	Normal highlighted
Press Enter	Click on Normal	Distribution parameters displayed (Mean = 300, Std Deviation = 0)
Press Enter 3 times (or press Alt-O or Esc)	Click on Ok	Return to Normal highlighted
Press Alt-E or Esc	Click on exit	Return to Quantity Present highlighted and marked [X]
Arrow to Episodes per Day, press Enter	Click on Episodes per Day	Percentile highlighted
Press Enter	Click on Percentile	Frequency Distribution displayed
Press Alt-O or Esc	Click on Ok	Return to Percentile highlighted
Press Alt-E or Esc	Click on Ok	Return to Episodes per Day highlighted and marked [X]
Review other inputs by arrowing to each and pressing Enter	Review other inputs by clicking on each	Decline in Rate highlighted, all inputs marked [X]
Press Alt-E or Esc (or arrow to Done! and press Enter)	Click on Done! Or Exit	Return to Indoor Sources submenu with Frequent (No Loading) highlighted and marked
Arrow to Long-term (No Loading), press Alt-I (for Input)	Click on Long-term (No Loading)	Long-tem (No Loading) submenu displayed

Keyboard Entries	Mouse Actions	Result
Press Alt-L	Click on Load	Cases and descriptions displayed
Arrow to PILOT and press Enter (unmark any other marked cases), press Alt-O	Click on PILOT (unmark any other marked cases) then Ok	Percent of Cases highlighted
Review inputs by arrowing to each and pressing Enter	Review inputs by clicking on each	Decline in Rate highlighted, all inputs marked [X]
Press Alt-O or Esc (or arrow to Done! and press Enter)	Click on Done! or Exit	Return to Indoor Sources submenu with Long-term (No Loading) highlighted and marked
Press Alt-E or Esc	Click on Exit	Return to Concentrations menu with Indoor Sources highlighted
Arrow to Outdoor Concentrations, press Enter	Click on Outdoor Concentrations	Daily values highlighted
Press Enter or Alt-I (for Input)	Click on Input	Lognormal highlighted, HARVARD (1/1) shown as selected case
Press Enter	Click on Input	Distribution parameters displayed (Mean = 72.0, Std Deviation = 39.3)
Press Alt-O or Esc	Click on Ok	Return to Lognormal highlighted
Press Alt-E or Esc	Click on Exit	Return to Daily Values highlighted
Press Alt-E or Esc	Click on Exit	Return to Concentrations menu with Outdoor Concentrations highlighted
Arrow to Penetration Factors, press Enter, press Alt-L, mark PEN1, press Alt-O	Click on Penetration Factors, then Load, then PEN1 and Ok	Normal highlighted and PEN1 (1/1) displayed

Keyboard Entries	Mouse Actions	Result
Press Alt-E or Esc	Click on Exit	Return to Concentrations menu with Penetration Factors highlighted
Arrow to Indoor Sinks, press Enter, press Alt-L, mark SINK2 (unmark others), press Alt-O	Click on Indoor Sinks, Load, SINK2 (unmark others) and Ok	Normal highlighted and SINK2 (1/1) displayed
Press Alt-E or Esc	Click on Exit	Return to Concentrations menu with Indoor Sinks highlighted
Arrow to Volumes, press Enter	Click on Volumes	Volumes submenu displayed
Press Alt-L, mark RTI-TMLA and SOCAL-3, press Alt-O	Click on RTI-TMLA and SOCAL-3, then Ok	Lognormal highlighted, SOCAL-3 (2/2) displayed
Press Alt-B or Alt-N	Click on Back or Next	RTI-TMLA (1/2) displayed
Press Alt-W	Click on Weight	Weights displayed
Enter 50 for RTI-TMLA and 0 for SOCAL-3, press Alt-O	N/A	Model beeps, displays message at bottom, adjusts weights to add to 100 (50 and 50)
Press Alt-O or Enter	Click on Ok	Return to Lognormal highlighted
Press Alt-E or Esc	Click on Exit	Return to Concentrations menu with Volumes highlighted
Arrow to Air Exchange Rates, press Enter	Click on Air Exchange Rates	Lognormal highlighted
Press Alt-L, mark TEAMLA1, TEAMLA2, SOCAL1, SOCAL2, SOCAL3 and CALIAQSC, press Alt-O	Click on TEAMLA1, TEAMLA2, SOCAL1, SOCAL2, SOCAL3 and CALIAQSC, then Ok	Lognormal highlighted, CALIAQSC (6/6) displayed

Keyboard Entries	Mouse Actions	Result
Press Alt-W	Click on Weight	Weights displayed
Enter 17 for first 3 cases, 16 for SOCAL2, 17 for SOCAL3 and 16 for CALIAQSC, press Alt-O	N/A	Return to Lognormal highlighted
Press Alt-E or Esc	Click on Exit	Return to Concentrations menu with Air Exchange Rates highlighted
Arrow to Number of Trials, press Enter	Click on Number of Trials	Number of Trials submenu displayed
Arrow to 100 (or press A), press Enter or Alt-O	Click on 100 then Ok	100 trials selected, return to Concentrations menu with Number of Trials highlighted
Arrow to Random Number Seed, press Enter	Click on Random Number Seed	Random Number Seed submenu displayed
Arrow to Enter a Random Number, press Enter	Click on Enter a Random Number	Cursor blinking in box for Specify Random Number Seed
Enter 1096, press Enter twice (or Enter then Alt-O)	Enter 1096, click on Ok	Return to Concentrations menu, Random Number Seed highlighted
Arrow to Done!, press Enter	Click on Done!	Run menu highlighted
Press Enter key	Click on Run	Run Options displayed
Tab until Results for Hourly Conc. Plus Daily is highlighted, press space bar	Click on Results for Hourly Conc. Plus Daily	X appears next to choice
Tab to Title of Run	Click on Title of Run	Cursor blinking in box for Title of Run
Key in LINKED SOURCES FOR NO2, then press Enter	N/A	Cursor blinking in box for Output Filename
Key in NO2LINK, then press Enter	N/A	Ready to run model

Keyboard Entries	Mouse Actions	Result
Press Enter or Alt-O	Click on Ok	Model execution begins, % done displayed, then results for CONCENTRATION, DAILY
Press Alt-N	Click on Next	Results for CONCENTRATION, HOURLY
Press Alt-N or Alt-B	Click on Next or Back	Results for CONCENTRATION, DAILY
Press Alt-P	Click on Print	Results for DAILY to printer, beep when done
Press Alt-F	Click on File	File NO2LINK.GCD saved, beep when done
Press Alt-E	Click on Exit	Pop-up for Save Statistics and Save Detailed File
Tab to Save Detailed File, press space bar	Click on Save Detailed File	Both choices marked
Press Alt-E	Click on Exit	Statistics (.STC) and details (.PRN) saved, return to Concentrations menu
Press Esc twice, then Enter	Click on Quit	Exit the model
Type DIR at DOS prompt	N/A	Four files for NO2LINK with extensions of STC, GCD, ASC and FMT