4. Inputs for Indoor Concentrations

The Concentrations menu will be displayed when you select Indoor Concentrations in your scenario. The menu items are shown in Figure 4-1. Inputs are required for indoor sources, outdoor concentrations, penetration factors, indoor sinks, volumes, and air exchange rates. Each of these submenus is discussed separately in the subsections that follow. The submenus relate to parameters for a mass-balance model, and you can save inputs for subsequent access in later runs of the scenario.

The submenus do not need to be accessed in any specific order; but you must select one set of inputs under each submenu for the model to execute properly.

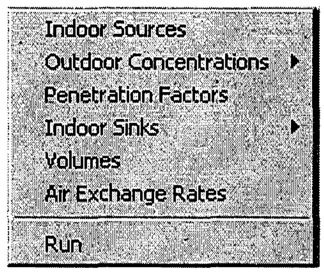


Figure 4-1 Pull-down menu for Concentrations

When you have finished providing information in each of the submenus, you will use the Run command to generate results for the indoor concentrations scenario.

4.1. Indoor Sources

Click indoor Sources, and CPIEM will display the Indoor Sources dialog box.

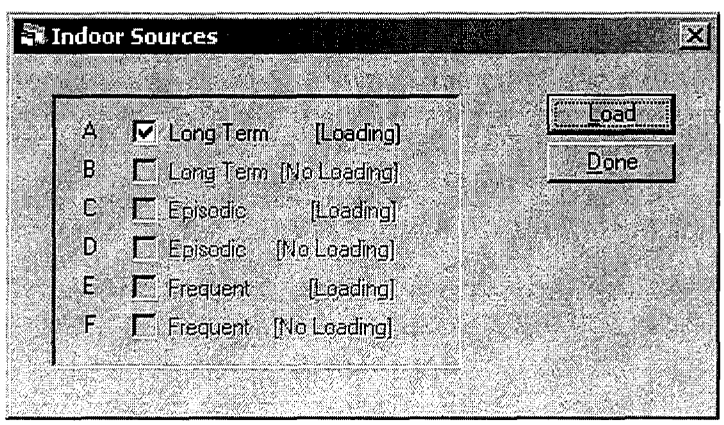


Figure 4-2 Indoor Sources dialog box

The types of indoor sources that you have selected for the scenario will be displayed with a check mark. These sources are the only ones that will be available to add information to (inputs) as cases. If you want to add an indoor source, you must edit your scenario and add the indoor source type there.

You must enter information for each indoor source that is to be described. Indoor sources are classified into three types:

- Long-term sources, such as interior finishes, furnishings, and some appliances, tend to be relatively static features of buildings.
- Episodic sources typically are used or present regularly or infrequently; 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 (for example, vacuuming, using a fireplace), generally are best treated as frequent sources within the model.

Each of the three types of sources is further distinguished as one of the following:

- Loading
- No Loading

That is, for each type you can describe the quantity of material present or used either in absolute terms (no loading, for example, in square feet of finishing material) or in relation to building volume (loading, for example, in square feet per unit volume). The choice is at the user's discretion—for some sources, such as pilot lights, the quantity (amount of fuel used) is not logically related to volume, whereas for sources such as carpeting the quantity (square feet installed) would be related. In the latter case, the model multiplies the volume in cubic meters (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.

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

* *You can express this input as an absolute quantity (for example, grams used for a product or square meters present for a material) or in relation to the volume of a structure (for example, g/m² or m²/m³). Absolute quantities are input through the "No Loading" option (choice B, D, or F in Figure 4-3), whereas relational quantities are input with the "Loading" 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.*

Table 4-1 Inputs required for three types of indoor sources

Inputs for all indoor sources are saved as cases. Your indoor source must have at least one case for the model to execute properly. You must rename and provide information for each case that you add. Examples are given below that show the general navigation path to the case detail dialog boxes for any indoor source. The inputs that are required for the case in each indoor source will be explained in the subsections for each indoor source type.

4.1.1. Long-term Sources

Long-term sources with quantity expressed as loading, **Long Term [Loading]**, (Figure 4-3) require 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" (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" i.e. “Selected” for the model to execute properly.

From the Indoor Source dialog box, click **Load**, and CPIEM will display the Long Term [Loading] dialog box.

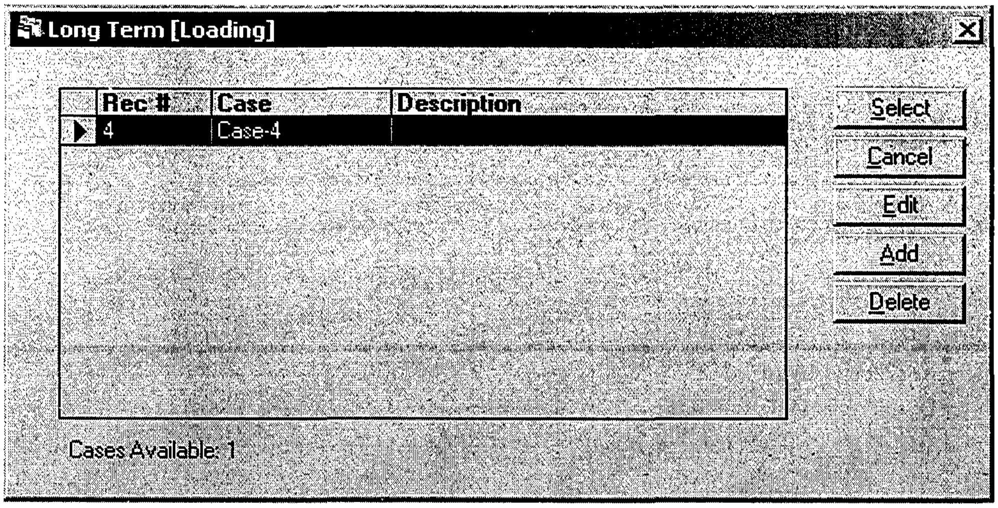


Figure 4-3 Long Term [Loading] case dialog box

CPIEM displays a default new case. Click **Edit**. CPIEM will display the Long Term [Loading] case detail dialog box.

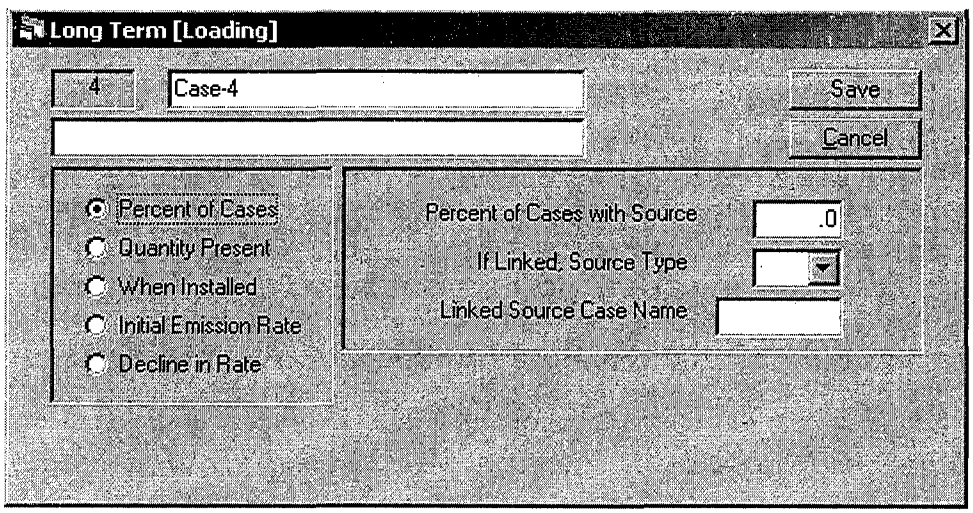


Figure 4-4 Long Term [Loading] case details dialog box, Percent of Cases

You can change the default name by selecting the entire default name and typing a new one. This name will denote the case within the databases and should be unique. You can type a description of the case in the box below the name box.

P rcent of Cases is used to denote the percent of cases with the source present. A special feature that can be used here is linkage of sources and cases. 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 (because it is always in operation). A subset of gas ranges has pilot lights. In this case, after providing inputs for gas-range cooking and then saving these inputs as a case with the name "GASCOOK", you can then provide inputs for pilot lights and link this source to

GASCOOK. CPIEM 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.

More than one type of source can be linked to the same file (for example, 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 you inadvertently make this link, then CPIEM would ignore it. (The model does not provide any indication to the user that the link is ignored in such cases.)

Quantity Present is used to express the quantity within loading, even though units are implied and not expressly presented. The choices of presentation are identical in format to that for environments within the exposure/dose model, with five options for describing the distribution: Normal, Lognormal, Triangular, Uniform, and Percentile. The units for load factor are at your 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 Rat** must be in complementary 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.

The choices of input distributions for **When Installed**, **Initial Emission Rate**, and **Decline in Rate** are the same as for Quantity Present. **When Installed** is the time since the installation of the source occurred and has units of months. It is used in conjunction with **Decline in Rate,** which has units of $months^{-1}$. If there is no decline in emission rates over time, **Decline in Rate** should be given a normal distribution of zero for the mean and standard deviation, and **When Installed** can be given any arbitrary value.

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), and 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 complementary 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:

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

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

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

from which the value of r is calculated to be $-\ln(0.5) \cdot 12$, 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 dialog box used for **Long Term [No Loading]** is nearly identical to that for long-term sources with loading.

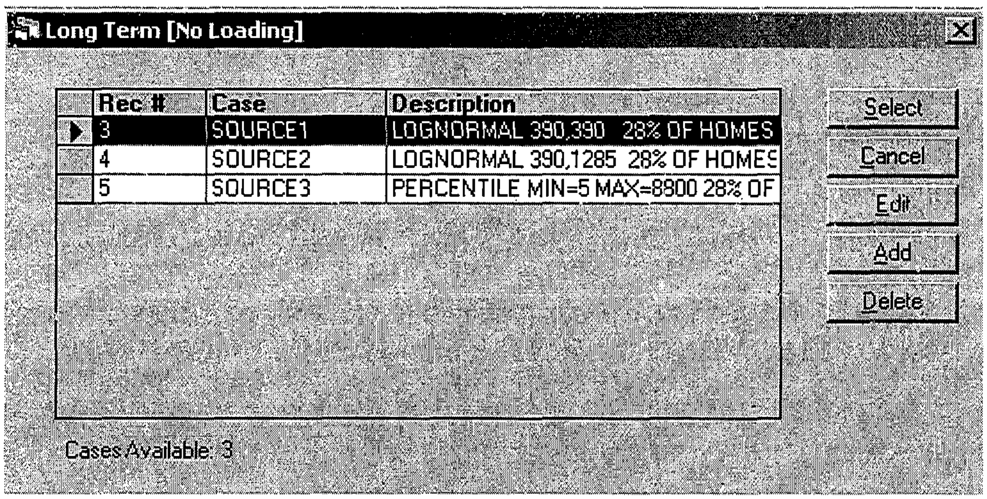
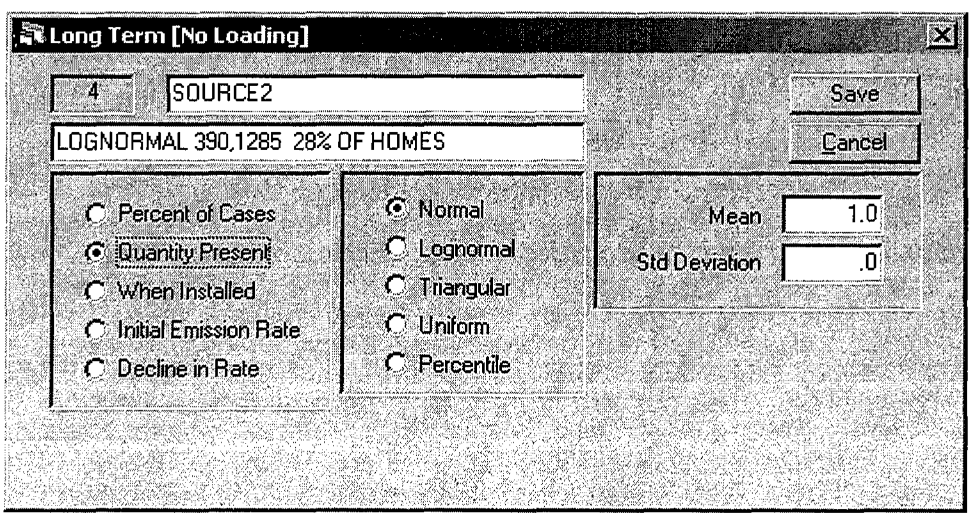


Figure 4-5 Long Term [No Loading] case dialog box



Figur 4-6 Long Term [No Loading] cas d tails dialog box, Quantity Pr s nt

The only difference is input of **Quantity Present** (e.g., ft^2) instead of the loading factor. The emission rate, which can be constant or declining over time, must be input in complementary 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).

4.1.2. Episodic Sources

The inputs for **Episodic Sources [Loading]** (Figure 4-7) are similar to those for long-term sources, with three differences:

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 $days^{-1}$.

A sixth type of description—the exponential distribution—can be used for the time since use. A single parameter—the mean time since last use—is sufficient to characterize the exponential distribution.

An input is required for duration of use, expressed in hours.

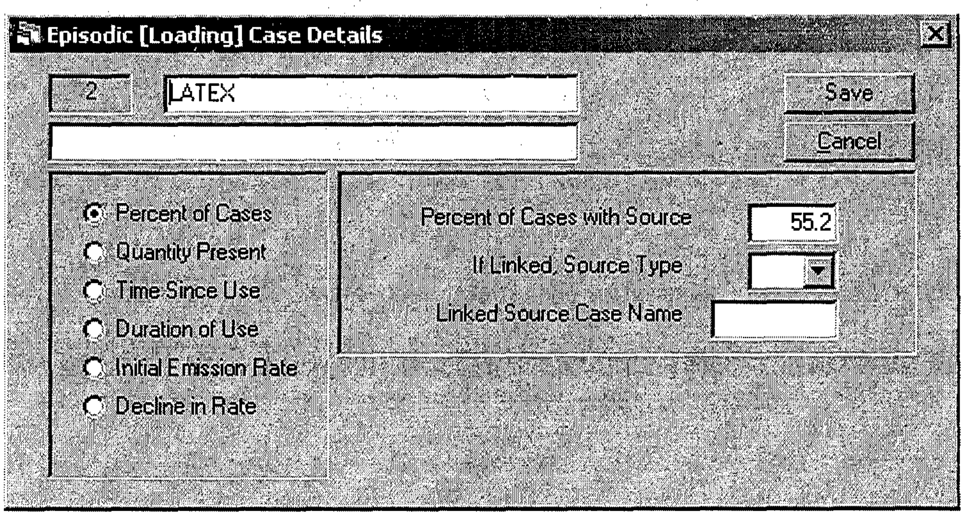


Figure 4-7 Episodic Sources [Loading] case details dialog box, Percent of Cases

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, because the model randomly selects an hour between 9:00 A.M. and 8:00 P.M.

The inputs for **Episodic Sources [No Loading]** are the same as for episodic sources with loading, 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 loading cases, 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 [Loading] (Figure 4-8) 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 loading 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 loading case, the quantity per unit volume will be multiplied by the structure volume to determine the total quantity used, as in the previous cases.

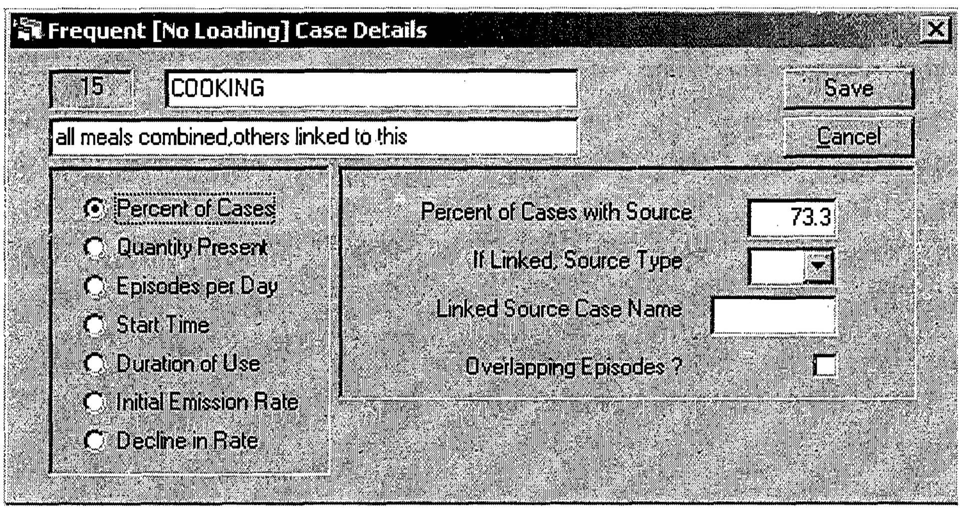


Figure 4-8 Frequent Sources [Loading] case details dialog box, Percent of Cases

The input for **Episodes Per Day** is similar to most other inputs in that five types of distribution are allowed. However, the "percentile" distribution 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 (Percent of Cases in Figure 4-9) is entered in the left-hand column and the associated value in the right-hand column.

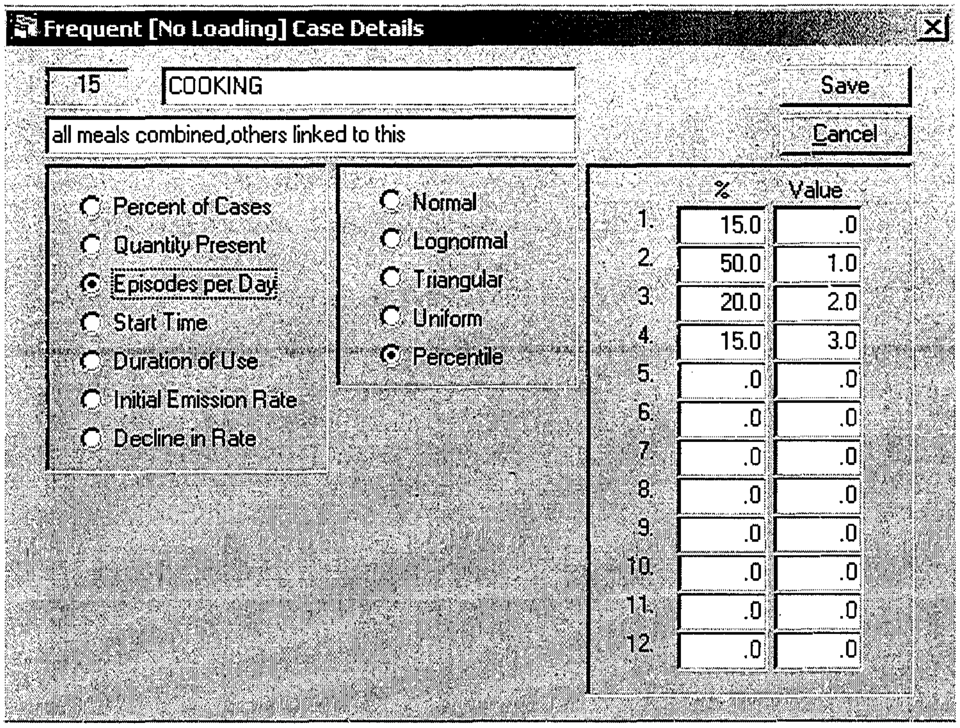


Figure 4-9 Episodes per Day with Percentile Distribution case details dialog box, Episodes per Day

For **Start Time** (Figure 4-10), 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.

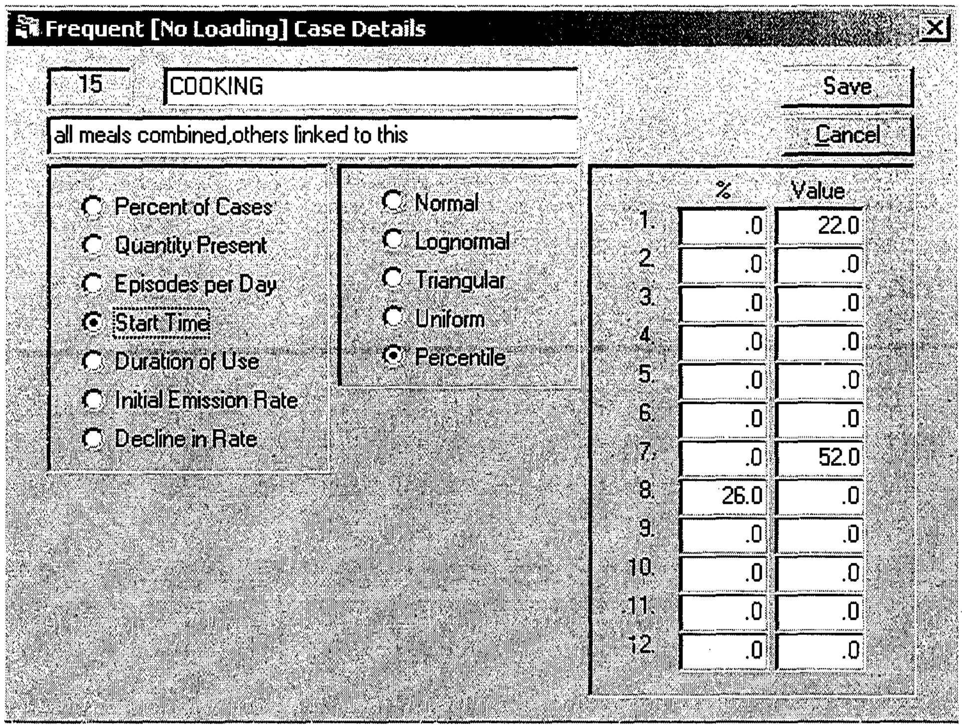


Figure 4-10 Start Time case details dialog box, Start Time

For **Overlapping Episodes** (Figure 4-11), 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.

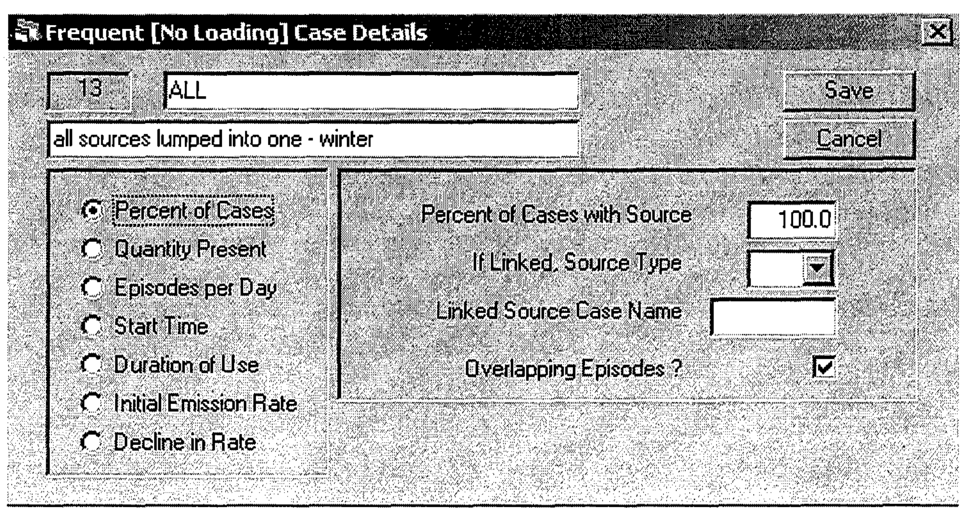


Figure 4-11 Overlapping Episodes case details dialog box, Percent of Cases

For the **Episodic [No Loading]**, 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.

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

Table 4-2 Examples of Input Combinations for Frequent Sources

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

Outdoor concentrations can be input as either of the following:

- Hourly (average) values
- Daily (average) values

If hourly values are selected (Figure 4-12), then the only allowable input is a dataset (Figure 4-13), 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.

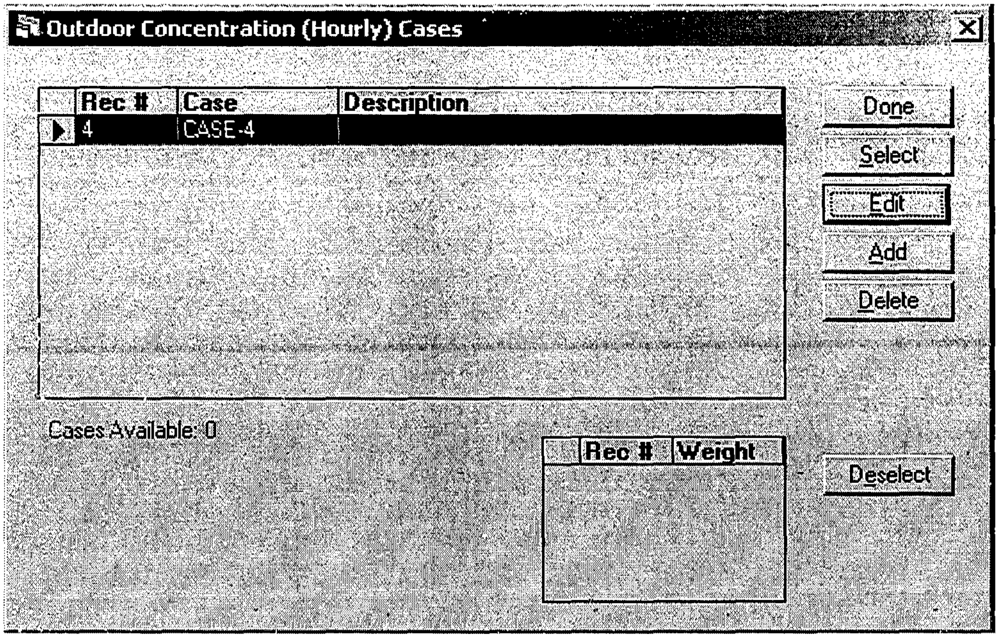


Figure 4-12 Outdoor Concentration (Hourly) case dialog box

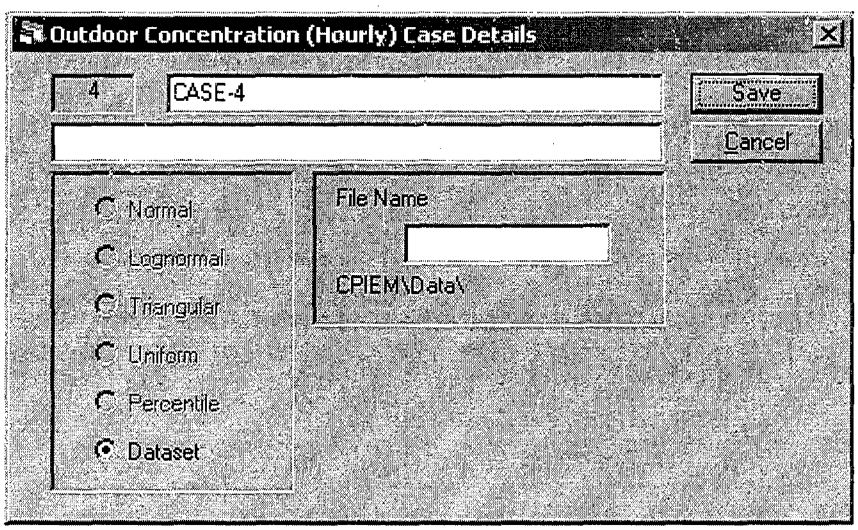


Figure 4-13 Outdoor Concentration (Hourly) case details dialog box, Dataset

If daily values are chosen (Figure 4-14), 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.

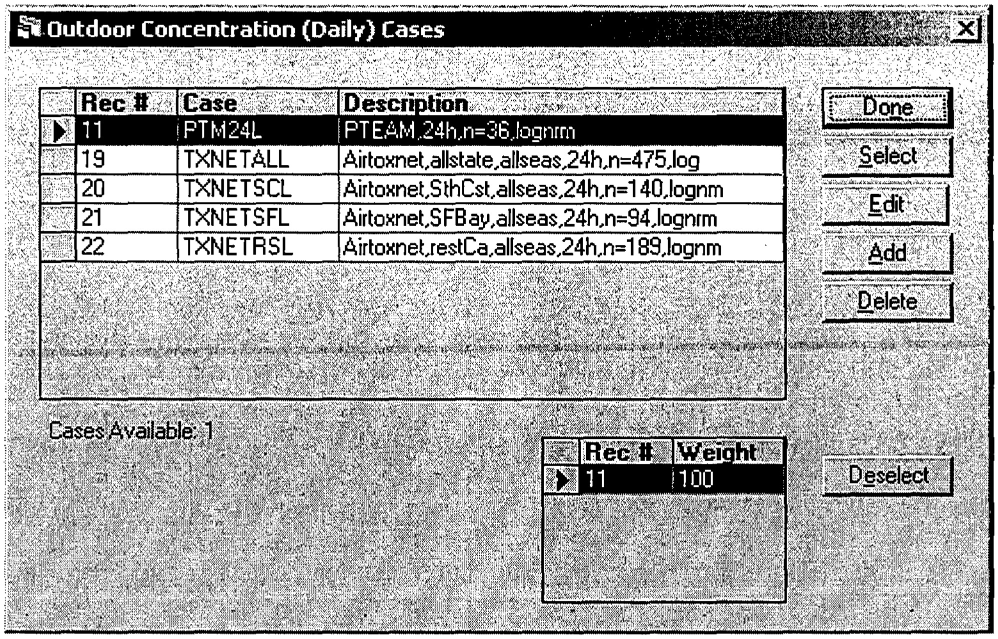


Figure 4-14 Outdoor Concentrations (Daily) case dialog box

4.3. Pollutant Removal Rates (Factor K)

This version of CPIEM allows the user to specify values for three separate pollutant removal rates, representing three different types of removal processes, or **Indoor-Sinks**. Each is expressed as a first-order decay rate with units of inverse hours, and conveys irreversible losses. to indoor sinks such as finishing materials and furnishings. In the absence of reliable information, conservative assumptions of zero for the removal rates (i.e., no pollutant removal) are advised.

4.3.1. Background

In addition to ventilation and filtration, pollutant mass may be removed from the air by (1) reactive decay with other compounds in the air or with surfaces (irreversible); (2) adsorption by surfaces; or (3) deposition to surfaces. It also may be added to the air by (4) deadsorption from surfaces or (5) resuspension from surfaces. The original version of CPIEM specified the removal rates for the first three processes with a single variable in the mass balance algorithm, "factor k", as follows.

$$V\frac{d}{dt}C_{in} = pQC_{out} + S - kVC_{in} - QC_{in} \qquad (4\text{-}1)$$

where:

C_{in}	=	indoor concentration (mass/volume)
p	=	penetration factor (dimensionless fraction)
Q	=	air flow rate (mass/time)

k	=	pollutant removal rate (1/time)
C_{out}	=	outdoor concentration (mass/volume)
S	=	indoor generation rate (mass/time)

Although the factor *k*'s for these removal processes function the same way in the mass balance algorithm, they are quite different and the associated rates correspond to different characteristics of the microenvironment. Common pathways for atmospheric decay indoors are reactions with hydroxyl radicals, ozone, or nitrate. The rates vary widely among pollutants. For example, in relatively unpolluted air (i.e., OH radical concentration of 0.05 ppt, ozone concentration of 0.06 ppm), 1,3-butadiene and cresol have expected atmospheric lifetimes of less than 6 hours, while benzene and carbon tetrachloride have expected atmospheric lifetimes of more than 60 days.

Most VOCs have negligible deposition to surfaces, but highly acidic, semivolatile, and polar compounds can have large deposition rates. Evidence of surface deposition may reflect either a chemical reaction with a surface, resulting in the transformation of the pollutant (an irreversible sink), or "deep" adsorption by surface material. "Deep" adsorption refers to a process by which a VOC is reversibly adsorbed by a surface material, but the rate of desorption is significantly longer than the time constant of the diurnal cycle of air concentrations. See section 4.3 of *Update and Refinement of a Population Exposure Methodology: Final Report* (Rosenbaum et al. 2002) for additional detail.

Deposition of pollutants onto surfaces reduces average ambient concentrations. This effect may be significant for particles. Dry deposition for most gaseous pollutants is slow, however, with the exception of highly acidic species such as hydrochloric acid (HCl) and polar compounds such as formaldehyde and cresol, as discussed above. Dry deposition rates for particles are primarily a function of particle size, and are much larger for coarse particles (those with diameters between 2.5 and 10 μm) than for fine particles (those smaller than 2.5 μm). Deposition of coarse particles is primarily a result of gravitational settling. However, for fine particles, deposition is a more complex phenomenon that depends upon the amount of turbulence near the surface, and the nature of the surface. Available information for deposition rates is often in the form of deposition velocities, i.e. m/sec. In order to estimate a removal rate (1/sec), the deposition velocity must be combined with information on the dimensions of the room. This calculation is currently done outside of the CPIEM model.

Note that the same pollutant may be subject to more than one of these processes. For example, formaldehyde is known to decay rapidly from photolysis (4 to 10 hour atmospheric lifetime), as well as from reaction with hydroxyl radicals (30 to 36 hour atmospheric lifetime), and possibly from reaction with nitrate radicals. It is also a polar compound subject to dry deposition.

The impacts on concentrations of de-adsorption and resuspension are similar to that of an indoor emission source, and thus they may be represented by similar terms in the mass balance algorithm. However a simpler approach, requiring less input data is to combine de-adsorption with adsorption, and to combine resuspension with deposition, so that the factor k terms represent net removal rates. This is typically how data are presented in the literature. We have implemented this latter approach.

In order to assure that the characterizations of these three removal processes are clear to the user, and to allow for the specification of more than one removal process for a single pollutant, separate terms to represent each process have been added to the mass balance algorithm. Thus, the user now has the option of specifying 3 separate rate constants for pollutant removal in units of 1/time as follows:

k_1 = reactive decay rate

k_2 = net surface adsorption rate (adsorption – de-adsorption)

k_3 = net deposition rate (deposition – resuspension)

Thus the governing relationship presented in equation 4-9 is modified as follows:

$$V\frac{d}{dt}C_{in} = pQC_{out} + S - (k_1 + k_2 + k_3)VC_{in} - QC_{in} \qquad (4\text{-}1a)$$

In cases where there is more than one removal process, the value for each *k* is selected independently from the specified distributions, which may be of different types. Thus, this formulation provides increased flexibility for characterizing the effects of removal processes on indoor concentrations.

As noted above, reactive decay and adsorption processes are most relevant to gases, and vary widely among compounds. Adsorption also varies according to the nature of the surface with which the compound makes contact. Deposition is most rapid for particles with the rate dependent on both the particle size and its degree of polarity. Highly polar compounds in the gaseous phase may also be subject to deposition.

The CPIEM database contains data on reactive decay for 3 pollutants, and on adsorption for one pollutant combined with 4 different surfaces. Although no particle deposition rate data that met the inclusion criteria were identified in time to incorporate into CPIEM2.0, such data can easily be added to the database by the user when identified.

4.3.2. Adding a Pollutant Sink Case

To add a new case to any of the pollutant sink rate, open the , click **Add.** CPIEM will display a new line with a default name. To select criteria to be use for this case, select that new line and then click **Edit**.

You can change the default name and description by selecting each in turn and typing a new name and description.

Follow the procedures below to select the criteria for the new case.

4.4. 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, except for data sets. (Note that although the input screens for adding data for volumes or air exchange rates indicate that data sets are allowed, this feature is not currently functional.)

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. A small number of data values are provided in the CPIEM data base. In the absence of reliable information, a conservative assumption of one for the penetration factor (i.e., no interception by the building envelope) is advised.

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.

4.5. Number of Trials and Random Number Seed

The "Number of Trials" functions similarly to that for the exposure/dose model. 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 random number seed that controls the sampling of values for the simulation, functions in the same manner as for the exposure/dose model. 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.

5. Executing Model Calculations

5.1. Running an Exposure/Doses Scenario

After you have finished selecting parameters within the Population Subgroup, Indoor Concentrations, and Breathing Rates dialog boxes, you can run the scenario.

From the **Exposure/Doses** menu, select **Run**.

CPIEM will display the Scenario Input Summary dialog box.

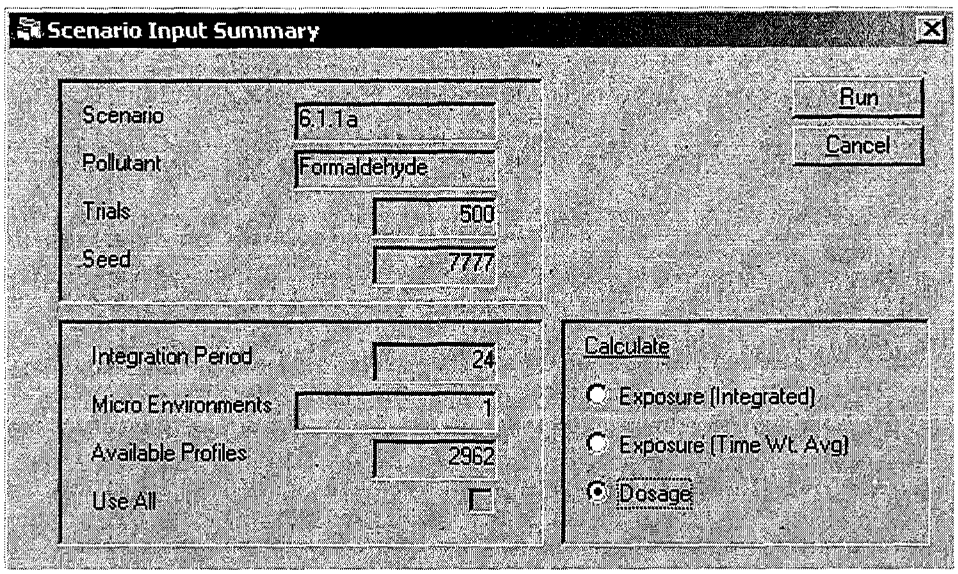


Figure 5-1 Scenario Input Summary dialog box

The Scenario Input Summary dialog box displays information about the parameters you have entered:

- Scenario name
- Pollutant
- Number of trails and seed number
- Integration period
- Which micro environments you selected, using the 1 through 9 code
- Number of available profiles
- Whether you opted to use all profiles

There is a box titled Calculate that contains the options you have for the kind of calculation that CPIEM will run. For the run, you can select:

- Exposure (Integrated)
- Exposure (Time Weighted Averaged)
- Dosage

If you want to calculate both exposure and dose, you must run the scenario twice, selecting exposure the first time and dosage the second time. Dosage is the default setting.

Select one of the options, and then click **Run**.

CPIEM will run the scenario using the parameters that you specified, and will present results of the run as:

- Graphical displays
- Data files

CPIEM will display graphics of the results in the PDF & CDF Plots dialog box.

CPIEM also generates data files that contain the numeric data for the run.

5.1.1. Graphical Display of Results

There are three views within the PDF & CDF Plots dialog box:

- Probability Density Function (PDF histogram)
- Cumulative Distribution Function (CDF)
- Data View

You can use the button marked 1/3, 2/3, and 3/3 to toggle between views. 1/3 is tne PDF, 2/3 is the CDF, and 3/3 is the data view. The PDF and CDF views contain the name of the scenario, in this case First, over the graphical display.

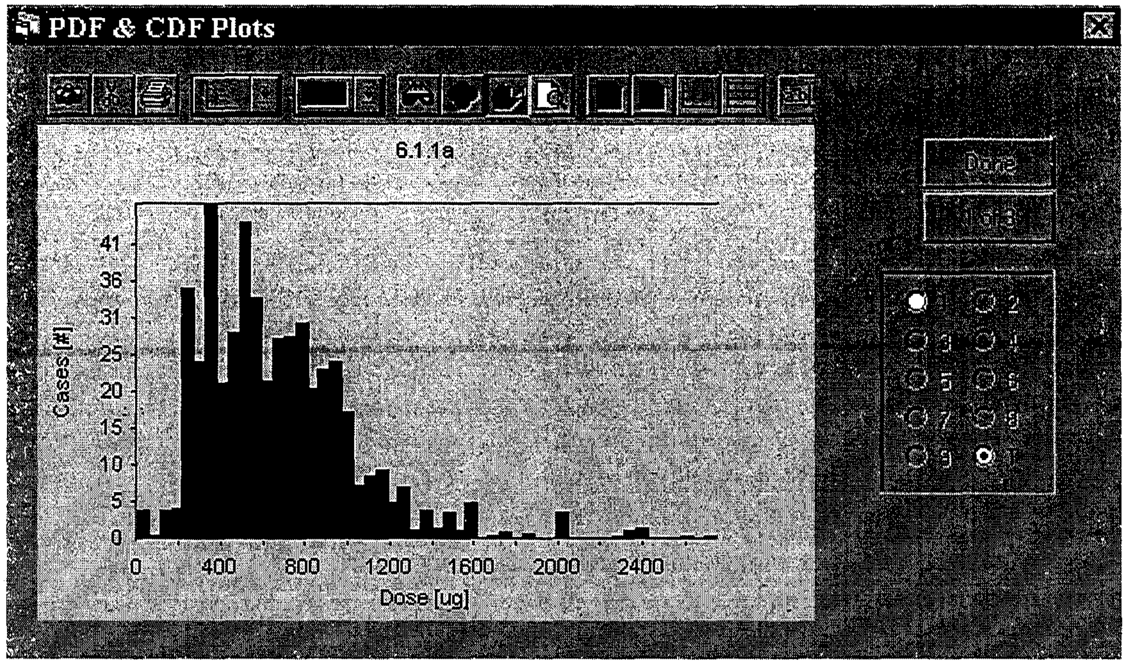


Figure 5-2 PDF & CDF Plots dialog box, Probability Density Function view

The **Probability Density Function** view shows a bar chart by case number and dosage by the unit of pollutant that you selected for this run: milligram (mg), microgram (ug), or nanogram (ng).

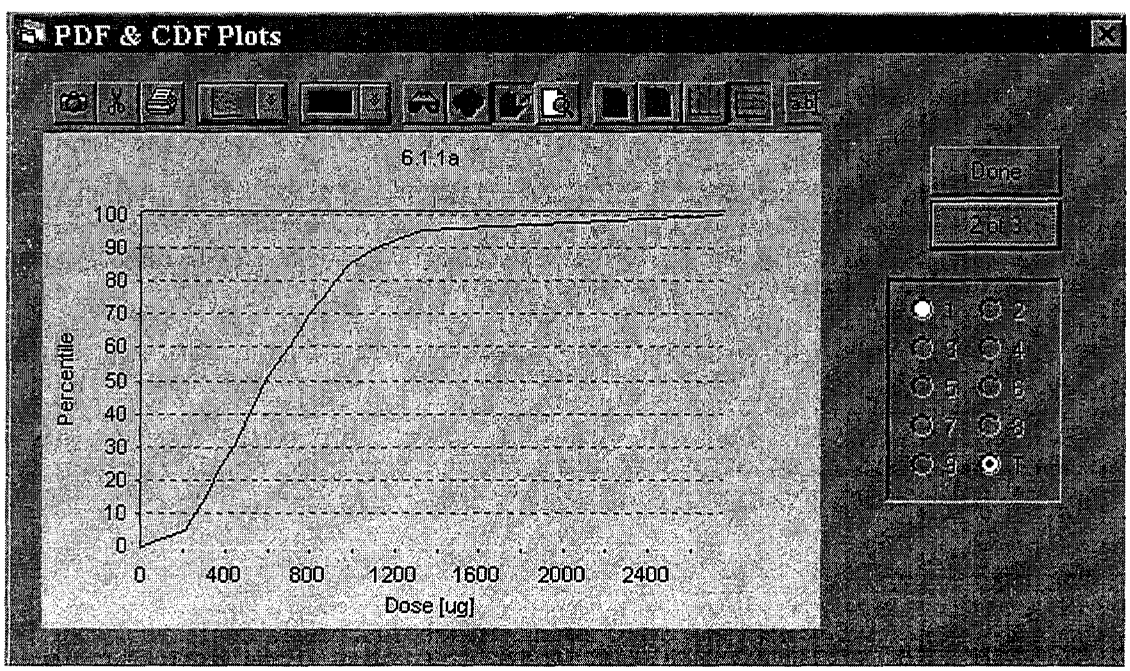


Figure 5-3 PDF & CDF Plots dialog box, Cumulative Distribution Function view

The **Cumulative Distribution Function** view shows a line chart by percentile of cases and dosage by the unit of pollutant that you selected for this run: milligram (mg), microgram (ug), or nanogram (ng).

Both views have a number of buttons that can be used to change the presentation of the information and which help you record, save, and print the information.

From left to right the buttons are:

Copy Snapshot button that copies the information to the clipboard as a bitmap

Button that copies numeric data to the clipboard

Print button that prints the information as text to your default printer

Three-dimensional button that toggles between a flat and a three-dimensional display of the graphics in the chart

Zoom button that can be used to change the size of the display of the chart

Show Legend button that toggles between showing and hiding the chart legends

Vertical Grid button that can be used to display or hide a vertical grid in the chart

Horizontal Grid button that can be used to display or hide a horizontal grid in the chart

Edit Titles button that can be used to change the titles in the chart

You can use the buttons described above to make changes to the presentation and then copy the information as a bitmap and paste this information into Windows applications such as Word or PowerPoint.

Do not click any menu on the main screen until you have finished saving or printing the information you want for this run. The graphics of the run calculations will be cleared, and you must rerun the scenario to have the information displayed again.

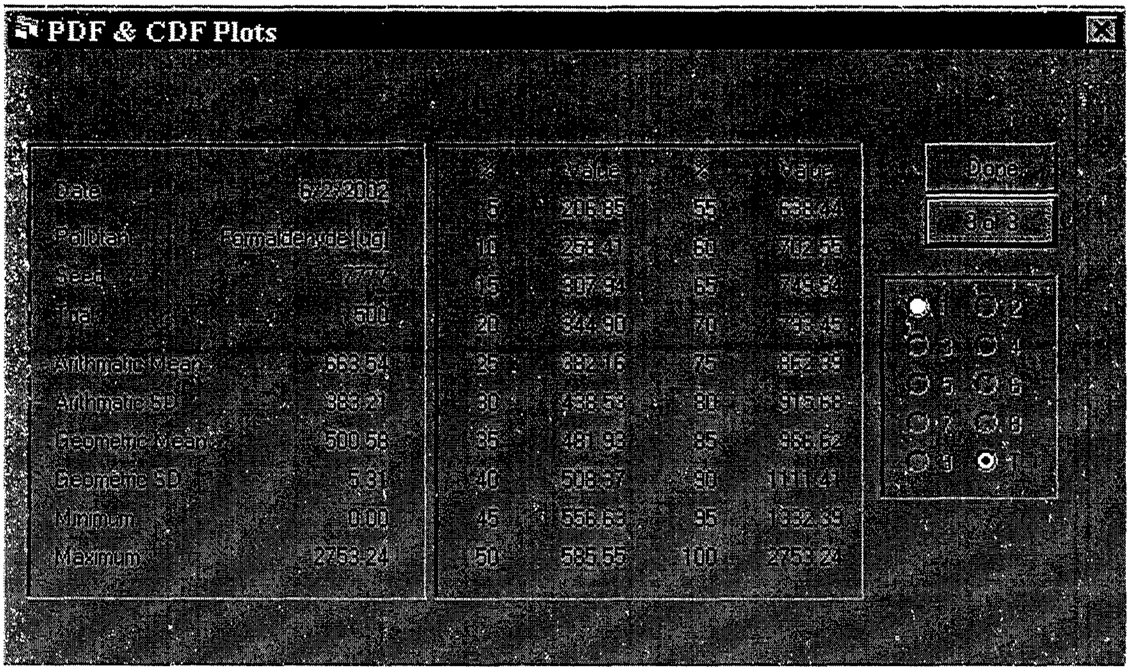


Figure 5-4 PDF & CDF Plots dialog box, data view

The **Data View** contains much of the information that is covered in the data files.

5.1.2. Data Files Containing Results

CPIEM generates ANSI data files in a directory named Data that is located in the CPIEM program file directory.

There are two files created for each run:

A statistics data file with an extension of **.std** if the run was calculating dosage, or **.ste** if the run was calculating exposure.

A detailed data file that has an extension of **.prn**.

Each file has a default name that uses the first six letters of the name of the scenario.

```
Title:        6.1.1a
Description: 6.1.1 a (Residence)
Pollutant:   Formaldehyde (ug)
Int. Period: 24
Trials:       500   (2962)
Random seed:  7777


Residential (ENV1)
        Case #    Weight
           45        1
Breathing Rates
        Case #    Weight
            1        1


                              ENV1      TOTALS

Arith Mean                  663.54      663.54
Arith Std Dev               383.21      383.21
Geo Mean                    500.58      500.58
Geo Std Dev                   5.31        5.31
Minimum                       0.00        0.00
Maximum                    2753.24     2753.24

       5%                   206.85      206.85
      10%                   258.41      258.41
      15%                   307.94      307.94
      20%                   344.90      344.90
      25%                   382.16      382.16
      30%                   438.53      438.53
      35%                   481.93      481.93
      40%                   508.37      508.37
      45%                   556.63      556.63
      50%                   585.55      585.55
      55%                   638.44      638.44
      60%                   702.55      702.55
      65%                   749.54      749.54
      70%                   793.45      793.45
      75%                   862.39      862.39
      80%                   915.68      915.68
      85%                   986.62      986.62
      90%                  1111.41     1111.41
      95%                  1332.39     1332.39
     100%                  2753.24     2753.24
```

Figure 5-5 Example of a Statistics Output File for Doses

The statistics data file contains statistics for the arithmetic mean and standard deviation, geometric mean and standard deviation, minimum, maximum, and various percentiles of the exposure or dose distribution.

1	48521	1	2.506	18.20	615.93	505.94
2	63995	3	0.200	24.00	1225.15	770.82
3	20181	1	1.020	18.83	1293.42	156.07
4	56805	3	0.172	15.25	1861.84	960.43
5	47311	2	0.762	21.00	1255.16	717.23
6	1581	2	1.296	21.25	368.29	318.90
7	60111	2	0.626	19.17	649.62	546.81
8	63665	3	0.254	23.00	1707.19	716.28
9	64125	3	0.200	24.00	540.44	283.73
10	53965	3	0.371	12.25	817.83	337.15
11	30581	1	0.226	17.25	1524.04	1314.21
12	4421	2	0.181	14.50	873.75	457.97
13	8901	2	0.648	19.67	946.10	660.66
14	6281	1	2.593	7.42	713.42	448.89
15	48475	3	0.054	19.72	1516.77	755.05
16	42165	3	0.377	20.00	792.78	381.53
17	31585	3	0.166	18.00	2157.90	917.11
18	5041	2	0.648	16.50	285.90	214.86
19	1403	1	0.270	21.00	2408.10	1691.40
20	26281	2	0.453	15.83	925.00	488.79
21	23315	3	0.067	11.47	473.11	273.62
22	46891	1	0.184	21.00	1487.19	1168.51
23	62761	1	0.626	15.25	1642.90	1216.46
24	5661	1	0.972	15.08	1924.42	1467.24
25	45835	3	0.100	14.25	673.32	349.26
26	41015	3	0.201	18.08	1277.58	587.57
27	1851	2	0.294	9.50	462.64	370.11
28	39205	3	0.147	.00	.00	.00
29	62051	2	3.760	18.25	566.33	353.76
30	31553	2	0.365	14.83	990.05	518.39
31	5181	2	0.294	17.00	1209.29	924.75
32	65065	3	0.150	23.00	1274.21	659.27
33	15491	1	0.181	19.50	1385.51	1110.19
34	65351	2	2.129	19.25	1243.10	865.33
35	15531	2	1.296	17.17	736.82	477.86
36	63771	2	0.626	22.50	1514.10	861.36
37	29291	1	0.334	11.98	1015.72	750.84
38	66031	2	0.313	16.80	1024.88	617.37
39	27471	1	2.041	19.97	1185.47	926.71

Figure 5-6 Example of First 50 Records of a Detailed Output file

The detailed file contains columns of numeric data. The fixed-column numeric format for the detailed file allows it to be readily imported into spreadsheet software.

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 second field contains the case ID number that is the identifier assigned by ARB to individuals who participated in the activity surveys.

The third filed is the sex/age field, which 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 fourth field is the time-weight field, developed by ARB staff to compensate for unequal selection probabilities among participants in the activity surveys. It is used by the model to develop weighted summary statistics.

The fifth field contains the amount of time in the environment.

The sixth field contains the time-integrated exposure.

The seventh field contains the potential inhaled dose for each environment selected by the user.

For the example above, the user chose only one environment (residential). If additional environments were selected the information in fields 5 through 7 would be repeated for each one, starting with an eighth column.

5.2. Running an Indoor Concentrations Calculations Scenario

After you have entered all information in the sections in the Concentrations menu (see Section 4.5), you can run the scenario. Select **Run** from the **Concentrations** menu. CPIEM will display the Scenario Input Summary dialog box.

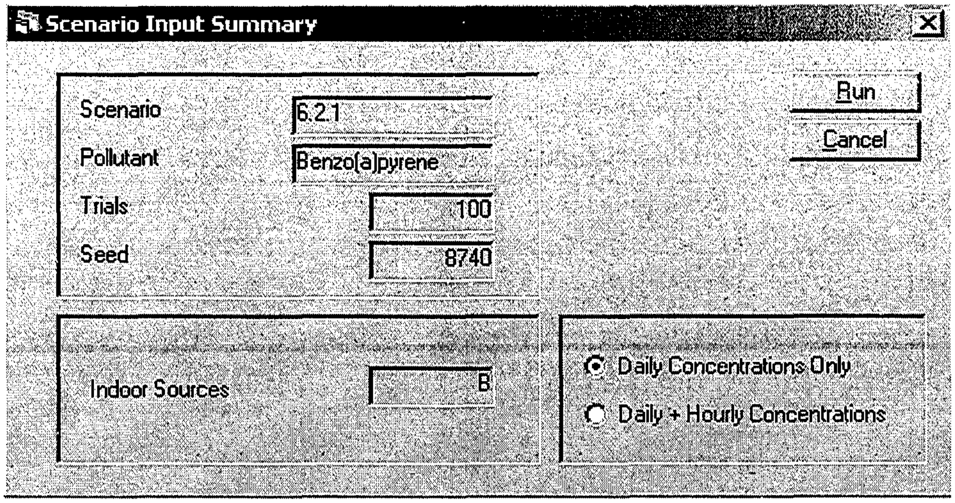


Figure 5-7 Scenario Input Summary dialog box

The Scenario Input Summary dialog box displays information about the parameters you have entered:

- Scenario name
- Pollutant
- Number of trails and seed number
- Integration period
- Which indoor source type you selected, using the A through F code

You can instruct CPIEM 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.

You must have selected at least one type of indoor source to perform concentration calculations. If you try to run the scenario without selecting any indoor sources, then a warning message will be displayed and you will be directed to supply the missing information.

Note that if you want to run a scenario with no indoor sources (to assess the impact of outdoor concentrations on indoor levels), then you can select one type of indoor source and set the emission rate to zero for that source.

Click **Run**, and CPIEM will run the scenario using the information you provided. CPIEM will display results using the same three views within the PDF & CDF Plots dialog box as for Exposure/Doses:

- Probability Density Function (PDF histogram)
- Cumulative Distribution Function (CDF)
- Data View

You can use the button marked 1/3, 2/3, and 3/3 to toggle between views. 1/3 is the PDF, 2/3 is the CDF, and 3/3 is the data view. The PDF and CDF views contain the name of the scenario over the graphical display.

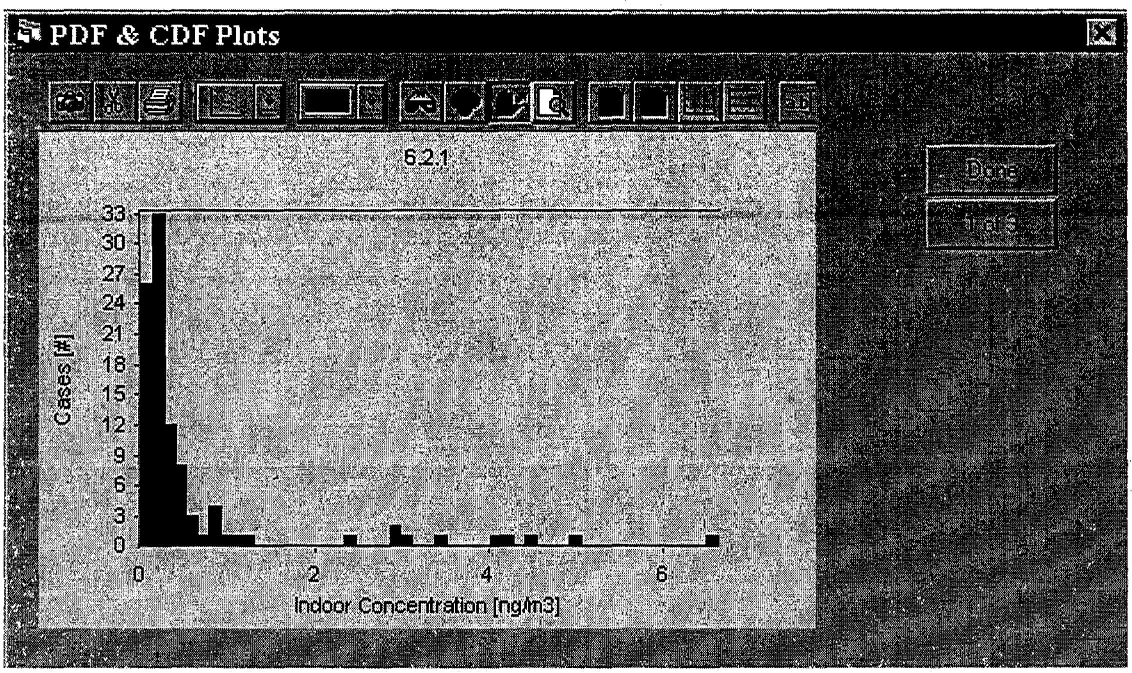


Figure 5-8 PDF & CDF Plots dialog box, Probability Density Function view

The **Probability Density Function** view shows a bar chart by case number and dosage by the unit of pollutant that you selected for this run: milligram (mg), microgram (ug), or nanogram (ng).

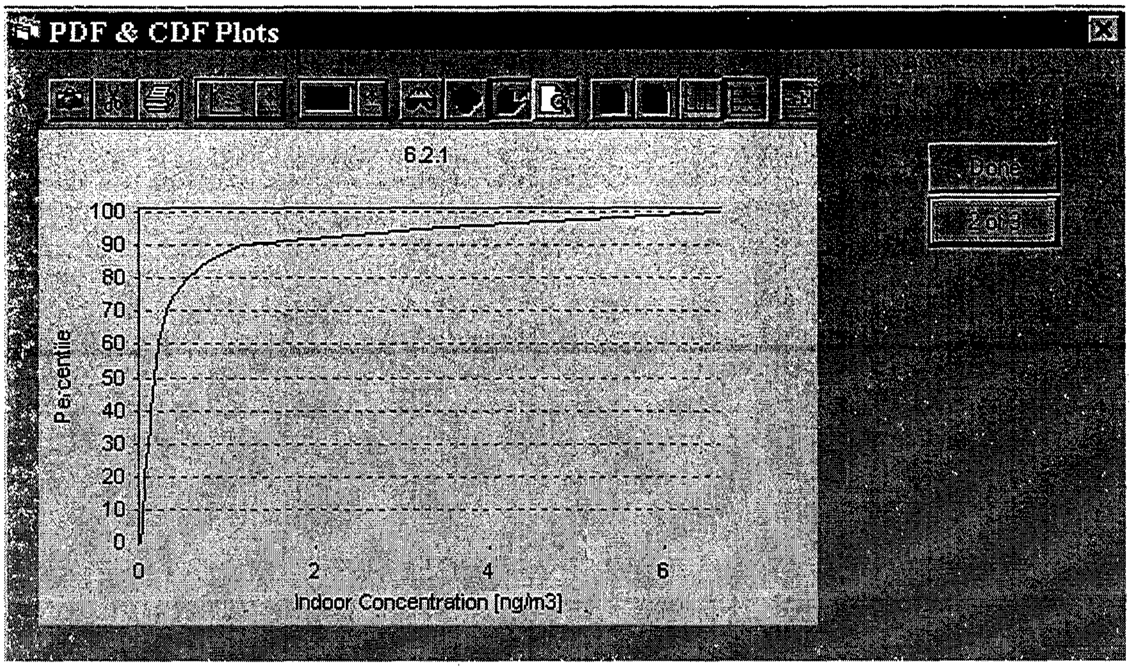


Figure 5-9 PDF & CDF Plots dialog box, Cumulative Distribution Function view

The **Cumulative Distribution Function** view shows a line chart by percentile of cases and indoor concentrations by the unit of pollutant that you selected for this run per unit volume: mg/m3, ug/m3, or ng/m3.

Similarly, both views have a number of buttons that can be used to change the presentation of the information and which help you record, save, and print the information.

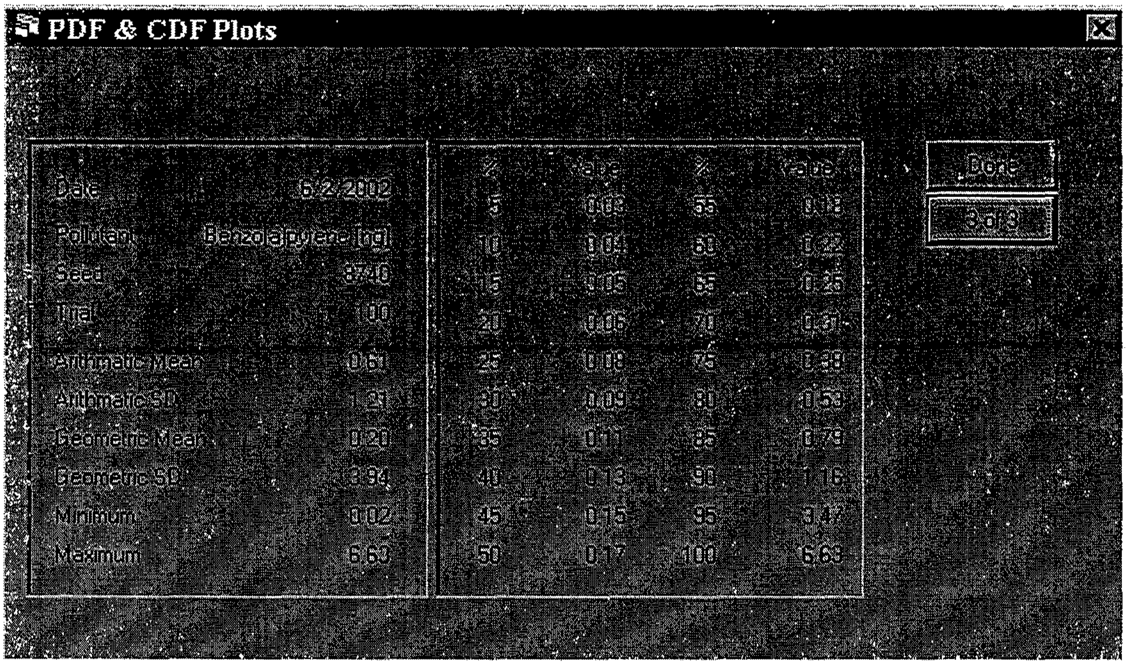


Figure 5-10 PDF & CDF Plots dialog box, Data view

CPIEM also provides the option to calculate and display hourly concentrations in addition to the daily, if this option is selected prior to the run. Note that the hourly-concentration graph is smoother than that for daily concentrations because it is based on 24 times the number of observations (replicates).

The statistics file (Figure 5-11), with an extension of .stc, contains the statistics displayed in Figures 5-8 and 5-9. The detailed file (*.asc) contains the index (trial) number, average concentrations for each of 24 hours,

```
Title:        6.2.1
Description: 6.2.1 Long Term Source
Pollutant:    Benzo(a)pyrene (ng)
Trials:        100
Random seed:  8740
Indoor Source: B
       Case #
            4
Outdoor Concentration (Daily)
        Case #    Weight
           11          1
Penetration Factor
        Case #    Weight
            4          1
Indoor Sink - Reactive Decay Rate
        Case #    Weight
            4          1
Volume
        Case #    Weight
            3       0.34
            4       0.33
            5       0.33
Air Exchange Rate
        Case #    Weight
           10          1
Indoor Sink - Adsorption Rate
        Case #    Weight
            4          0
Indoor Sink - Deposition Rate
        Case #    Weight
            4          0
                               DAILY
Arith Mean                      0.61
Arith Std Dev                   1.21
Geo Mean                        0.20
Geo Std Dev                     3.94
Minimum                         0.02
Maximum                         6.63
       5%                       0.03
      10%                       0.04
      15%                       0.05
      20%                       0.06
      25%                       0.08
      30%                       0.09
      35%                       0.11
      40%                       0.13
      45%                       0.15
      50%                       0.17
      55%                       0.18
      60%                       0.22
      65%                       0.25
      70%                       0.31
      75%                       0.38
      80%                       0.53
      85%                       0.79
      90%                       1.16
      95%                       3.47
     100%                       6.63
```

Figure 5-11 Example of Statistics 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 17 hours. The concentrations are identical across hours for each trial because a constant, long-term indoor source was chosen.

```
 1 .31  .31  .31  .31  .31  .31  .31  .31  .31  .31  .31  .31  .31  .31  .31  .31  .31
```

```
 2 .22  .22  .22  .22  .22  .22  .22  .22  .22  .22  .22  .22  .22  .22  .22  .22  .22

 3 .38  .38  .38  .38  .38  .38  .38  .38  .38  .38  .38  .38  .38  .38  .38  .38  .38
 4 .15  .15  .15  .15  .15  .15  .15  .15  .15  .15  .15  .15  .15  .15  .15  .15  .15

 5 .03  .03  .03  .03  .03  .03  .03  .03  .03  .03  .03  .03  .03  .03  .03  .03  .03

 6 .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06  .06

 7 .30  .30  .30  .30  .30  .30  .30  .30  .30  .30  .30  .30  .30  .30  .30  .30  .30

 82.45 2.45 2.45 2.45 2.45 2.45 2.45 2.45 2.45 2.45 2.45 2.45 2.45 2.45 2.45 2.45 2.45

 9 .79  .79  .79  .79  .79  .79  .79  .79  .79  .79  .79  .79  .79  .79  .79  .79  .79

10 .15  .15  .15  .15  .15  .15  .15  .15  .15  .15  .15  .15  .15  .15  .15  .15  .15

11 .19  .19  .19  .19  .19  .19  .19  .19  .19  .19  .19  .19  .19  .19  .19  .19  .19

122.94 2.94 2.94 2.94 2.94 2.94 2.94 2.94 2.94 2.94 2.94 2.94 2.94 2.94 2.94 2.94 2.94

13 .09  .09  .09  .09  .09  .09  .09  .09  .09  .09  .09  .09  .09  .09  .09  .09  .09

14 .04  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04

15 .26  .26  .26  .26  .26  .26  .26  .26  .26  .26  .26  .26  .26  .26  .26  .26  .26

16 .03  .03  .03  .03  .03  .03  .03  .03  .03  .03  .03  .03  .03  .03  .03  .03  .03

17 .96  .96  .96  .96  .96  .96  .96  .96  .96  .96  .96  .96  .96  .96  .96  .96  .96

18 .17  .17  .17  .17  .17  .17  .17  .17  .17  .17  .17  .17  .17  .17  .17  .17  .17

19 .24  .24  .24  .24  .24  .24  .24  .24  .24  .24  .24  .24  .24  .24  .24  .24  .24

20 .10  .10  .10  .10  .10  .10  .10  .10  .10  .10  .10  .10  .10  .10  .10  .10  .10

21 .61  .61  .61  .61  .61  .61  .61  .61  .61  .61  .61  .61  .61  .61  .61  .61  .61

22 .24  .24  .24  .24  .24  .24  .24  .24  .24  .24  .24  .24  .24  .24  .24  .24  .24

23 .18  .18  .18  .18  .18  .18  .18  .18  .18  .18  .18  .18  .18  .18  .18  .18  .18

24 .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08

25 .04  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04  .04

26 .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08

27 .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08

284.25 4.25 4.25 4.25 4.25 4.25 4.25 4.25 4.25 4.25 4.25 4.25 4.25 4.25 4.25 4.25 4.25

29 .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08  .08
30 .14  .14  .14  .14  .14  .14  .14  .14  .14  .14  .14  .14  .14  .14  .14  .14  .14

31 .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05  .05

32 .38  .38  .38  .38  .38  .38  .38  .38  .38  .38  .38  .38  .38  .38  .38  .38  .38
```

Figure 5-12 Example of Part of a Detailed Output File for Concentrations

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6. 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 example run, 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 number of trials, and concentration inputs were provided for one environment—residential. A lognormal distribution was chosen, for which the arithmetic mean and standard deviation were specified. A random number seed of 7777 was chosen. The option to calculate dosage was chosen.

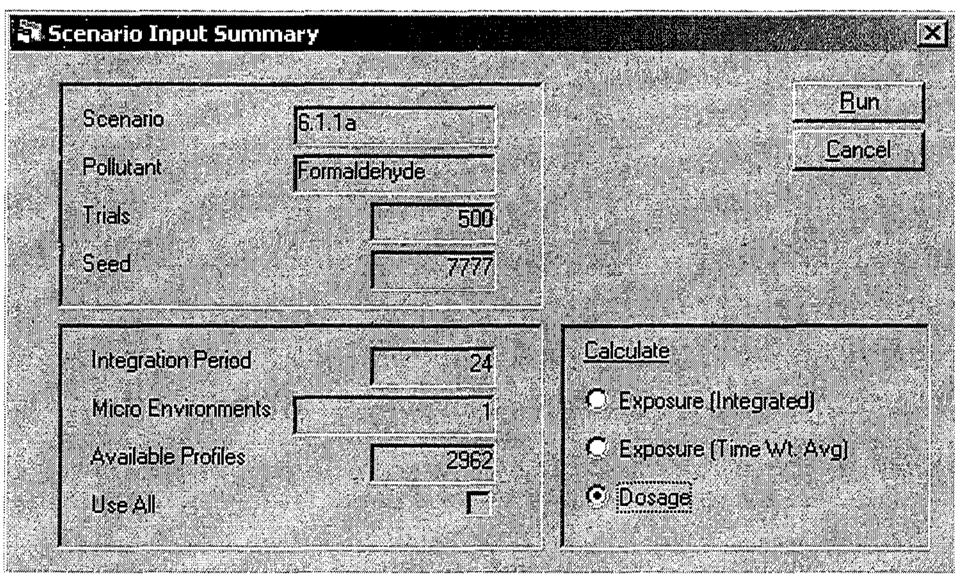

Figure 6-1 Scenario Input Summary for 6.1.1a example

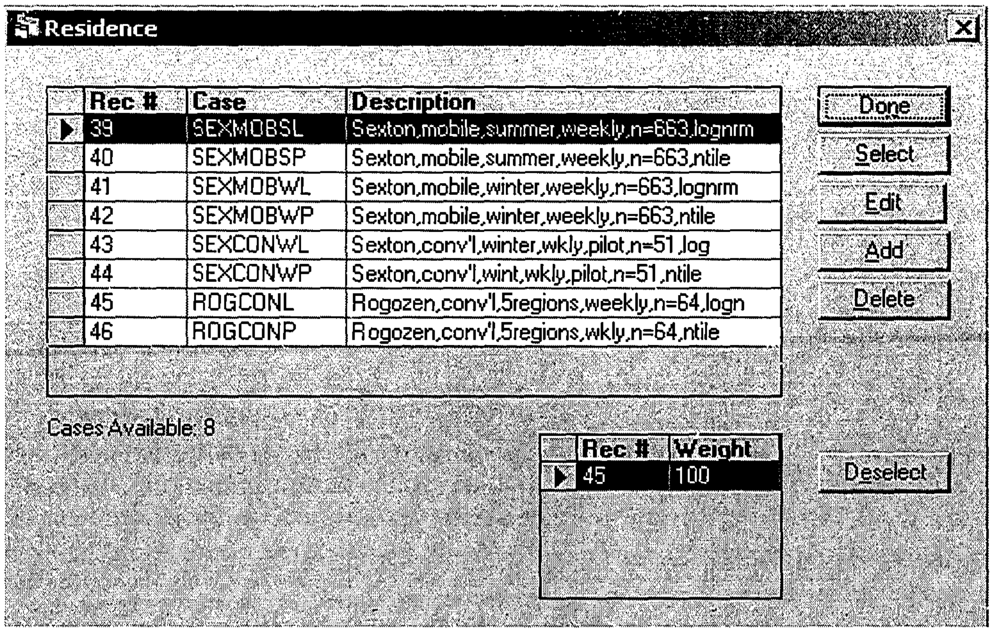

Figure 6-2 Weights for residences in 6.1.1a example

The results of the model run are shown in the figure below.

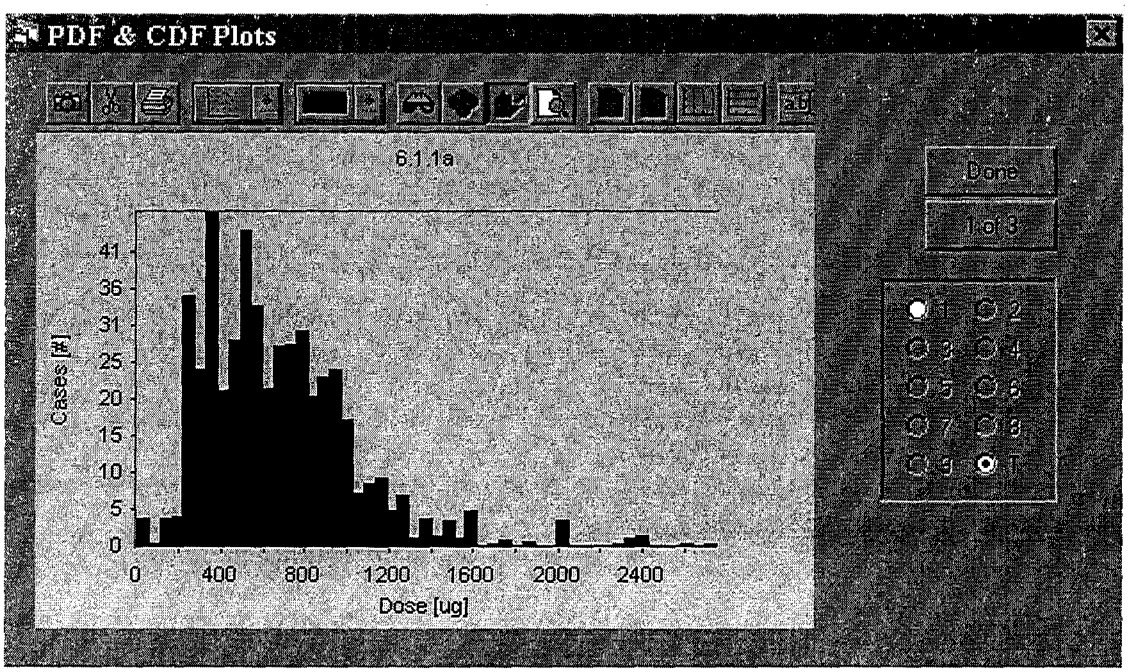

Figure 6-3 Probability density function graph of results for 6.1.1a example

The information below the PDF plot indicates the dosage of the pollutant, and the number of cases. The results include an arithmetic mean dose of 663.5 µg and a geometric mean dose of 500.6 µg. The shape of the PDF is consistent with that deriving from a lognormal distribution.

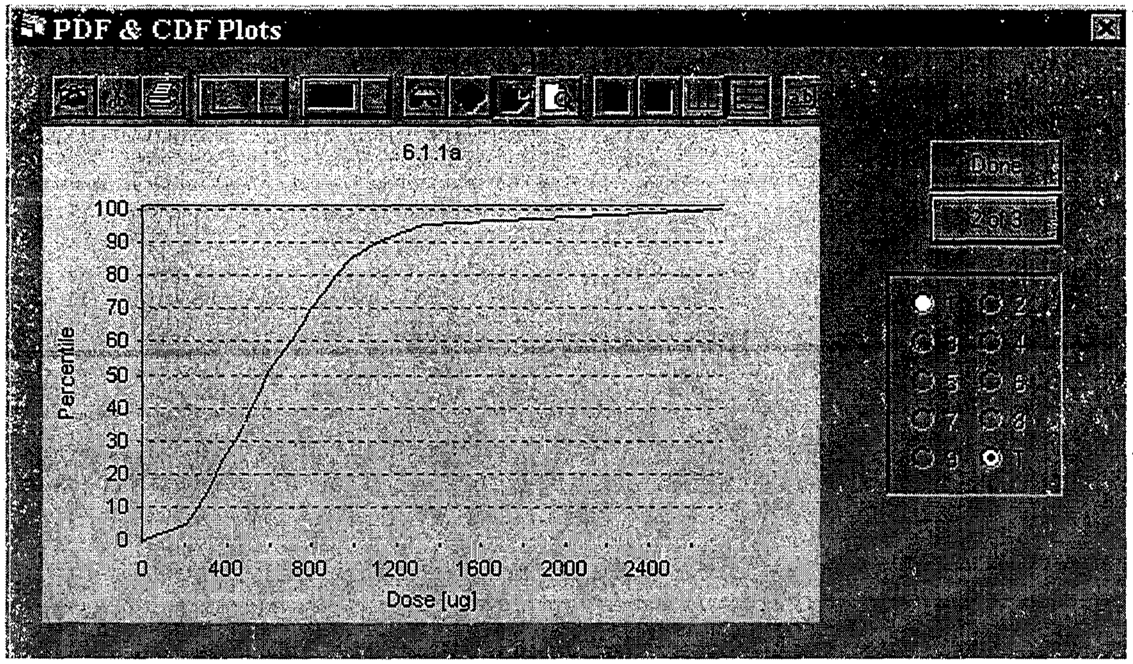

Figure 6-4 Cumulative distribution function graph of results for 6.1.1a example

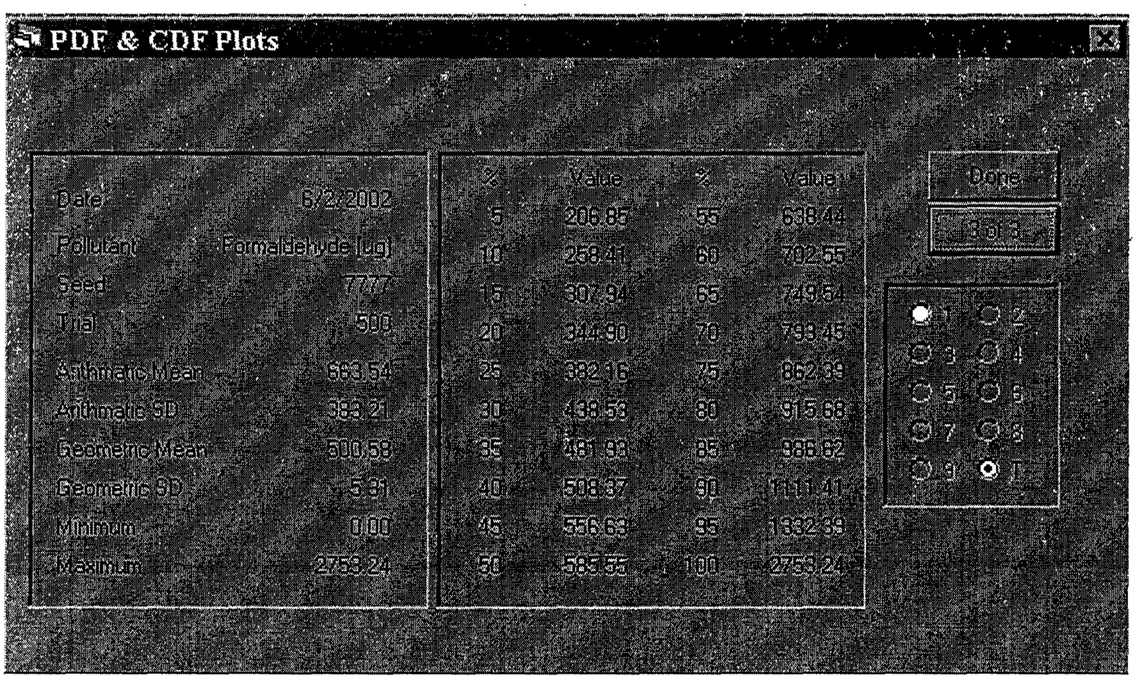

Figure 6-5 Statistical Summary for 6.1.1a example

For the second example, shown below, residential was again selected as the only environment. In this case, however, four concentration distributions were loaded, with each described as lognormal. Weights were assigned to the four distributions as shown. The last two distributions pertain to conventional houses, which account for about 96 percent of the California population.