USER'S GUIDE FOR CAP88-PC

VERSION 1.0

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INTRODUCTION

1.1   BACKGROUND

On October 31, 1989 the Environmental Protection Agency (EPA) issued final rules for radionuclide emissions to air under 40 CFR Part 61, National Emission Standards for Hazardous Air Pollutants (NESHAPS). Emission monitoring and compliance procedures for Department of Energy (DOE) facilities (40 CFR 61.93(a)) require the use of CAP-88 or AIRDOS-PC computer models, or other approved procedures, to calculate effective dose equivalents to members of the public.

The CAP-88 (which stands for Clean Air Act Assessment Package-1988) computer model is a set of computer programs, databases and associated utility programs for estimation of dose and risk from radionuclide emissions to air. CAP-88 is composed of modified versions of AIRDOS-EPA (Mo79) and DARTAB (ORNL5692). The original CAP-88 program is written in FORTRAN77 and has been compiled and run on an IBM 3090 under OS/VS2, using the IBM FORTRAN compiler, at the EPA National Computer Center in Research Triangle Park, NC. CAP-88 is distributed by the Oak Ridge National Laboratory Radiation Shielding Information Center (RSIC).

1.2   PURPOSE

The CAP88-PC software package allows users to perform full-featured dose and risk assessments in a personal computer environment for the purpose of demonstrating compliance with 40 CFR 61.93(a). CAP88-PC provides the CAP-88 methodology for assessments of both collective populations and maximally-exposed individuals, and allows users to edit all environmental transport variables. The complete set of dose and risk factors, census data, and stability array data used in CAP-88 is provided. CAP88-PC differs from the dose assessment software AIRDOS-PC in that it estimates risk as well as dose, it offers a wider selection of radionuclide and meteorological data, it provides the capability for collective population assessments, and it allows users greater freedom to alter values of environmental transport variables.

There are a few differences between CAP-88 and earlier versions of the mainframe programs AIRDOS-EPA, PREPAR and DARTAB with which users may be familiar. These differences are discussed separately in Appendix E.

1.3   MODEL SUMMARY

CAP88-PC uses a modified Gaussian plume equation to estimate the average dispersion of radionuclides released from up to six sources. The sources may be either

elevated stacks, such as a smokestack, or uniform area sources, such as a pile of uranium mill tailings. Plume rise can be calculated assuming either a momentum or buoyancy-driven plume. Assessments are done for a circular grid of distances and directions with a radius of 80 kilometers (50 miles) around the facility.

The program computes radionuclide concentrations in air, rates of deposition on ground surfaces, concentrations in food and intake rates to people from ingestion of food produced in the assessment area. Estimates of the radionuclide concentrations in produce, leafy vegetables, milk and meat consumed by humans are made by coupling the output of the atmospheric transport models with the U.S. Nuclear Regulatory Commission Regulatory Guide 1.109 terrestrial food chain models.

CAP88-PC uses population arrays in the same format as the main frame CAP88 Program. Sample population distributions for several DOE facilities are provided with CAP88-PC which were generated from a database of 1980 census data. Since census enumeration districts vary widely in size, the database is not precise at estimating population groups close in to a facility. Accordingly, the arrays can be modified with user-supplied supplemental data obtained from on-site population surveys. Distributions of beef cattle, milk cattle and crop productivity are generated by the program for the assessment area using average agricultural productivity data for each of the fifty States. A library of meteorological data for dispersion estimates is supplied with CAP88-PC for most major cities and DOE facilities.

Dose and risk are estimated by combining the inhalation and ingestion intake rates, air and ground surface concentrations with the dose and risk conversion factors used in CAP-88. The effective dose equivalent is calculated using the weighting factors in ICRP Publication 26. Risks are based on lifetime risk from lifetime exposure, with a nominal value of 4E-4 cancers/rem. Doses and risks can be tabulated as a function of radionuclide, pathway, location and organ. CAP88-PC also tabulates the frequency distribution of risk, showing the number of people at various levels of risk. The risk levels are divided into orders of magnitude, from one in ten to one in a million.

The mathematical models and equations used in CAP88-PC are discussed in detail in the "Mathematical Models" section.

1.4   VERIFICATION

The CAP88-PC programs represent the best available verified codes for the purpose of making comprehensive dose and risk assessments. The Gaussian plume model used in CAP88-PC to estimate dispersion of radionuclides in air is one of the most commonly used models in Government guidebooks. It produces results that agree with experimental data as well as any model, is fairly easy to work with, and is consistent with the random nature of turbulence.

The Office of Radiation Programs has made comparisons between the predictions of annual-average ground-level concentration to actual environmental measurements, and found very good agreement. In the recent paper "Comparison of AIRDOS-EPA Prediction of Ground-Level Airborne Radionuclide Concentrations to Measured Values" (Be86), environmental monitoring data at five Department of Energy (DOE) sites were compared to AIRDOS-EPA predictions. EPA concluded that as often as not, AIRDOS-EPA predictions are within a factor of 2 of actual concentrations.

1.5   LIMITATIONS

Like all models, there are some limitations in the CAP88-PC system. EPA plans to make improvements on a continuing basis as new techniques become available.

While up to six stack or area sources can be modeled, all the sources are modeled as if located at the same point; that is, stacks cannot be located in different areas of a facility. The same plume rise mechanism (buoyant or momentum) is used for each source. Also, area sources are treated as uniform. Variation in radionuclide concentrations due to complex terrain cannot be modeled; all assessments assume a flat plain.

Errors arising from these assumptions will have a negligible effect for assessments where the distance to exposed individuals is large compared to the stack height, area or facility size.

Dose and risk estimates from CAP88-PC are applicable only to low-level chronic exposures, since the health effects and dosimetric data are based on low-level chronic intakes. CAP88-PC cannot be used for either short-term or high-level radionuclide intakes.

1.6   HARDWARE ENVIRONMENT

The following is a description of the hardware which will be required to use this software system.

Computer:

  !   DOS (Disk Operating System) version 2.0 or higher

  !   IBM PC AT or compatible

  !   At least 640K RAM with a minimum of 500K free (the memory required for CAP88-PC to complete an assessment may vary from machine to machine and more complex assessments may require more available RAM.)

!   Either a 1.2M 5.25 inch or 1.4M 3.5 inch high density floppy disk drive and a hard (fixed) disk drive.

!   A Parallel communications port (used for printer IO)

!   Intel 80x87 math coprocessor chip

      NOTE: The CAP88-PC software will malfunction if a math coprocessor is not present. The computer may freeze and require the user to reboot the machine.

Display:

!   EGA or VGA color monitor

Printer:

!   Any parallel printer compatible with the system and connected to LPT1.   Other printers may work, but we cannot guarantee the results.

1.7   USER PROFILE

Users of this software package should have some familiarity with personal computers and DOS. They should understand basic DOS commands such as DIR (Directory), CD (Change Directory), and COPY, and know how to format and use diskettes. For more information on these topics consult a DOS user's manual. It is assumed that users have a working knowledge of the computer programs CAP88, AIRDOS-EPA, and DARTAB.

This software is intended for use by health physicists experienced in dose assessment. The following references are recommended:

Briggs, G.A., "Plume Rise, AEC Critical Review Series", TID- 25075, 1969.

EPA 520/1-89-005 Risk Assessment Methodology: Draft Environmental Impact Statement for Proposed NESHAPS for Radionuclides, Volume 1, Background Information Document, United States Environmental Protection Agency, Office of Radiation Programs, Washington, D.C. 20460, February 1989.

Gifford, F.A., Jr., "Turbulent diffusion-typing schemes: A review", Nuclear Safety 17(1):68-86, 1976

Moore, R.E., Baes, C.F.III, McDowell-Boyer, L.M., Watson, A.P., Hoffman, F.O., Pleasant, J.C., Miller, C.W., "AIRDOS-EPA: A Computerized Methodology for Estimating Environmental Concentrations and Dose to Man from Airborne Releases of Radionuclides", (Reprint of ORNL-5532), EPA 520/1-79-009, U.S. EPA Office of Radiation Programs, Washington, D.C., 20460.

Pasquill, F., "The Estimation of the Dispersion of Windborne Material", Meteorology Magazine, 90:33, 1961.

Rupp, E.M., Beall, S.E., Bornwasser, L.P., Johnson, D.H., "Dilution of Stack Gases in Cross Winds", USAEC Report AECD-1811 (CE-1620), Clinton Laboratories, 1948.

Turner, D.B. "Workbook of Atmospheric Dispersion Estimates", Air Pollution Control Administration, Cincinnati, Ohio, 1969.

1.8   TYPOGRAPHIC CONVENTIONS

Throughout this manual the following conventions and terminology are used:

!   Double quotes are used to define terminology.

!   Bold text inside angle brackets (<>) signifies a single press of a specific keyboard key. The following are examples of some of the keys represented by this convention:

> <**Enter**>   Enter/Return key
> <**Insert**>   Insert key
> <**Home**>   Home key
> <**Delete**>   Delete Key

!   An uppercase bold-faced word that is present as part of a command is a keyword or filename that must be typed exactly as shown. Lowercase is used for names that vary or that the user supplies to the program.

!   The up, down, left, and right arrow keys are referred to as "cursor keys".

!   A collection of data contained within a single file that is used to perform an assessment is referred to as a "dataset".

Chapter 2

INSTALLING THE SYSTEM

CAP88-PC is designed to be installed on a personal computer with an EGA or VGA monitor, a math coprocessor and a hard drive.

2.1   BEFORE INSTALLATION

2.1.1   Backups

Before installing the system, we recommend that you create a backup of the original installation disk using the DOS command DISKCOPY. Since the contents of the installation disk are compressed, the COPY command cannot be used. Use the backup to install the system. If for any reason the backup becomes corrupted, you will have the original distribution disk intact.

2.1.2   System Requirements

The configuration file (CONFIG.SYS) is a file that contains certain commands that DOS checks when you start up your computer. Each time you start DOS, it searches the root directory of the drive in which it was started for a file named CONFIG.SYS. The **config.sys** file lets you change your system's default configuration settings.

It is important to have the following lines in your CONFIG.SYS file:

        Files   = 20
        Buffers   = 20

The Files command sets the number of open files that DOS can access. The Buffers command sets the number of disk buffers for DOS to allocate in memory at the time the computer is booted (a disk buffer is a block of memory that DOS user to hold data when reading or writing). A number greater that 20 may be assigned using the Buffers command. Since each additional buffer takes up memory, if there are significantly more than 20, the memory they consume may not allow CAP88-PC to load in memory or at some point during execution there may not be enough memory for CAP88-PC to complete execution. If this happens simply reduce the number of buffers while running CAP88-PC.

It is also important to have ANSI.SYS specified in your CONFIG.SYS file. The entry would be in the following form:

<drive>**:**directory name**\ANSI.SYS**
Where:
<drive> is the hard drive where your operating system is located.

directory name is the directory or subdirectory where the operating system resides.

If you already have a directory named CAP88PC, you will need to totally eliminate the old CAP88PC directory and all files associated with it. The datasets created by Version 1.0 are not compatible with the datasets generated by the CAP88-PC prototype. We recommend that you do one of the following:

(1)   Run the UNINSTALL program provided on the installation disk and described in section 2.2.

(2)   Use appropriate DOS commands to delete the CAP88PC directory and all subdirectories.

2.2   UNINSTALL EXISTING CAP88-PC

The installation dis contains a program that will delete an existing CAP88PC directory, all its subdirectories, and files.

CAUTION: The UNINSTALL program has been thoroughly tested. Nevertheless, to protect against any possible malfunction of the program for any possible reason, we strongly recommend backing up the entire hard drive on which the existing CAP88PC directory resides before running the UNINSTALL program.

To run the UNINSTALL program, place the backup of the installation disk you have created in your high density 3.5 or 5.25 inch disk drive, as appropriate, and type:

<drive>:**UNINSTALL**
Where <drive> is the letter of the floppy drive you are running the uninstall program from.

The UNINSTALL program will ask for the drive to uninstall CAP88-PC from, which is the letter of the hard drive where the existing CAP88PC directory is located.

NOTE: Do not press <**Enter**> after entering the drive letter.

2.3   INSTALLATION

The Installation disk contains the entire CAP88-PC System including all required data files. The system cannot be run from the Installation disk because all CAP88-PC system programs and data on the disk are in a compressed form (to minimize disk space). The Installation disk contains a program that will uncompress all programs and data as the system is being installed.

To install, place the backup of the installation disk you have created in your high density 3.5 or 5.25 inch disk drive, as appropriate, and type

        <drive>**:INSTALL**

        Where <drive> is the letter of the floppy drive you are installing from.
The INSTALL program will ask for the source drive, which is the letter of the drive where the installation disk has been placed, and the target drive, which is the letter of the hard drive that CAP88-PC system to.

        NOTE: Do not press <**Enter**> after entering the source drive and target drive letters.

The Install program will create a directory named CAP88PC and four subdirectories (DATASETS, OUTPUT, POPFILES, AND WNDFILES) on your hard drive.

        WARNING: After installing the CAP88-PC system, do not alter or delete any of the files in the CAP88PC directory. Doing so could cause unpredictable behavior in the CAP88-PC System.

It would not be wise to delete file from the DATASETS or OUTPUT subdirectories using DOS commands. You may inadvertently delete or lose access to assessments that you have generated.

You may want to delete population and wind files that you know you will never use. If you find that you have deleted a file that you need, you can reload the population and wind files from the installation disk following the instructions in section 2.4. When reinstalling population or wind files, however, you get all the population or wind files on the installation disk.

2.4   REINSTALLATION OF POPULATION OR WIND FILES

These instructions would be used if some or all of your population and/or wind files were deleted and you needed to reinstall them. It is not possible to selectively reload individual population or wind files, all those residing o the installation disk will be loaded on your hard drive in the appropriate directory.

The following instructions are written assuming that:

> **!**   Your current working directory is CAP88PC (your DOS prompt will look something like **C:\CAP88PC**)

> **!**   The hard drive that CAP88PC is installed on is drive **C**.

> **!**   Your 3.5" floppy drive is drive **B**.

If the **drive letters** are different on your machine, be sue to substitute the correct drive letters where appropriate in the commands that follow.

After the population or wind files are reinstalled on your drive, you may want to selectively delete those files that you are sure will never be used in order to minimize wasted space on your hard drive. Be careful not to delete those that you will be using.

2.4.1   Reinstalling Population Files

> (1)   Place the Installation disk into floppy drive b:.

> (2)   Type **cd popfiles**

> (3)   Type **copy b:popfiles.zip**

> (4)   Type **b:pkunzip popfiles.zip**

> (5)   Type **del popfiles.zip**

> (6)   Type **cd..**

After completing these steps you will be in the CAP88PC directory.

2.4.2   Reinstalling Wind Files

> (1)   Place the Installation disk into floppy drive b:.

(2)   Type **cd wndfiles**

(3)   Type **copy b:wndfiles.zip**

(4)   Type **b:pkunzip wndfiles.zip**

(5)   Type **del wndfiles.zip**

(6)   Type **cd ..**

After completing these steps you will be in the CAP88PC directory.

Chapter 3

SCREEN INTERFACE FEATURES

3.1   INTRODUCTION

The philosophy behind CAP88-PC is to allow the user to easily set up input data for an assessment, store the input data in a "dataset", execute the assessment, print the output files, and delete both input data and output files if desired. Up to 180 separate problems (datasets and associated output files) can be stored at one time.

The user sets up input data for assessments on a series of screens which contain variables that are logically grouped together; for example, one screen has all the weather-related data, another the source term data, and so on. The user can move back and forth among the screens to edit data at will. Input data is stored in datasets, which can be executed (the assessment made), further modified, or deleted.

The screen software creates an input file for use by the FORTRAN programs that actually generate the assessment.

3.2   ON-SCREEN INSTRUCTIONS

Context-sensitive instructions are displayed on the bottom line of each screen, except for the Main Menu. The instructions on the bottom line will change depending on what keys are valid for a given screen. Some key presses are valid for a screen even though they are not listed on the bottom line. For example, sometimes some or all of the cursor keys and the <**Enter**> key are valid but not listed. The bottom line of Figure 3-1 is typical of the on-screen instructions.

3.3   INVALID KEYS

There are numerous places throughout the program where only certain keys are valid. Pressing an invalid key will cause a tone to sound.

```
                                                    ┌─────────────────┐
                                                    │ Sample Dataset  │
                                                    └─────────────────┘

                          RADIONUCLIDE LIST


              Nuclide         Nuclide

             ▶U-238 ┐           BI-210  ┐
              TH-234│           PO-210  ┘
              PA-234│           H-3
              U-234 │           I-125
              TH-230│
              RA-226│
              RN-222│
              PO-218│
              PB-214│
              BI-214│
              PO-214│          [    ]
              PB-210┘


              Number of nuclides: 16


  <Esc>Quit   <F2>Scr Menu <PgUp/Dn>Prev/Next <Space>List Box <Delete>Del
```
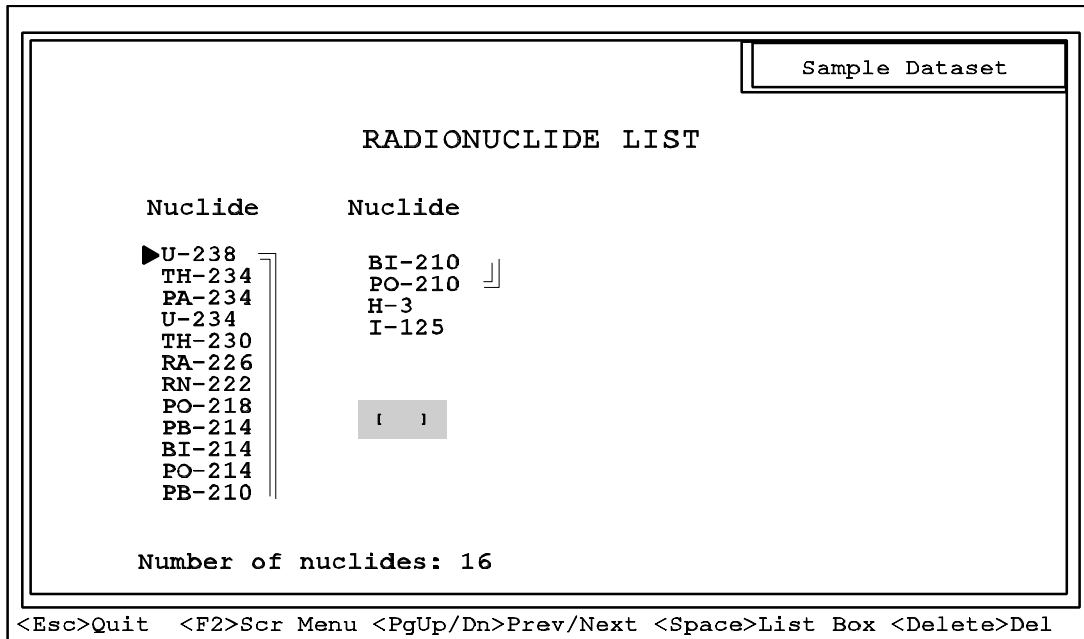
Figure 3-1. Sample of Bottom Line On-Screen Instructions

3.4   SCREEN COMPONENTS

3.4.1   Menus

There are three types of menus used in CAP88-PC:

    (1)   Selection Arrow
    (2)   Highlight
    (3)   Tag

The following keys perform the same functions for each type of menu:

● <↑> and <↓> change which item is currently highlighted.

● <**Enter**> selects the currently highlighted item.

● At any time while a menu is active, pressing <**Home**>will highlight the first item, and pressing <**End**> will highlight the last item.

3.4.1.1   Selection Arrow Menu. The Main Menu is the only menu which uses the selection arrow to select a single option from a list of options. The Main Menu is described in more detail in Chapter 4 and is depicted in Figure 4-2.

3.4.1.2   Highlight Menu. A highlight menu allows you to choose a single item from a list of two or more. Use the cursor keys to highlight the desired item and press <**Enter**> to select it. Figure 3-2 is a sample highlight menu.

```
          SCREEN MENU

   Faculity Information
   Run Information
   Meteorological Data
   Source Data
   Agricultural Data
   Radionuclide List
       Release Data
       Size & Class Data
   Quit
```
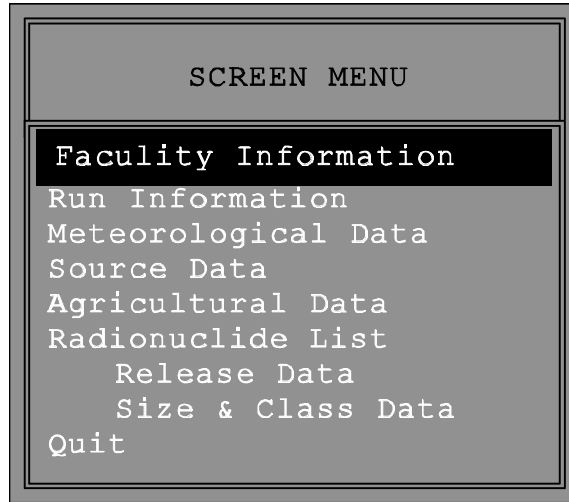
Figure 3-2. Highlight Menu

3.4.1.3   Tag Menu. A tag menu allows you to select or "tag" one or more items in a list. To tag/untag an item, press <**Space**> when the selection arrow points to the desired item. When an item is tagged it will have an asterisk to the

```
   * Synopsis Report
     General Data
     Weather Data
   ▶ Dose and Risk Equivalent Summaries
     Dose and Risk Conversion Factors
     Concentration Tables
     Chi/Q Tables
```

Figure 3-3. Tag Menu

left of it. A tag menu item that is displayed in dark letters is not available for selection

(for example, this might indicate that a file does not exist, and therefore cannot be selected). The selection arrow will only point to valid selections; it will skip past items that are displayed in dark text. Figure 3-3 is a sample tag menu.

3.4.2   <u>Dialogue Boxes</u>

A dialogue box is a text message surrounded by a double-line border. Dialogue boxes are used to inform you that a specific condition exists within the program. Depending on the context of the message, <**Y**> or <**N**>, or some other key press may be required to exit the dialogue box. Figure 3-4 is a sample dialogue box.

```
     The selected nuclide
            U-238
     is the beginning of the
         Uranium chain,

     Add the chain (Y/N)?
```
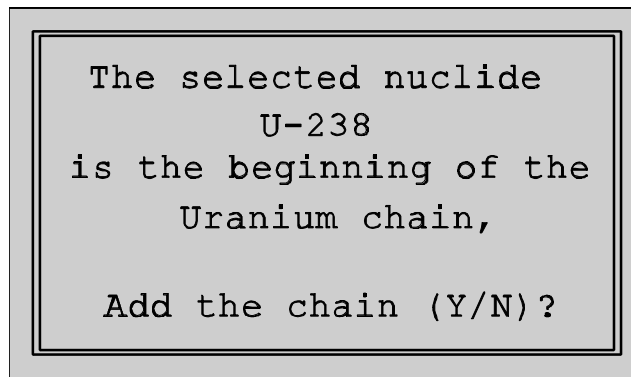
Figure 3-4. Sample Dialogue Box

3.4.3   <u>Fields</u>

At any time, only one field on the screen is "active" (i.e. actions taken by the user can affect what is contained in that specific field). The active field will either contain a blinking cursor, or will be highlighted in a specific color (the default is magenta). When a group of several fields are first displayed to the screen, the top left-most field will be active. There are several ways to exit the active field:

- <**Enter**>   Makes the next valid field active. If the last field on a screen is the active field, <**Enter**> will take you to the next screen.

- <**Esc**>   Activates the QUIT MENU, which allows you to either save the data as a dataset, or quit without saving.

- <**PgUp**>   Makes the previous data-entry screen active.

- <**PgDn**>   Makes the next data-entry screen active.

- Cursor
  Keys   Makes the next valid field that is in the direction of the cursor key active. The cursor keys move in the direction of the arrow unless

there is no field directly in line with the active field. When there is no field directly above, below, to the right of, or to the left of the active field based on the direction of the cursor key pressed, nothing will happen. For example, to get to a field above but to the right of the active field, press the → and move to the field directly below the field you want to move to, then press the up arrow to get to the desired field.

There are three types of fields used in CAP88-PC: toggle fields, list box fields, and data fields. Each field type is displayed in a different foreground color when inactive. The colors specified here are the default colors, and can be easily changed by the user (for more information on this, see section 4.2.6).

3.4.3.1   Toggle Fields. Some variables used in CAP88-PC have only a few correct settings. For example, variables which control the generation of tables are either "on" or "off". For ease of use, these fields are treated as "toggle fields" in CAP88-PC, where the user can switch back and forth among possible settings by pressing <**Space**>. Press <**Enter**> or use an appropriate cursor key to move on to the next field.

Toggle fields will appear as white on black when the field is inactive. When active, they will be yellow on magenta.

3.4.3.2   List Boxes. "List boxes" are used to select one item from a large list of items. A separate list box is used to select from available state names, population files, wind files and radionuclides. To activate a list box, press <**Space**> while the field is active, and the list box will appear. Highlight the desired state, file, or nuclide using the cursor keys, then press the <**Enter**> key to select the highlighted item.

List boxes have a search feature: by pressing any letter key, the list box automatically finds the first item that begins with that letter. If no match is found, the currently highlighted item becomes the top item in the box.

List boxes will appear as yellow on black when the field is inactive. When active, they will be yellow on magenta. Figure 3-5 is a sample list box.

```
Alabama
Alaska
Arizona
Arkansas
California
Colorado
Connecticut
D.C.
Delaware
```
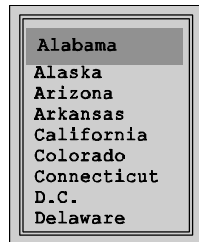
Figure 3-5. List Box

3.4.4.3   Data Fields. A data field is used to store a single piece of information such as text, an integer, or a floating point number. While a data field is active, you can only enter characters that are valid for that specific field. If you attempt to enter an invalid character, a tone will sound and the contents of the field will not change.

A data field may initially be blank or may contain data. In some cases, the data will be a default value that can be left as is or modified. A data field is displayed as green on black, and when a data field is active, a blinking cursor will appear in it.

While entering data into a data field, you will normally be in "overwrite" mode (if you type a character, it will overwrite the character that the cursor is currently resting on). You can, however, activate an "insert" mode by pressing <**Insert**>. While in Insert mode, the program will only allow you to press keys that will add characters to the field (<**Home**>, <**End**>, etc. are disabled). As you insert characters, those characters in the field that are to the right of the cursor will be squeezed out of the field. Pressing <**Insert**> while Insert mode is active will disable Insert mode, and return you to overwrite mode. Following is a list of other keys you can use while a data field is active:

- <**Home**>   Moves the cursor to the beginning of the field.

- <**End**>   Moves the cursor to the end of the field's current contents (if the field is blank, the cursor will not move).

- <**←**>, <**→**>   Moves the cursor one character in the specified direction, if doing so allows the cursor to remain in the field. Otherwise, the field that is in the specified direction, if any, becomes active.

- <**Delete**>   Deletes the character that the cursor is currently resting on, causing everything to the right of the cursor to move one space to the left.

- <**Alt**>-<**D**>   Deletes the entire contents of the field.

- <**Backspace**>   Shifts the cursor and everything to the right of it one space to the left, thereby deleting the character that was directly to the left of the cursor.

- <↑> and <↓>   Makes the field that is in the specified direction, if any, active.

- <**Enter**>   Makes the next field active.

When you enter a character or digit in the last space of a data field, the next field will become active, just as if you had pressed <**Enter**>.

3.4.4.3.1   Integer Field. An integer field can contain only digits (0-9). All integers input using the CAP88-PC screen interface must be non-negative unsigned values. You will be able to recognize an integer field by the lack of a decimal point in whatever data is displayed in the field, regardless of whether it is default data or user-entered.

3.4.4.3.2   Floating Point Field. A floating point field contains a floating point number, which may be expressed in either exponential notation or decimal notation.

If you enter a number in decimal notation and do not include a decimal point, one will be added to the right of the number that you typed in.

Numbers expressed in exponential notation must be within the range of 1.18e-38 to 3.40e+38, and a decimal point must precede the "**E**" or "**e**".

When you attempt to exit a floating point field, the field is checked to make sure it contains a valid number in a valid form. If a number is not in valid notation or is out of range, a dialogue box will pop up and provide some information relative to the range or the proper notation to use. Figures 3-6, 3-7, and 3-8 are the dialogue boxes that will provide this information.

```
     The current field contains an invalid
              floating point number.


  Press <F1> to display the syntax for floating
  point numbers, any other key to re-enter . . .
```
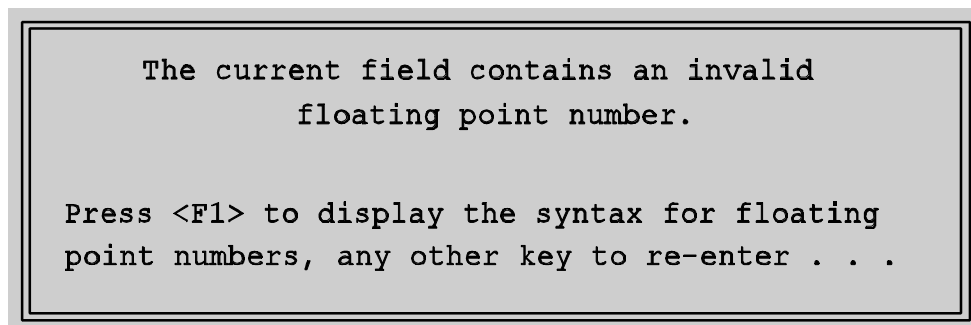
Figure 3-6. Invalid Floating Point Number Message

```
          For an IBM-PC, the Syntax for a
               floating point number is:

  [sign]<integer_part><decimal_point><fraction_part>

     Both <integer_part> and <fraction_part> are
         sequences of digits. Either, but not
                 both, may be omitted.

   If the number is entered in exponential notation,
    the syntax is the same as above, followed by:

              <'E' or 'e'>[sign]<exponent>

       Press a key to re-enter the number...
```

Figure 3-7. Syntax for A Floating Point Number

```
    The current field contains a floating
      point number that is out of range.

       For an IBM-PC, the range for a
           floating point number is:

             1.18e-38 to 3.40+38

         Press key to re-enter . . .
```

Figure 3-8. Floating Point Number Out of Range Message

3.4.4.3.3 <u>Text Field</u>. A text field is an alphanumeric field where all alphabetic characters and digits are valid. Most other characters are also valid. It should be obvious which fields are text fields.

Chapter 4

PROGRAM OPERATION

4.1 HOW TO EXECUTE CAP88-PC

Once CAP88-PC is installed: from the DOS prompt, change directories (CD) to the CAP88PC directory, type **CAP88PC**, and press <**Enter**>.

The program first displays a notice showing who to contact for more information on CAP88-PC, a statement of the program limitations, and acknowledgments (Figure 4-1). The Main Menu will appear after you press any key.

```
                       CAP88-PC Version 1.0


 Please direct all correspondence regarding CAP88-PC to:


Barry Parks
EPA Office of Radiation Programs
Las Vegas facility
P.O. Box 98517
Las Vegas, NV            Phone (782) 798-2443    FTS 545-2443


CAUTION!  This software is intended for use by health physicists
that are experienced in dose assessment, CAP88-PC is based on the
Gaussian plume model with its associated limitations.  The model
is intended only for evaluating low-level, chronic releases.


Acknowledgments:  Thanks to Christopher Nelson, whose assistance
made this model possible, and to Kathleen Manafi, Mark Minks, and
Linda Perrin, whose computer expertise made it happen.


Please press a key to continue...
```

Figure 4-1. CAP88-PC Information Screen

4.2 MAIN MENU OPTIONS

You can select one of the seven Main Menu options (Figure 4-2) by using the cursor keys to move the selection arrow to the desired option, and pressing the <**Enter**> key.

```
┌─────────────────────────────────────────────────────────┐
│                                                         │
│                 CAP88-PC Version 1.00                   │
│                                                         │
│                     MAIN MENU                           │
│                                                         │
│              ┌───────────────────────┐                  │
│              │ ▶ Modify dataset      │█                 │
│              │   Create dataset      │█                 │
│              │   Delete file(s)      │█                 │
│              │   Execute             │█                 │
│              │   Print results       │█                 │
│              │   Select Colors       │█                 │
│              │   Quit                │█                 │
│              └───────────────────────┘█                 │
│                █████████████████████████                │
│                                                         │
│            EPA Office of Radiation Programs             │
│                  Las Vegas Facility                     │
│                   (702) 798-2443                        │
│                                                         │
└─────────────────────────────────────────────────────────┘
```
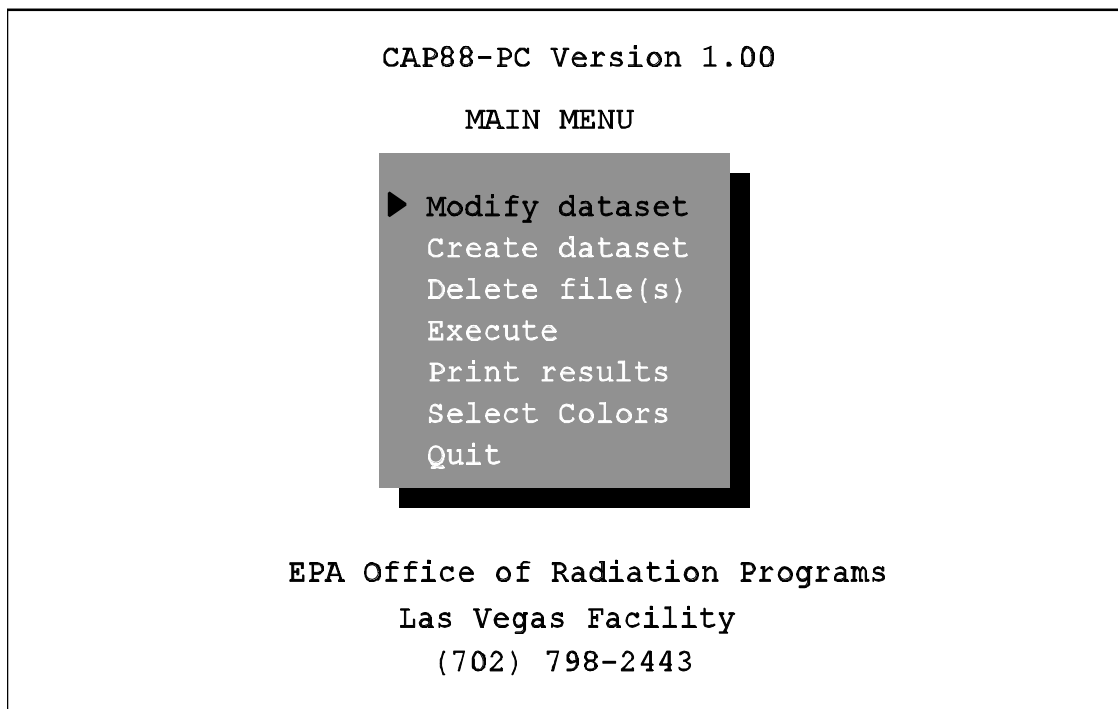
Figure 4-2. Main Menu

When one of the **Modify**, **Delete**, **Execute**, or **Print** options are selected, a **SELECT DATASET TO ...** screen will appear. This screen allows you to select a specific dataset to perform the chosen option on. Since this screen is used with four Main Menu options, the title of the screen changes depending on which option is chosen.

The bottom half of the screen is used to display dataset names. This area is referred to as the "dataset name display area". The top half of the screen contains the dataset name, the date the dataset was created and the comments included in the dataset.

When the screen first appears, the dataset name in the top left corner of the dataset name display area will be highlighted. Use the cursor keys to move through the datasets names. As different datasets are highlighted the information in the top half of the screen changes to reflect information relative to the dataset that is highlighted.

If no datasets exist, a dialogue box (Figure 4-3) will be displayed informing you of this condition.

```
            No datasets exist,


   Press any key to return to MAIN MENU...
```
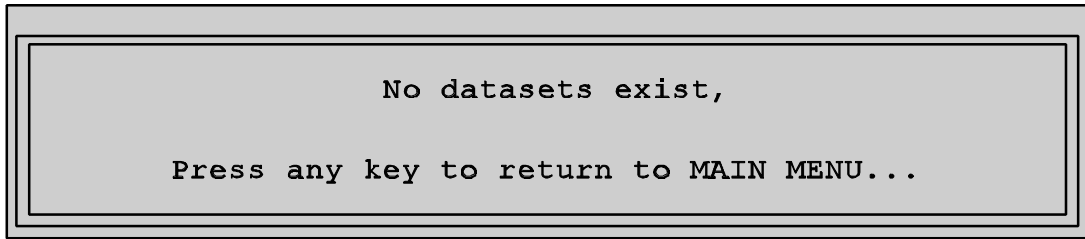
Figure 4-3. No Datasets Exist Message

Maximum Datasets: A maximum of **180** datasets can be stored on the hard drive and accessed by CAP88PC at any given time. The reason for this is the limitation of available memory required to store information relative to each dataset for immediate display to the screen. When the number of datasets reaches the limit, you may want to delete unneeded datasets and/or save some datasets on floppy disks. When you save datasets onto floppy disks, be sure to print the PREFIXES.DAT file (in the CAP88PC directory) to get a listing of dataset names and their associated DOS files names for future reference (you will need this information to restore the datasets back to the hard drive). To restore datasets from a floppy to the hard drive, print a current listing of the PREFIXES.DAT file and compare the DOS file names of the datasets on the floppy with the DOS file names of the datasets on the hard drive. **If there are DOS file names on the floppy that are the same as DOS file names on the hard drive, the datasets on the hard drive will be overwritten if you restore the datasets from the floppy.** To avoid this situation, rename all files associated with the datasets on either the floppy or the hard drive. For example, assuming a DOS file name of E.SCR, rename all files associated with the dataset using the following command:

REN E.* filename**.***

CAUTION: If you save datasets to a floppy and then want to restore them to the hard drive, be sure to compare dataset names and DOS file names of the datasets on the floppy with the DOS file names on the hard drive to avoid overlaying existing datasets.

```
        The maximum number of
                 180
        datasets already exist.

        One cannot be created.

Please press a key to return to MAIN MENU...
```
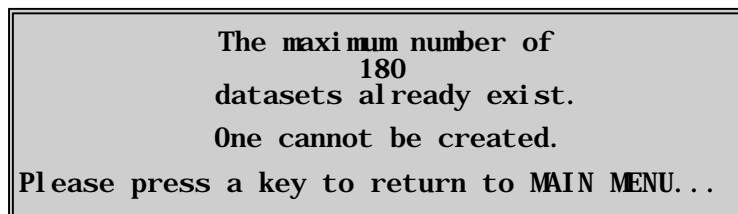
Figure 4-4. Maximum Number of Datasets Exist Message

When the limit of 180 datasets has been reached, a message will be displayed (Figure 4-4). This message or a similar one will displayed when you attempt to create a dataset, or when you are modifying a dataset and try to save it under a new name.

4.2.1   Modify Dataset

Most often, the user will be making modifications to existing input datasets rather than creating new assessments. For this reason, the Modify Dataset option is listed first. A dataset is the file where input data for CAP88-PC is stored. Output created during dataset execution is stored in separate output files.

```
                 SELECT DATASET TO MODIFY

   Dataset: Sample Dataset      Date: Dec. 4, 1991  8:42 am

   Comments: The comment field is displayed for each dataset
             whenever the user scrolls through dataset names.

                                                   Page 1/1

         Sample Dataset

         Test dataset 1
         Test dataset 2
         Test dataset 3
         Yet another file




 <Esc> Return to MAIN MENU  <↑><↓><◄▓<►> Move   <Enter> Select
```
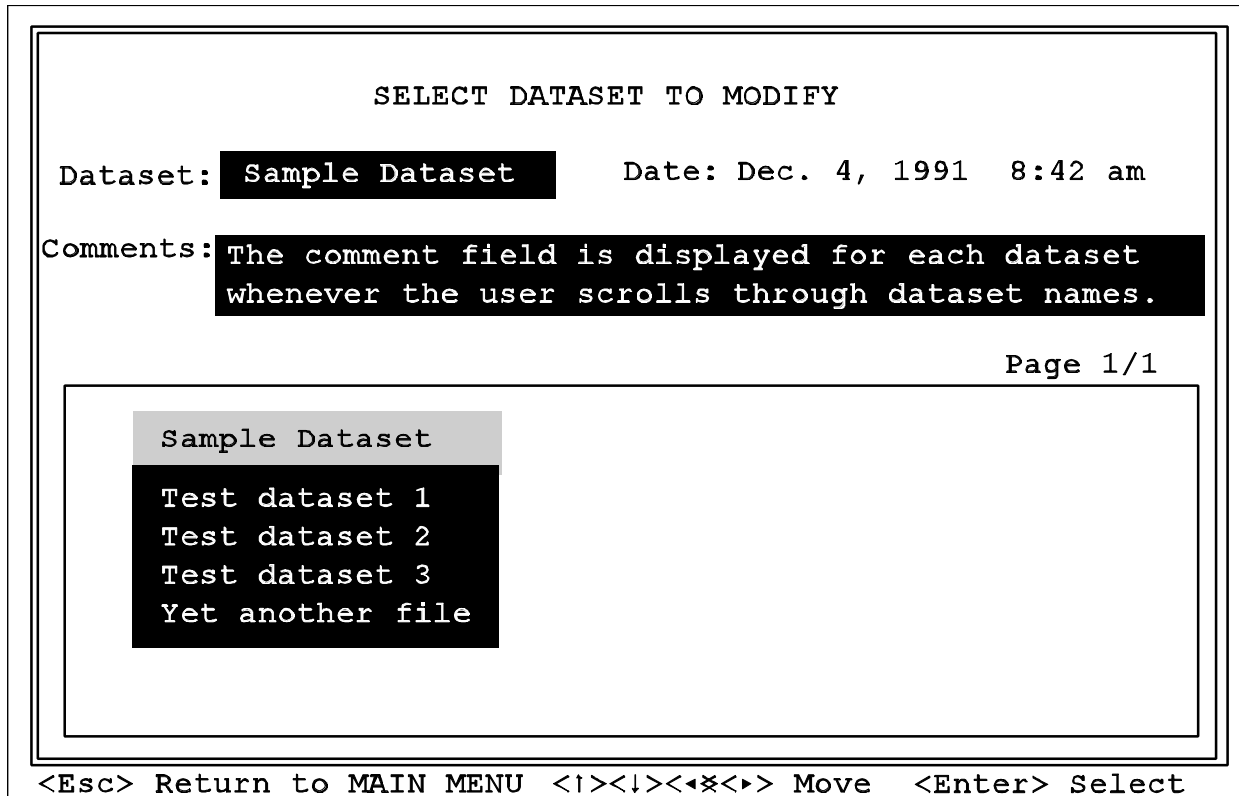
Figure 4-5. SELECT DATASET TO MODIFY Screen

After selecting the Modify Dataset option, the user selects the dataset to modify using the SELECT DATASET TO MODIFY screen (Figure 4-5). Once a dataset has been selected, the Data Entry/Selection screens will appear in a preset order. While in a Data Entry/Selection screen, you can also press <F2> to activate the SCREEN MENU, which you can use to move to any other Data Entry/Selection screen. The Data Entry/Selection screens are discussed in more detail in Section 4.3.

4.2.2   <u>Create Dataset</u>

The Create Dataset option is identical to Modify Dataset, except that instead of selecting an existing dataset at the beginning, you assign a name for the dataset which you will create. The screens presented to the user when creating a dataset are the same screens used when modifying a dataset, except that default data appears where applicable rather than data selected/entered by the user. Figure 4-6 is the screen that will appear if **Create dataset** is selected from the Main Menu.

```
                        CREATE DATASET



            New dataset name:  Sample Dataset









 <Esc> Return to MAIN MENU
```
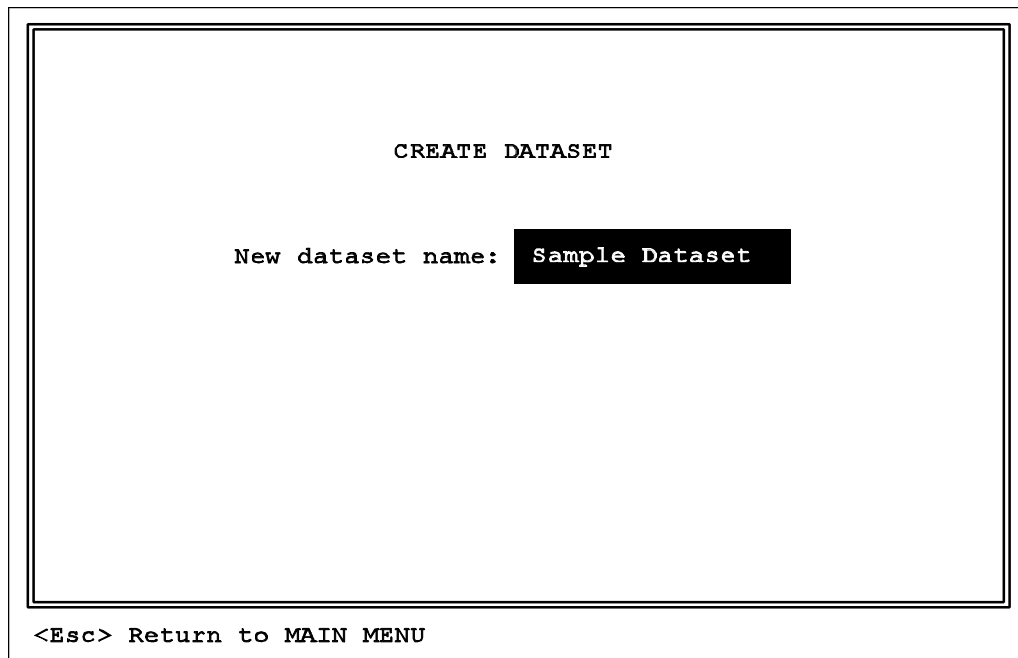
Figure 4-6. CREATE DATASET Screen

If the dataset name entered already exists, a message will appear on the screen and you will be asked to enter another name (Figure 4-7). If the dataset name does not exist, the dataset will be created with the user-specified name.

```
 Dataset <Sample Dataset> already exists. Please enter another name.
```

Figure 4-7. "Dataset <...> Already Exists" Message

4.2.3   Delete File(s)

First, you are prompted to select a dataset to delete from the SELECT DATASET TO DELETE screen (Figure 4-8). Use the cursor keys to highlight the desired dataset name, then press the <**Enter**> key to select.

```
                    SELECT DATASET TO DELETE

   Dataset:  Sample Dataset      Date: Dec. 4, 1991  8:42 am

   Comments: The comment field is displayed for each dataset
             whenever the user scrolls through dataset names.

                                                   Page 1/1

         Sample Dataset

         Test dataset 1
         Test dataset 2
         Test dataset 3
         Yet another file




 <Esc> Return to MAIN MENU  <↑><↓><◄><►> Move   <Enter> Select
```
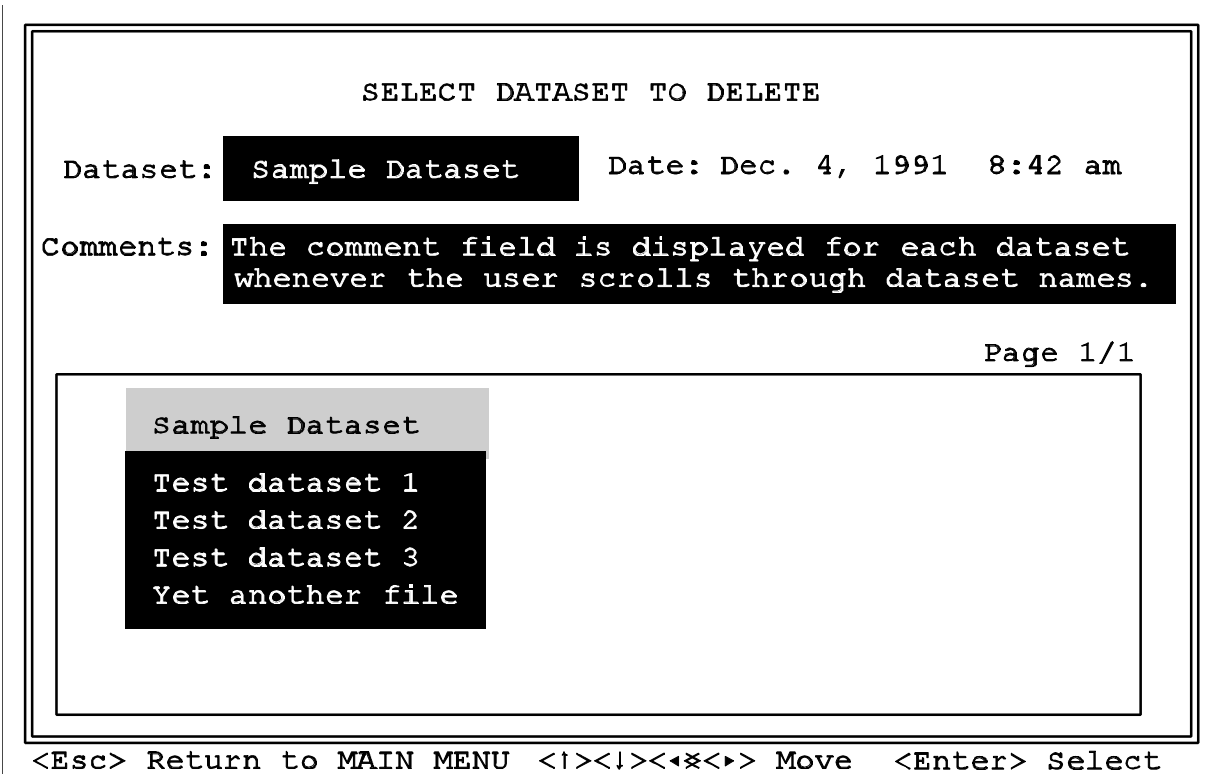
Figure 4-8. SELECT DATASET TO DELETE Screen

After you select a dataset, the DELETE MENU will appear on the screen, giving you the option of either deleting the dataset and all associated output files or deleting individual output files (since each assessment creates multiple output files) (Figure 4-9). Use the cursor keys to highlight your choice and press <**Enter**>.

```
              DELETE MENU

   Delete dataset and output files
   Delete individual output files
```
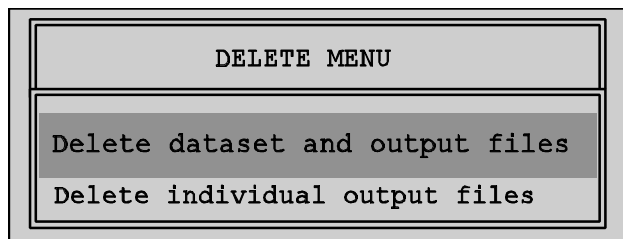
Figure 4-9. DELETE MENU

4.2.3.1   Delete Dataset and Output Files. If you select this option, no further choices are required. The input dataset and all output files will be deleted. Note that the only way to delete the dataset is to choose this option.

4.2.3.2   Delete Individual Output Files. If you choose this option, a tag menu appears which allows you to select individual output files to delete (Figure 4-10). To select a file, move the selection arrow to the desired item using the cursor keys, and press <**Space**> to "tag" the item for deletion. This may be repeated as often as desired. Output files which have already been deleted or were not generated are displayed in gray text in the tag menu, to signify that they are not available for deletion and cannot be tagged. When all selections have been made, press the <**G**> key (to "go"), and the tagged files will be deleted.

```
  * Synopsis Report
    General Data
    Weather Data
  ▶ Dose and Risk Equivalent Summaries
    Dose and Risk Conversion Factors
    Concentration Tables
    Chi/Q Tables
```

Figure 4-10. Tag Menu To Delete Output

4.2.4   Execute

This option allows you to select a dataset for execution, using the same procedure as MODIFY DATASETS (Figure 4-11). However, before actually executing the assessment, the program will check to make sure that you have selected the following items in the dataset:

  ! a **state**
  ! a **population file** (if the run is a population run)
  ! a **wind file**
  ! at least **one radionuclide**

If the preceding items are present, the program will execute the selected dataset, then return to the Main Menu. If one or more of them is missing, a message will be displayed (Figure 4-12) so you will know to modify the dataset accordingly. If for some reason a population or wind file has been selected but no longer exists, a message will be displayed informing the user. The user may need to reload the wind and/or population files from the installation disk (reference section 2.4).

```
                 SELECT DATASET TO EXECUTE

  Dataset: Sample Dataset        Date: Dec. 4, 1991  8:42 am

  Comments: The comment field is displayed for each dataset
            whenever the user scrolls through dataset names.

                                                    Page 1/1

        Sample Dataset

        Test dataset 1
        Test dataset 2
        Test dataset 3
        Yet another file




 <Esc> Return to MAIN MENU  <↑><↓><◄><►> Move   <Enter> Select
```
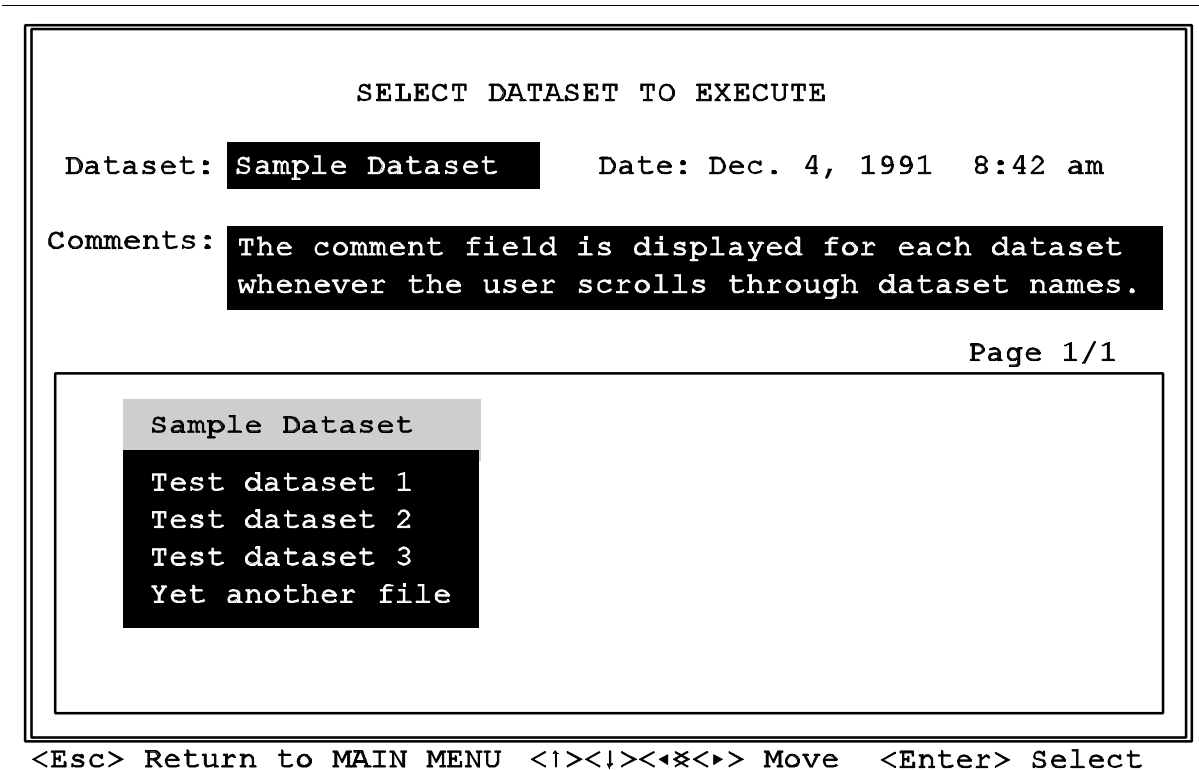
Figure 4-11. SELECT DATASET TO EXECUTE Screen

```
          Cannot execute dataset
                Test Dataset

    One or more of the following have
    not been selected:

        (1)   state
        (2)   population file
        (3)   wind file
        (4)   at least one nuclide


     Please press a key to continue...
```
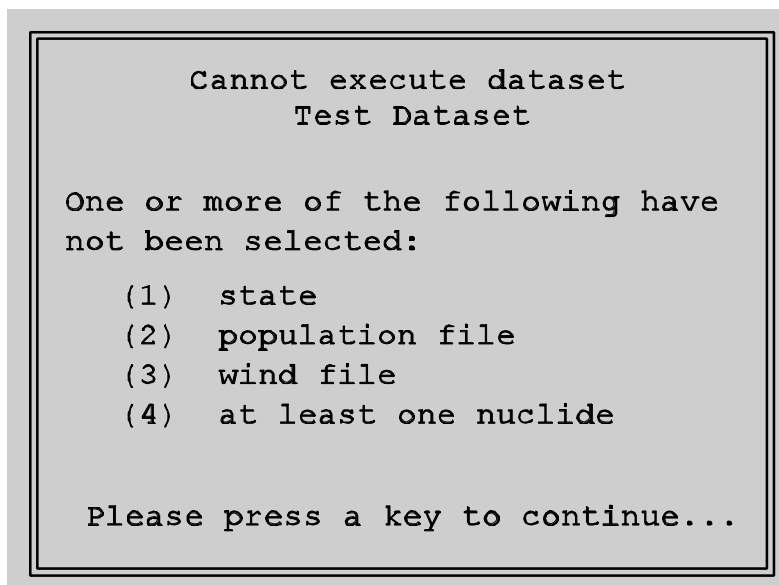
Figure 4-12. "Cannot execute dataset" Screen

4.2.4.1   Defaults. When a dataset is executed, the first thing the system does is determine if the defaults detailed in Chapter 5 have been altered. If they have been changed, a warning message will be displayed. The message will list the changes that have been made, specifying the original default value and the value that replaces it. The user will be given the option of having all defaults reset to the original values (Figure 5-1). There are some defaults that must never be changed by the user. If any changes have been made to these defaults, they will be automatically reset and a message notifying the user will be printed to the screen (Figure 5-2). If no defaults have been changed, execution continues without interruption. Chapter 5 contains more information on this topic.

4.2.4.2   Output: When a dataset is executed, the output is written to multiple files (to facilitate printing and deleting). For example, concentration tables and chi/q tables, if selected, are written to separate files, which may be printed or deleted at the user's option. This prevents output files from becoming too numerous and taking up large amounts of disk space.

If a specific dataset has been executed previously, there will be existing output. If this is the case, a message will be displayed that will ask you if you want to overwrite the output (Figure 4-13). If you respond with <**Y**>, the assessment will continue, and existing output will be overwritten. If you respond with <**N**>, the program will take no further action, and will return to the Main Menu. If you want to execute the dataset and keep the existing output, you could Modify the dataset from the Main Menu, save it under a new name, and then execute the new dataset name.

```
          Output for dataset
            Test Dataset
           already exists.


         Overwrite it? (Y/N)?
```
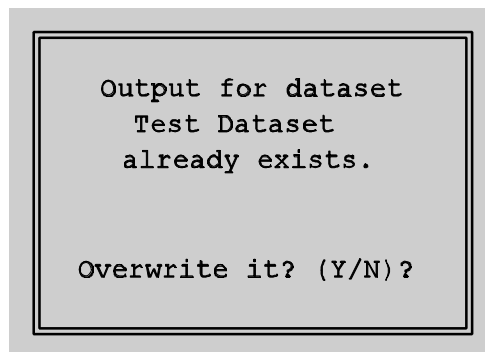
Figure 4-13. Output Exists Message

Datasets that have been executed will have output files appearing in white text in the tag menus for the PRINT RESULTS and DELETE FILE(S) options. Output files which have not been generated will be displayed in gray text in the tag menus (Figure 4-10).

4.2.5   Print Results

Because the output generated by CAP88-PC can become extremely large (particularly if the optional tables are selected), CAP88-PC writes multiple output files, rather than one large file, to facilitate printing and deletions.

CAP88-PC generates the following five output files (each with an identifying extension) for each assessment: Synopsis Report (.SYN), General Data (.GEN), Weather Data (.WEA), Dose and Risk Equivalent Summaries (.SUM), and Dose and Risk Conversion Factors (.FAC). The Concentration Tables (.CON) and Chi/Q   Tables (.CHI) are generated only if specifically selected by the user.

> NOTE: To **view** these output files, print the **PREFIXES.DAT** file located in the CAP88PC directory using the DOS **PRINT** command, a word processor, or text editor. Locate the dataset name in the column on the left; the corresponding DOS file name will be listed to the right of the dataset name. After you have determined the DOS file name, change to the **\CAP88PC\OUTPUT** subdirectory, add the appropriate extension listed above to the DOS file name and use a text editor or word processor to view the file which is in ASCII format.

```
                    SELECT DATASET TO PRINT

   Dataset: Sample Dataset        Date: Dec. 4, 1991  8:42 am

   Comments: The comment field is displayed for each dataset
             whenever the user scrolls through dataset names.

                                                        Page 1/1

         Sample Dataset

         Test dataset 1
         Test dataset 2
         Test dataset 3
         Yet another file




 <Esc> Return to MAIN MENU  <↑><↓><◄><►> Move   <Enter> Select
```
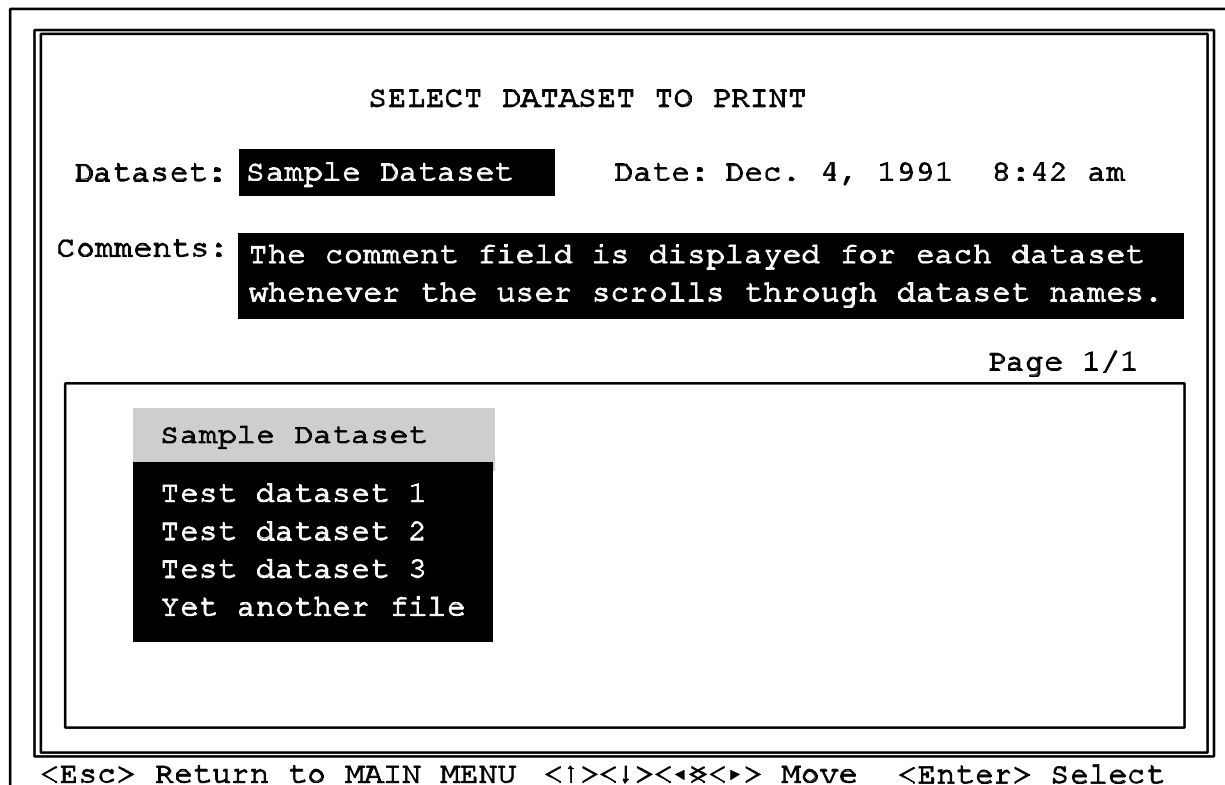
Figure 4-14. SELECT DATASET TO PRINT Screen

4.2.5.1   Printing. The SELECT DATASET TO PRINT screen allows the user to select datasets for printing (Figure 4-14). Use the cursor keys to highlight the desired dataset, and press the <**Enter**> key. A tag menu just like the one used to delete output files (Figure 4-10) will appear.

Use the tag menu to select the individual output files to be printed. To select the output files, use the cursor keys to move the selection arrow to the desired output file, then press <**Space**> to "tag" the file for printing. This may be repeated as often as desired. An asterisk will be displayed beside each tagged file to signify that it has been selected for printing. When all selections have been made, press the <**G**> key (for "go"), and the tagged files will be printed.

Any output files which have been deleted, or that have not been generated, will be displayed in gray text in the selection menu, to signify that they are not available for printing.

> NOTE: If the tag menu comes up with all output files printed in gray text, including the Synopsis file, the dataset has not been executed.

```
┌─────────────────────────────────┐
│         PRINTER ERROR!          │
│                                 │
│      Error encountered while    │
│      attempting to print file   │
│                                 │
│             E. SYN              │
│                                 │
│           in directory          │
│                                 │
│          CAP88PC\OUTPUT         │
│                                 │
│    Press any key to continue... │
└─────────────────────────────────┘
```

Figure 4-15. PRINTER ERROR! Message

If you get a **PRINTER ERROR** message (Figure 4-15), make sure that:

! the printer is turned on.

! the printer is **on line**.

! the printer has paper.

! the printer cable is securely connected to the computer.

! the printer is a parallel printer connected to LPT1.

Because communication with the printer is performed via a parallel port, every error condition cannot be detected accurately by the program. On occasion, your printer may not print, and a message will not be displayed. If this happens, make sure the printer is turned on. If it still won't print, check all of the above conditions.

4.2.6   <u>Select Colors</u>

This option allows you to change colors of some elements of the screen interface. A sample screen is displayed, with colors controlled by function keys; simply press the indicated function key to change the color. You can save your choices with **<S>**, reload the default colors with **<R>**, and load the most recent user-defined colors which have been saved with **<L>**. At any time you can press **<Esc>** to quit and return to the Main Menu. Figure 4-16 is the SELECT COLORS Screen.

> NOTE: The menu color and background color cannot be identical. If you want the background to be a particular color, be sure that the menu is not the same color. If it is, when you press the appropriate function key, that background color will not be an option.

```
                          SELECT COLORS


                                              ┌──────────────────────────┐
                                              │ <F3> Menu Background      │
        <F2> Screen Background                │ Menu Text                 │
                                              │ Menu Text                 │
       ┌──────────────────────┐               │ Menu Text                 │
       │ <F4> Field Foreground │               │ Menu Text                 │
       └──────────────────────┘               │ Menu Text                 │
                                              │ Menu Text                 │
                                              │ Menu Text                 │
        <L> Load user colors                  └──────────────────────────┘
        <S> Save user colors
        <R> Reset to defaults



   <Esc> Return to MAIN MENU
```
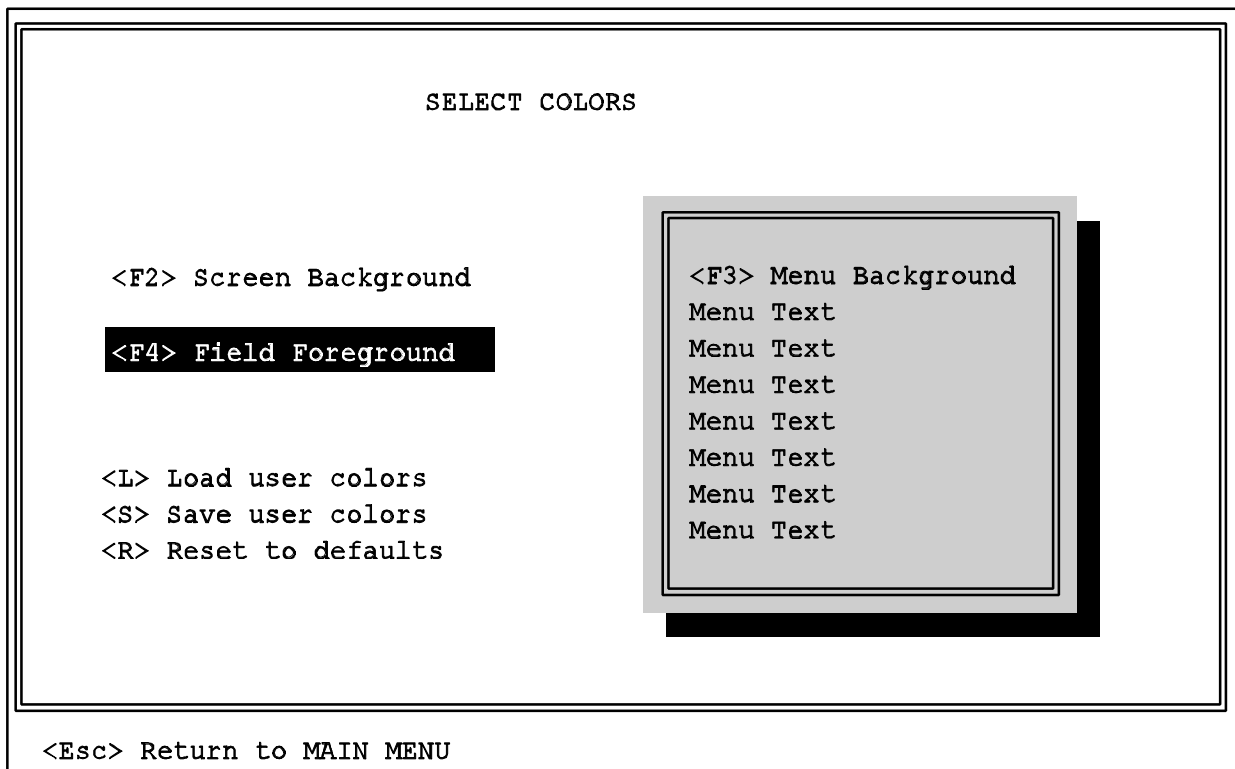
Figure 4-16. SELECT COLORS Screen

4.2.7   Quit

Selection of this option exits the program and returns the user to DOS.

4.3   DATA SELECTION/ENTRY SCREENS

Selection of the MODIFY DATASET or CREATE DATASET allows the user to set up a scenario for assessment. The user sets up input data for an assessment on a series of screens, which contain variables that are logically grouped together. For example, one screen has all the weather-related data, another the source term data, and so on. The user can move back and forth among the screens to edit data at will. Input data is stored in datasets, which can be executed (assessment generated), further modified, or deleted.

Eight screens are available for entering, selecting, or editing assessment information:

> **!**   Facility Information
> **!**   Run Information
> **!**   Meteorological Data
> **!**   Source Data
> **!**   Agricultural Data
> **!**   Radionuclide List
> > **!**   Release Data
> > **!**   Size & Class Data

Figure 4-17. SCREEN MENU

You may choose to go directly to any of these screens by pressing <**F2**>. This activates the SCREEN MENU (Figure 4-17). Use the cursor keys to highlight the name of the desired screen, and press <**Enter**>.

A common feature of the Data Entry/Selection screens is the **dataset name** you have selected or are creating, enclosed in a box in the upper righthand corner of the screen (Figure 4-19).

4.3.1 Facility Information

Facility and **address:** This information is fairly self-explanatory: Facility, Address, City, State, ZIP. The **State** name is important because it is used by the program to establish default values for agricultural arrays of beef cattle, milk cattle, and crop production according to reported state-wide averages. A state name must have been selected for an assessment to execute. State names are chosen from a list box, which appears when you press <**Space**> when the state field is active (Figure 4-18). To use the list box search feature, press any letter key and the list box automatically goes to the first state beginning with that letter.

```
Alabama
Alaska
Arizona
Arkansas
California
Colorado
Connecticut
D.C.
Delaware
```
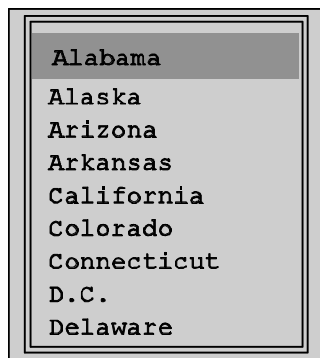
Figure 4-18. State List Box

Emission Year: The year in which the radionuclide emissions occurred.

Source Category: The category the assessment falls under. Examples include Department of Energy, Experimental, etc. Enter whatever you deem is appropriate.

Comments: Provided for your use, to help you distinguish one dataset from another. Comments are displayed when scrolling through file names in the Modify Dataset, Execute, Delete File(s), and Print Results options.

4.3.2 Run Information

Run Type: Users may select either an individual or population assessment. Toggle between these choices using <**Space**>.

Population File to Use: If you select a population run (Figure 4-19), you will need to select a population file. Press <**Space**> when this field is active and a list box will appear displaying your possible choices. (If no file has yet been selected, the field

consists of two brackets). Highlight the desired population file name using the cursor keys, and press <**Enter**> to select it. To use the list box search feature, press any letter key and the list box automatically goes to the first population file beginning with that letter.

```
                                              ┌─────────────────┐
                                              │  Sample Dataset │
                                              └─────────────────┘

                        RUN INFORMATION


                       Run Type:  ▐ Population ▌

            Population file to use:  ▐ NEVTSTST ▌

          Generate genetic effects:  ▐ Yes ▌

    Create Dose and Risk Factor file:  ▐ Yes ▌

    Create Concentration Table file:   ▐ No ▌

         Create Chi/Q Table file:      ▐ No ▌


   <Esc>Quit   <F2>Screen Menu   <PgUp/Dn>Prev/Next   <Space>Change
```

Figure 4-19. RUN INFORMATION Population Screen

Example population files are provided for many DOE sites which EPA has assessed. The population files provided with CAP88-PC are:

File	Facility	Latitude Deg M S	Longitude Deg M S
AMES	Ames Laboratory	42 0 0	93 36 0
ARGONNE	Argonne National Laboratory	41 43 0	87 58 45
BATTELLE	Battelle Columbus Laboratory	39 58 02	83 15 0
BETTSAPL	Bettis Atomic Power Plant	40 21 38	79 53 47
BROOKNLB	Brookhaven National Laboratory	40 52 15	72 52 30
OAKRIDGE	Oak Ridge Reservation	35 59 21	84 14 43
FERMILAB	Fermilab Batavia, Illinois	41 51 0	88 15 15
HANFORD	Hanford Reservation	46 26 0	119 35 0
IDAHO	All INEL Facilities	43 34 45	112 56 47
KPLKNOLL	Knolls Atomic Power Lab Knolls	42 49 23	73 52 06

File	Facility	Latitude Deg M S	Longitude Deg M S
KPLKSLRG	Knolls Atomic Power Lab Kesselring	43 01 30	73 54 50
KPLWNDSR	Knolls Atomic Power Lab Windsor	41 52 30	72 41 15
LOVELACE	Lovelace/Sandia, Albuquerque, NM	34 59 30	106 32 15
LOSALAMO	Los Alamos Laboratory	35 52 10	106 15 44
MOUNDFC	Mound Facility	39 37 51	84 17 17
NEVTSTST	Nevada Test Site, Nye County, NV	37 06 0	116 12 0
PADUCAH	Paducah Gaseous Diffusion Plant	37 08 0	88 49 0
PANTEXPL	Pantex Plant Amarillo, Texas	35 20 27	101 33 50
PINELLAS	Pinellas Plant, Pinellas Co., FL	27 52 30	82 45 15
PORTSMOU	Portsmouth Gas Diffusion Plant	39 02 0	83 0 0
RMICOMPY	RMI Ashtabula, OH	41 53 24	80 46 36
ROCKWELL	Rockwell, Rocketdyne Division	34 13 50	118 42 47
ROCKYFLT	Rocky Flats Plant, Golden, CO	39 53 40	105 11 45
SANDIALV	Sandia/Lawrence Livermore	37 40 27	121 42 18
SAVRIVPL	Savannah River Plant	33 17 20	81 40 40
UFCBERKL	Lawrence Berkeley Laboratory	37 52 36	122 15 01

> NOTE: These files are provided solely for the convenience of the user. The supplied arrays are not required to be used for compliance calculations, and no warranties are made concerning the accuracy of the data. Users are encouraged to upload their own documented population data for use with CAP88-PC.

Users are encouraged to use site-specific population arrays with CAP88-PC. Users who have been operating the CAP-88 mainframe software may download their population files in ASCII format for use on the CAP88-PC system (CAP88-PC uses the standard mainframe format). In order for CAP88-PC to recognize a new population file, it must be copied to the \CAP88PC\POPFILES subdirectory, and must have the .POP extension.

For an example of the proper format for population files, see Appendix F. Users are encouraged to compare their uploaded population files with the example files provided with the program to ensure that the files have been formatted correctly. It is imperative that the number of distances (NRAD=number of distances) be located on line 1 in columns 68 and 69, and the last digit must always be in column 69.

Distances: Selecting the "Individual" option will display 20 distance fields (Figure 4-20). The distances that are entered for an individual run are the distances at which you want the doses and risks calculated, in meters. The distances must be integers between 1 and 80000 (inclusive). A message will be displayed if you enter a distance that is outside this range (Figure 4-21). At least one distance must be entered for the dataset to execute. If no distances are entered, the AIRDOS program will abort.

Figure 4-20. RUN INFORMATION Individual Screen

Figure 4-21. Invalid Distance Message

Generate genetic effects?: No genetic effects will be calculated if this toggle field is set to No.

Create Dose and Risk Factor file?: This file can be very large if an assessment contains more than a couple of nuclides. It contains all the dose and risk factors used in the calculations.

Create Concentration Table file?: This file can be very large also. There are four values for each distance and direction for every radionuclide in the assessment.

Create Chi/Q Table file?: A table of χ/Q values for each radionuclide in the assessment.

4.3.3   Meteorological Data

The input data requested on this screen is fairly self-explanatory (Figure 4-22).

```
┌─────────────────────────────────────────────────────────┐
│                                  ┌──────────────────────┐ │
│                                  │  Sample Dataset      │ │
│              METEOROLOGICAL DATA └──────────────────────┘ │
│                                                           │
│                                                           │
│            Wind file to use:   ┌─────────┐                │
│                                │ UCC1026 │                │
│                                └─────────┘                │
│         Annual precipitation:  ┌──────┐   (cm/y)          │
│                                │ 100. │                   │
│                                └──────┘                   │
│    Annual ambient temperature: ┌─────┐   (°C)            │
│                                │ 10. │                    │
│                                └─────┘                    │
│               Height of lid:   ┌──────┐   (m)             │
│                                │ 1000 │                   │
│                                └──────┘                   │
│                                                           │
│                                                           │
│                                                           │
│                                                           │
├───────────────────────────────────────────────────────── │
│                                                           │
│  <Esc> Quit      < F2> Screen Menu    <PgUp/PgDn> Prev/Next   <
└─────────────────────────────────────────────────────────┘
```

Figure 4-22. METEOROLOGICAL DATA Screen

Wind file to use: This field is another list box (Figure 4-23). Press <**Space**> and your choices will appear. The search feature works here just as it does with other list boxes. A wind file must be selected for an assessment to execute.

```
ABQ0282
AGS1018
ALB0523
ALO0729
AMA0621
AMB0771
AVP0499
BAL1059
BDL1262
BDR0558
```
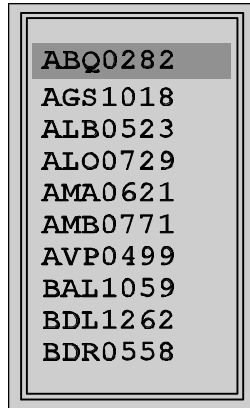
Figure 4-23. Wind List Box

A listing of weather data provided with CAP88-PC is provided in Appendix D. Users are encouraged to use site-specific weather data for making assessments with CAP88-PC.

AIRDOS Format Meteorological Files: Users who have been operating the CAP-88 mainframe software may download their weather files, in AIRDOS format, for use on the CAP88-PC system. Users are encouraged to compare these wind data files with the example files provided with the program to ensure that the new files are correctly formatted.

STAR Format Meteorological Files: Users who have stability arrays (STAR format) for use with CAP88-PC must first convert the data to AIRDOS format by using the GETWIND utility, as described in Chapter 7. An example of the proper STAR format for stability array files is shown in Appendix B. Users may also refer to the example stability array in the file SAMPLE.STR, which is provided with CAP88-PC and resides in the **\CAP88PC\WNDFILES** subdirectory.

In order for CAP88-PC to recognize a new wind data file, it must be copied to the **\CAP88PC\WNDFILES** subdirectory, and the filename must have the **.WND** extension.

Annual precipitation: The average annual precipitation (in centimeters).

Annual Ambient temperature: Average annual ambient temperature (in Celsius).

Height of lid: The height of the tropospheric mixing layer (in meters). This field must contain a positive non-zero value. A zero value will cause the AIRDOS program to abort when the dataset is executed.

4.3.4   <u>Source Data</u>

Some of the data requested on this screen depends on the values you assign to several toggle fields.

Source type: This field can be toggled between Stack (Figure 4-24) and Area (Figure 4-25) by pressing <**Space**>. Press the <**Enter**> key and go on to choose the number of sources.

```
┌──────────────────────────────────────────────────────────────────────┐
│                                                          ┌──────────────┐│
│                                                          │Sample Dataset││
│                                                          └──────────────┘│
│                              SOURCE DATA                                │
│                                                                        │
│                                                                        │
│      Source type:  Stack              Number of sources:   3           │
│            Source #:     1         2              3                     │
│                                                                        │
│                                                                        │
│          Height:  10.         5.           2.                          │
│              (m)                                                        │
│                                                                        │
│        Diameter:  1.          3.           5.                          │
│              (m)                                                        │
│                                                                        │
│      Plume rise:  Momentum    Enter exit velocity (meters/sec)         │
│                               for each source.                         │
│                   10          20           30                          │
│                                                                        │
│                                                                        │
│                                                                        │
└──────────────────────────────────────────────────────────────────────┘
 <Esc> Quit   <F2> Screen Menu    <PgUp/Dn> Prev/Next    <Space> Change
```

Figure 4-24. SOURCE DATA Screen With Stack and Momentum Selected

Number of Sources: Up to six (6) sources (stacks or areas) may be modeled. Press <**Space**> to toggle between 1 to 6 sources. Notice that the number of fields for Height, Diameter/Area, and Plume Rise Type (if Momentum or Buoyant) change as the number of sources change.

Height: Height of the source (in meters).

Diameter or Area: Diameter of stack (in meters), or the area of an Area source (in square meters).

Plume rise type: A toggle field. Use **<Space>** to select between Buoyant, Momentum, Fixed and Zero. If you select Buoyant, you will enter the heat release rate for each of the sources. If you select Momentum, you will enter the exit velocity for each source. If you select Fixed (Figure 4-25), you will enter the actual plume rise for each of the seven Pasquill Categories. If you select Zero, zero is entered for each of the seven Pasquill Categories, and no further action is required.

```
┌─────────────────────────────────────────────────────────────────────────┐
│                                                       ┌─────────────────┐ │
│                                                       │ Sample Dataset  │ │
│                                                       └─────────────────┘ │
│                            SOURCE DATA                                     │
│                                                                           │
│                                                                           │
│     Source type:   │ Area │          Number of sources: │ 3 │             │
│           Source #:    1          2          3                            │
│                                                                           │
│                                                                           │
│         Height:   ┌──────┐  ┌──────┐  ┌──────┐                            │
│           (m)     │ 10.  │  │ 5.   │  │ 2.   │                            │
│                   └──────┘  └──────┘  └──────┘                            │
│                                                                           │
│           Area:   ┌──────┐  ┌──────┐  ┌──────┐                            │
│           (m²)    │ 1.   │  │ 3.   │  │ 5.   │                            │
│                   └──────┘  └──────┘  └──────┘                            │
│                                                                           │
│       Plume rise: │ Fixed │       Enter plume rise (meters) for           │
│                                   each Pasquill category.                 │
│      A        B        C        D        E        F        G              │
│   ┌──────┐ ┌──────┐ ┌──────┐ ┌──────┐ ┌──────┐ ┌──────┐ ┌──────┐          │
│   │ 0    │ │ 0    │ │ 0    │ │ 0    │ │ 0    │ │ 0    │ │ 0    │          │
│   └──────┘ └──────┘ └──────┘ └──────┘ └──────┘ └──────┘ └──────┘          │
│                                                                           │
└───────────────────────────────────────────────────────────────────────────┘
   <Esc> Quit    <F2> Screen Menu      <PgUp/Dn> Prev/Next      <Space> Change
```

Figure 4-25. SOURCE DATA Screen With Area and Fixed Selected

4.3.5   Agricultural Data

This screen provides agricultural data for the assessment (Figure 4-26).

Source: This is a toggle field which presents several food source scenarios used by EPA. Use **<Space>** to select between Urban, Rural, Local, Regional, Imported and Entered. The various fractions change for each of the first five scenarios. The user cannot change the fractions in these scenarios. If you select Entered, however, you will be required to type in the usage values in the indicated fields. The program will require you to use values that sum to 1.0 in each of the three columns. When you attempt to leave the screen, an error message will appear if one or more of the columns do not sum to 1.0 (Figure 4-27).

Figure 4-26. AGRICULTURAL DATA Screen

Figure 4-27. Fractions Entered Error Message

Beef cattle density: Beef cattle state productivity data (beef cattle per square kilometer, etc.) can be typed in directly by the user (must be a positive non-zero value).

Milk cattle density: Milk cattle state productivity data (milk cattle per square kilometer, etc.) can be typed in directly by the user (must be a positive non-zero value).

Land fraction cultivated for vegetable crops: Vegetable crop state productivity data can be typed in directly by the user (must be a positive non-zero value).

The values that come up initially on the screen for the preceding three fields are state averages that may or may not be current. The user is encouraged to enter more current data, if available. If the user changes these values but decides to return to the defaults, it is necessary to return to the FACILITY INFORMATION Screen and re-select the appropriate **state**. If any of these fields contain a zero, the AIRDOS program will abort when the dataset is executed.

4.3.6   Radionuclide List

The RADIONUCLIDE LIST screen allows you to select Radionuclides for an assessment. If no nuclides have been selected the screen will have no radionuclides displayed and a message at the bottom will inform the user.

4.3.6.1   Selecting Radionuclides: Radionuclides are chosen using a list box (Figure 4-28), which appears when you press **<Space>**. Use the cursor keys or the letter search function to highlight the radionuclide you want to select, and press **<Enter>**. You may select up to 36 radionuclides for inclusion in the list.

```
                                                    ┌──────────────┐
                                                    │Sample Dataset│
                                                    └──────────────┘
                         RADIONUCLIDE LIST

              Nuclide
                               ┌──────────────┐
              [         ]      │   U-232      │
                               │   U233       │
                               │   U-234      │
                               │   U-235      │
                               │   U-237      │
                               │   U-238      │
                               │   U-240      │
                               │   W-181      │
                               │   W-185      │
                               └──────────────┘

          No nuclides have been selected, Press <Space> to select a nuclide.


   <Esc> Exit Menu   <↑><↓><PgUp><PgDn> Move    <letter> Search  <Enter> Select
```
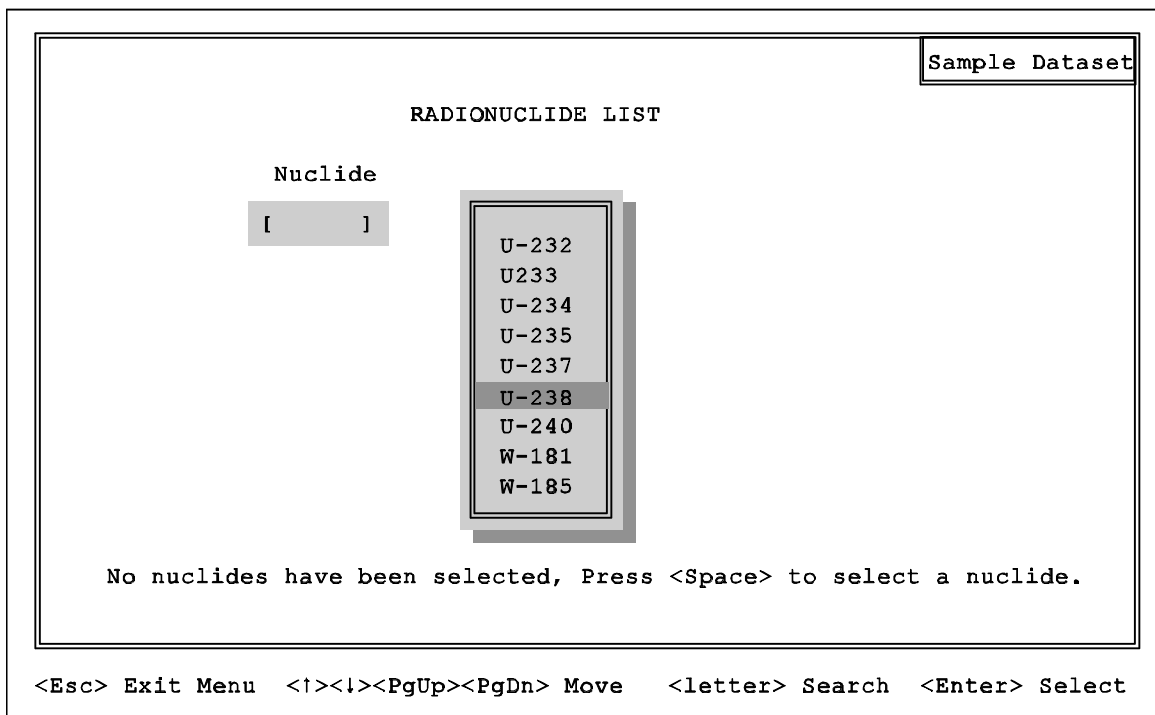
Figure 4-28. RADIONUCLIDE LIST Screen With No Radionuclides Selected

You may enter the same nuclide multiple times. If the nuclide has already been selected, however, a message (Figure 4-29) will appear informing you that it is already in the list. The message will give you the option of adding the nuclide. Press **<Y>** to add the nuclide, **<N>** to exit the message.

```
        The nuclide

          U-238

already appears in the list.


Do you want to add it (Y/N)?
```

Figure 4-29. Nuclide Already Exists Message

Also, you can select entire chains of nuclides and the program will automatically account for buildup of decay products in the chains. However, if you select a chain and the inclusion of that chain will cause the number of nuclides selected to exceed 36, a message will be displayed informing you that the chain cannot be added (Figure 4-30).

```
        Cannot add the
        Uranium Chain.

   There is not enough space
        left in the list.

Press a key to continue . . .
```

Figure 4-30. Cannot Add Chain Message

When 36 nuclides have been selected and you try to activate the list box to add another nuclide, a message will come up informing you that 36 nuclides have already been selected, and no additional nuclides can be selected (Figure 4-31).

```
Nuclide list is full.

Additional nuclides cannot be added
   until one or more are deleted.

Press a key to continue. . .
```

Figure 4-31. Nuclide List Is Full Message

4.3.6.2   Chains. There are two complex chains and four simple chains available on CAP88-PC. The following are the radionuclides and the chains that can be selected when you select that radionuclide:

!   Cs-137   Cesium (simple)
!   Ba-140   Barium (simple)
!   Mo-99   Molybdenum (simple)
!   Pb-210   Lead (simple)
!   U-238   Uranium (complex)
!   Th-232   Thorium (complex)

When one of these radionuclides is selected, a dialogue box will appear, informing you that the nuclide is the beginning of a chain (Figure 4-32), and asking you if you want to add the chain. If you respond with **<Y>** and there is enough room in the list, the entire chain will be added to the list. If you respond with **<N>**, only the individual nuclide will be added to the list. When a chain is added, all radionuclides in the chain count toward the total of 36.

```
The selected nuclide
        U-238
is the beginning of the
     Uranium chain.

Add the chain (Y/N)?
```

Figure 4-32. Chain Message

When chains are included in the radionuclide list, all radionuclides in the chain will be displayed with a double-line to the right of them, beginning with the first radionuclide in the chain and ending with the last radionuclide in the chain (Figure 4-33).

```
                                           ┌─────────────────┐
                                           │ Sample Dataset  │
                                           └─────────────────┘
                        RADIONUCLIDE LIST

           Nuclide            Nuclide

           U-238   ┐        BI-210    ┐
           TH-234  │        PO-210    ┘
           PA-234  │        H-3
           U-234   │        I-125
           TH-230  │        CS-137    ┐
           RA-226  │      ▶ BA-137M   ┘
           RN-222  │
           PO-218  │          [      ]
           PB-214  │
           BI-214  │
           PO-214  │
           PB-210  ┘

            Number of nuclides:  18


  <Esc>Quit   <F2>Scr Menu   <PgUp/Dn>Prev/Next   <Space>List Box   <Delete> del
```
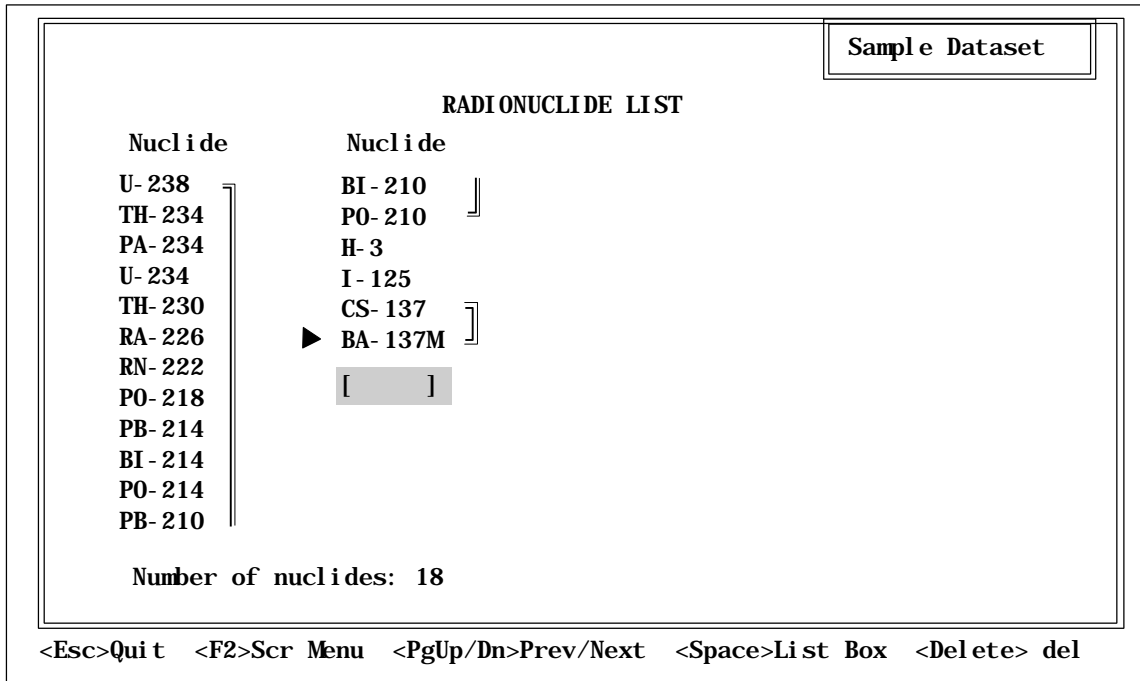
Figure 4-33. RADIONUCLIDE LIST Screen With Chains Selected

4.3.6.3   Delete Radionuclides: To delete radionuclides from the radionuclide list, highlight the radionuclide you want to delete and press <**Delete**>. If the nuclide is in a chain, a message will appear (Figure 4-34).

```
        ┌──────────────────────────┐
        │      The nuclide         │
        │         TH-234           │
        │     is a member of the   │
        │      Uranium chain.      │
        │                          │
        │   Delete the chain (Y/N)?│
        └──────────────────────────┘
```
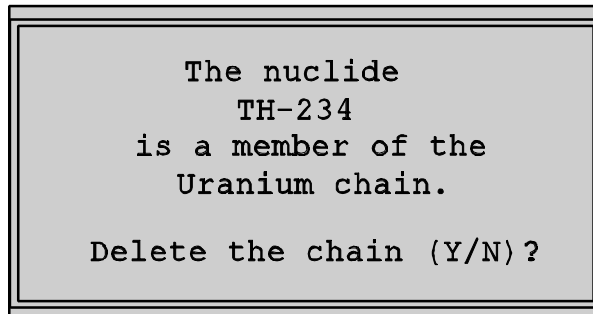
Figure 4-34. Delete Chain Message

The message gives you the option of deleting the entire chain. If you press **<N>**, no action is taken and you are returned to the radionuclide list (you cannot delete an individual nuclide from a chain).

4.3.7   Release Data

After at least one radionuclide has been selected in the RADIONUCLIDE LIST screen, you can use the RELEASE DATA screen to enter release rates for each radionuclide (Figure 4-35). If no nuclides have been entered, a message will pop up informing the user (Figure 4-36).

```
                                              ┌─────────────────┐
                                              │ Sample Dataset  │
                                              └─────────────────┘
                           SIZE AND CLASS DATA
              Source #:  <1>   2   3

              Nuclide Size   Class          Nuclide Size   Class

              U-238    1.0   Year           BI-210  1.0   Week
              TH-234   1.0   Year           PO-210  1.0   Week
              PA-234   1.0   Year           H-3     0.0   Gas
              U-234    1.0   Year           I-125   1.0   Day
              TH-230   1.0   Year
              RA-226   1.0   Week
              RN-222   1.0   Gas
              PO-218   1.0   Week
              PB-214   1.0   Day
              BI-214   1.0   Week
              PO-214   1.0   Week
              PB-210   1.0   Day

  <Esc>Quit   <F2>Scr Menu   <PgUp/Dn>Prev/Next   <Space>Change
```

Figure 4-35. RELEASE DATA Screen

```
          Nuclide list is empty.


          Select nuclides using the
          RADIONUCLIDE LIST screen.
```

Figure 4-36. Empty Nuclide List Message

Source #: A number will be displayed for each of the sources selected. For example, if 2 sources were selected on the SOURCE DATA screen, then a **1** and a **2** will be displayed on the screen. The source that is currently active (ready for release rates to be entered or changed) will be enclosed in angle brackets (**<1>**). If more than one source has been selected, you can press the <**F3**> key to change the **source #**.

Nuclide Release Rate (Ci/y): The release rates can be entered in decimal or exponential notation. When the **source #** changes, the release rates for that particular **source #** will be displayed to the screen and can be altered as necessary. Nuclides cannot be added or deleted while in this screen.

4.3.8   Size & Class Data

After at least one radionuclide has been selected using the Radionuclide List screen, you can use the SIZE & CLASS DATA screen to select particle size and clearance class for each nuclide (Figure 4-37). The data that comes up on the screen when you are creating a new dataset are the defaults for each nuclide. Both the size and class

are toggle fields. Use the <**Space**> bar to toggle

Figure 4-37. SIZE & CLASS DATA Screen

between the valid choices. Some radionuclides have only one choice, and others have up to four valid choices. Some radionuclides have no valid classes and are identified by a series of dashes, '----', in the Class field. Only the valid choices or dashes will be displayed as you toggle through the choices.

Size: Activity medium aerodynamic diameter (μm) (AMAD) for particulates. Particle size (AMAD) in μm for inhaled particles.

Class: Lung clearance class for inhaled particles. If a Class field contains '----', then class is not applicable to that particular radionuclide.

4.3.9   Quit Menu

The QUIT MENU (Figure 4-38) is activated by pressing **<Esc>** from one of the Data Entry/Selection screens. It can also be activated by selecting the Quit option from the SCREEN MENU. The QUIT MENU allows you to either save the current data as a dataset, or quit without saving.
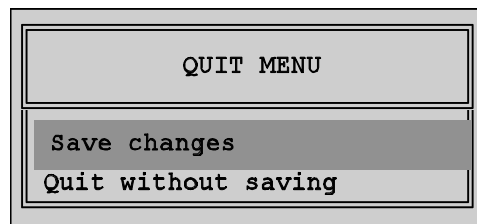
Figure 4-38. QUIT MENU

Use the cursor keys to highlight the desired choice and press **<Enter>** to select it. If you select **Quit without saving**, all the data you have entered using the Date Entry/Selection screens will be discarded, and there will be no way to retrieve it. If you select **Save changes**, the SAVE MENU will appear (Figure 4-39).
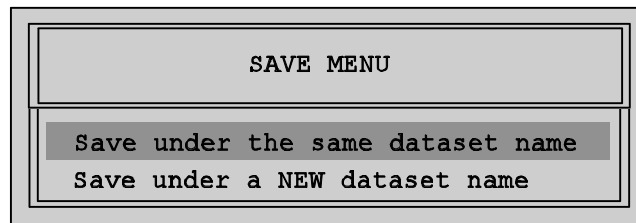
Figure 4-39. SAVE MENU

Once again, use the cursor keys to highlight the desired choice and press **<Enter>** to select it. If you choose **Save under the same dataset name**, all of the data in the Date Entry/Selection screens will be saved under the current dataset name. If you

select **Save under a NEW dataset name**, a dialogue box will appear, asking you to enter the new dataset name (Figure 4-40).

```
    Please enter a new
      dataset name:

[                    ]
```
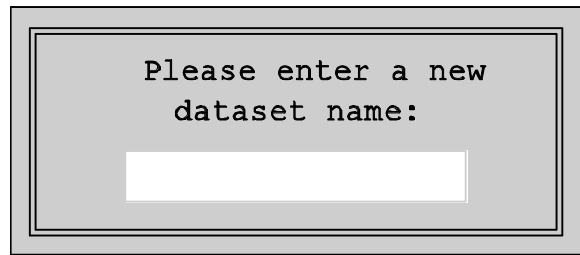
Figure 4-40. New Dataset Name Entry

After you enter a dataset name, the program will check to make sure no other datasets with the same name exist. If one is found, a dialogue box will appear (Figure 4-41). This process will continue until you enter a dataset name that does not exist.

```
          Dataset
           test
      already exists,

Press any key to continue...
```
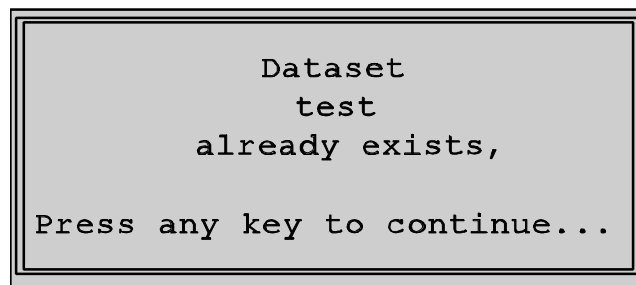
Figure 4-41. Dataset Exists Message

4.4   EXECUTION ERRORS

The following are possible errors that could occur during execution. Some are run time errors that might be attributable to such things as lack of memory or other memory-related problems, lack of disk space, divide by zero, etc. The entirety of the CAP88-PC system has been thoroughly and rigorously tested, but as with any program, there is always the possibility that an undiscovered bug could appear.

4.4.1   Screen Interface

There are several error conditions that could arise and prevent the screen interface from completing a particular function. When the program detects one of these errors, a message will appear, informing you that a particular error has been encountered. It is also possible that an undocumented error will occur, in which case it is recommended that you document the sequence of events that caused the error, and contact the EPA (as specified in section 4.4.3).

4.4.1.1   Out of Disk Space. If the program is writing a file and runs out of disk space, a message will be displayed (Figure 4-42).

```
                FILE ERROR!

          Error encountered while
          attempting to close file

                  c.SCR

               in directory

                 CAP88PC
        Press any key to continue...
```
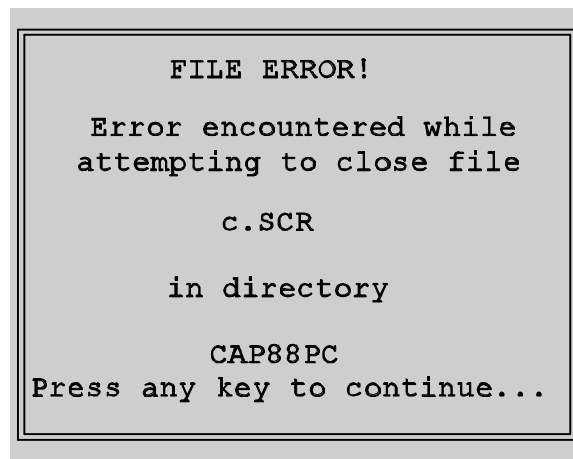
Figure 4-42. FILE ERROR (Closing) Message

If the message refers to a file with an extension of .SCR, the error was encountered while the program was attempting to save a dataset file. Pressing any key in response to the message will allow you to continue using the program, but you cannot be guaranteed that the dataset was saved in its entirety. To remedy this situation, you will need to free up some space on the hard disk you are running CAP88-PC from. To do this, take one or more of the following actions:

! Select the **Delete File(s)** option from the Main Menu and delete specific output files or complete datasets that are no longer needed.

! Exit the program and delete unnecessary files from the hard drive. **Do not use DOS to delete any files from the CAP88PC directory or any of its subdirectories.** The only way you can safely delete CAP88-PC files is by using the Delete option from the Main Menu.

! If the first two steps do not free a substantial amount of disk space, you will need to save complete datasets (with the associated output) to floppy disks. Follow the guidelines in section 4.2 in the paragraph concerning maximum datasets.

4.4.1.2   No Population Files. This message will be displayed if the program cannot find any population files (Figure 4-43). This check is performed when you are creating/modifying a dataset and press <Space> while the population file field is active. If the message is displayed, you will be able to modify and save the dataset, but you will not be able to select a population file for the dataset, and thus will not be able to execute the dataset.

If this error occurs, follow the instructions in section 2.4 to reload the population files from the installation disk.

```
          No population files found!

        refer to section 2.4 in the User's
        Guide for instructions on loading
          the population files onto our
                     hard disk.

           Press any key to continue...
```
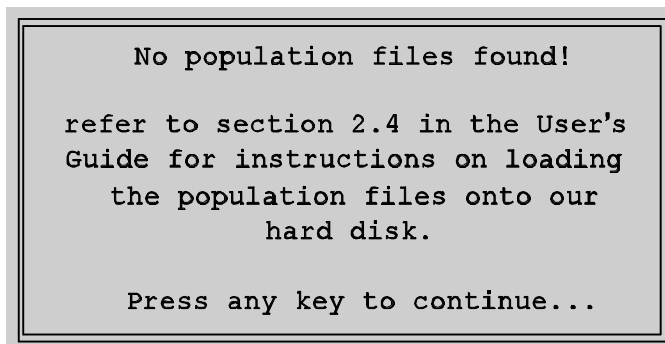
Figure 4-43. No Population Files Found! Message

4.4.1.3   No Wind Files. A message similar to Figure 4-43 will be displayed if the program cannot find any wind files. This check is performed when you are creating/modifying a dataset and press <Space> while the wind file field is active. If the message is displayed, you will be able to modify and save the dataset, but you will not be able to select a wind file for the dataset, and thus will not be able to execute the dataset.

If this error occurs, follow the instructions in section 2.4 to reload the wind files from the installation disk.

4.4.1.4   Population File Does Not Exist. When you choose to execute a dataset, the system checks to make sure that the population file specified in the dataset exists.   If the population file no longer exists, a message will be displayed. The message will notify you that execution has been aborted, and will specify the name of the missing population file (Figure 4-44)

```
┌─────────────────────────────────────────┐
│ ┌─────────────────────────────────────┐ │
│ │                                     │ │
│ │        Execution aborted.           │ │
│ │                                     │ │
│ │        Population file              │ │
│ │           RMICOMPY                  │ │
│ │          not found!                 │ │
│ │                                     │ │
│ │                                     │ │
│ │ Press any key to return to MAIN MENU... │ │
│ └─────────────────────────────────────┘ │
└─────────────────────────────────────────┘
```
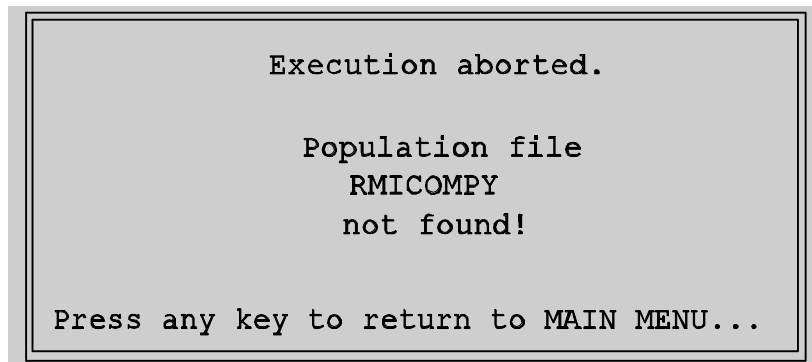
Figure 4-44. Population File Not Found Message

If the population file is one of the ones provided with the Installation Disk (listed in section 4.3.2), follow the instructions in section 2.4 to reload the population files from the Installation disk. If the population file is not one that was provided with the system, you will need to either locate a copy of the file and place it into the POPFILES subdirectory, or select another population file for the dataset.

4.4.1.5   Wind File Does Not Exist. When you choose to execute a dataset, the system checks to make sure that the wind file specified in the dataset exists.   If the wind file no longer exists, a message similar to Figure 4-44 will be displayed. The message will notify you that execution has been aborted, and will specify the name of the missing wind file.

If the wind file is one of the ones provided with the Installation Disk (listed in Appendix D), follow the instructions in section 2.4 to reload the wind files from the Installation disk. If the wind file is not one that was provided with the system, you will need to either locate a copy of the file and place it into the WNDFILES subdirectory, or select another wind file for the dataset.

4.4.1.6   Population File Error. If the system finds the appropriate population file during dataset execution, it will make sure that all of the required information can be read from the file without error. If an error is encountered, execution of the dataset will be aborted, and a message will be displayed (Figure 4-45).

```
        Execution aborted.

       Error encountered while
    reading from population file
              ARGONNE
       Refer to section 4.4.1 in
          the User's Guide.

   Press any key to return to MAIN MENU...
```

Figure 4-45. Population File Error Message

If this error is encountered, you will need to check the contents of the offending
population file against the format listed in Appendix F. While the message is being
displayed, make a note of the population file name. Next, exit the program, and change
directory (CD) to the POPFILES subdirectory. The actual DOS filename of the
population file will be <prefix>.POP, where <prefix> is the name that the message
displayed. The file contains standard ASCII text and can be viewed using a text editor.
If you cannot locate the cause of the problem by checking the format of the file, contact
the EPA (as specified in section 4.4.3).

4.4.1.7   State File Error. This message will be displayed if the program encounters
an error while reading state-specific data from a data file (Figure 4-46). This check is
performed when you are creating/modifying a dataset and press **<Space>** while the
state field is active. If the message is displayed, you will be able to modify and save
the dataset, but you will not be able to select a state for the dataset, and thus will not
be able to execute the dataset.

```
    Error #3 encountered while
  attempting to read state data.

    Refer to section 4.4.1 in
        the User's Guide.


    Press any key to continue...
```
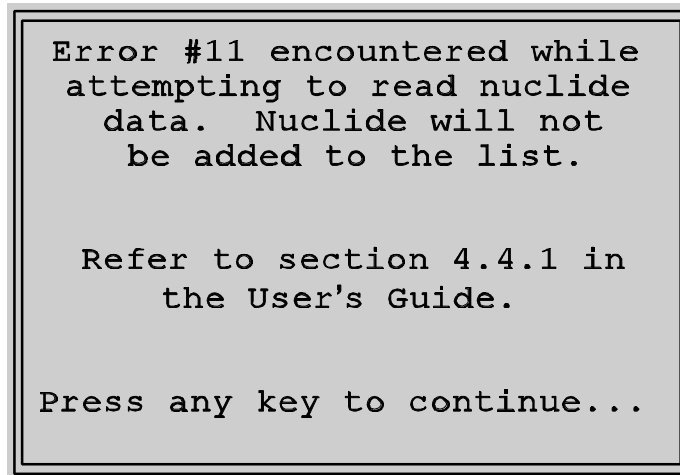
Figure 4-46. State File Error Message

If this error occurs, contact the EPA (as specified in section 4.4.3).

4.4.1.8   Nuclide File Error. This message will be displayed if the program encounters an error while reading nuclide-specific data from a data file (Figure 4-47). This check is performed when you are creating/modifying a dataset and press **<Space>** while the nuclide list is active. If the message is displayed, you will not be able to add the selected nuclide to the nuclide list. You will be able to modify, save, and execute the dataset.

```
   Error #11 encountered while
    attempting to read nuclide
       data.  Nuclide will not
        be added to the list.


     Refer to section 4.4.1 in
         the User's Guide.


  Press any key to continue...
```

Figure 4-47. Nuclide File Error Message

If this error occurs, contact the EPA (as specified in section 4.4.3).

```
     Error  encountered while
     attempting to write the
        nuclide dump file.


     Refer to section 4.4.1 in
         the User's Guide.


  Press any key to continue...
```

Figure 4-48. Nuclide Dump File Error Message

4.4.1.9   Nuclide Dump File Error. This message will be displayed if the program encounters an error while writing a specific file that contains nuclide list data (Figure 4-48). This file is not used by the system, but is written every time you exit the program,

and can be used to help diagnose problems. If the message is displayed, it will not affect the functionality of the system.

If this error occurs, contact the EPA (as specified in section 4.4.3).

4.4.1.10   Not Enough Memory to Execute. This message indicates that a program is too large to load into memory, or that execution cannot continue due to lack of memory. If this happens, try doing the following:

  ! Remove terminate-and-stay-resident programs (TSRs) such as the DOS Shell, or other shells, menu systems, etc. You may need to reboot your machine to remove some TSRs.

  ! Check your AUTOEXEC.BAT file for commands that load TSRs. If you have your AUTOEXEC.BAT file configured to load a menu system or other application, commenting out these lines and re-booting will give you more memory.

  ! Check your CONFIG.SYS file for 'DEVICE=' commands. These commands load device drivers into memory. Commenting out unnecessary lines and re-booting will give you more memory.

  ! Check your CONFIG.SYS file for the 'BUFFERS=' command. If more than 20 are assigned, reducing the number to 20 and re-booting will give you more memory.

After doing the above, try running the system again.

4.4.2   FORTRAN Programs

If you encounter an error during execution of an assessment which is not documented here, document the problem and contact EPA (as specified in section 4.4.3).

4.4.2.1   Math Coprocessor: If you try to execute CAP88-PC without a math coprocessor, the computer will freeze and you will have to reboot. **There will be no message to warn you of this condition**. If you do need to utilize CAP88-PC without a math coprocessor, contact EPA (reference section 4.4.3) and it may be possible to provide you with a specially compiled version that will run without a coprocessor. You must realize, however, that CAP88-PC would run very slowly without a coprocessor.

4.4.2.2   Lack of Disk Space: If any of the FORTRAN programs encounter a lack of disk space when they attempt to write to a file, the following type of message will be displayed:

Unable to Write File (See Section 9.4 in F77L Manual), File=
\CAP88PC\OUTPUT**file name, Unit=**xx**, Record=**xx**, Position=**x **in**
subroutine name **called by** _calling subroutine

4.4.2.3   Lack of Memory: If any of the FORTRAN programs encounter a lack of memory, the following type of message will be displayed:

Too Big to Fit into Memory

4.4.2.4   RADRISK File Errors: The DARTAB code will terminate if it detects certain error conditions when reading either one of the two RADRISK data files. If this happens, one of the following messages will be written to the file ERROR.FIL, which is located in the CAP88PC directory:

NUC = xxxxxxx **FROM THE RADRISK1.DAT FILE DOES NOT**
MATCH THE CURRENT NUCLIDE = xxxxxxx

> This message means that the program has not found the correct radionuclide in the RADRISK1.DAT file, which contains ingestion dose and risk factors. If this happens, follow the directions in Section 4.4.3.

NUC = xxxxxxx **FROM THE RADRISK2.DAT FILE DOES NOT**
MATCH THE CURRENT NUCLIDE = xxxxxxx
RADRISK2 = xxxxxxx   **SKIP =** xxxxx

> This message means that the program has not found the correct radionuclide in the RADRISK2.DAT file, which contains inhalation dose and risk factors. If this happens, follow the directions in Section 4.4.3.

NUC = xxxxxxx   **NUCLIDE =** xxxxxxx
GI_INH_RAD2 = x.xxxE-xx   **GI_INH(K) (FROM INPUT.DAT) =** x.xxxE-xx
DON'T MATCH

> This message means that the program has found a discrepancy between the inhalation factor in the INPUT.DAT file (generated by the screen package) and the RADRISK2.DAT file. If this happens, follow the directions in Section 4.4.3.

TRYING TO READ PAST THE LAST RADRISK2.DAT RECORD FOR   NUCLIDE
xxxxxxx
NUC = xxxxxxx   **M =** xxx   **NR_INH_FCTRS =** xxx

This message means that the program could not find an appropriate matching inhalation record in the RADRISK2.DAT file. If this happens, follow the directions in Section 4.4.3.

4.4.3   <u>What To Do If Errors Occur</u>

This section outlines the course of action you should take if you encounter an apparent error with the CAP88-PC system.

If the error occurred during the use of the screen interface, try to locate the error condition in section 4.4.1. If the error occurred while executing a dataset, try to locate the error condition in section 4.4.2. If the error is not listed in the appropriate section, check for obvious situations that may be causing the error, such as lack of disk space, insufficient memory, etc., and take actions to correct these situations if you determine they are present.

If the cause of the problem is unclear, there may be a bug within one of the programs. Do the following if you encounter any unresolvable problems:

! Make a note of exactly what actions you took that produced the error, and try to reproduce it. If the error involves a particular dataset, make a note of the dataset name.

! Contact Barry Parks of the EPA Office Of Radiation Programs in Las Vegas at (702) 798-2443 or FTS 545-2443. If the problem cannot be readily resolved, continue the process as described in the remaining steps.

! Re-run CAP88-PC and exit the Main Menu by pressing <**Esc**>. This causes a new copy of the **PREFIXES.DAT** file to be written by the system. Print or view on your screen the PREFIXES.DAT file, to determine the **DOS File Prefix** of the dataset that you were using when you encountered the problem.

! Copy the dataset file onto a floppy disk. The DOS filename of the dataset file is <prefix>.**SCR**, where <prefix> is the **DOS File Prefix** of the dataset as listed in the PREFIXES.DAT file. The dataset file is located in the **\CAP88PC\DATASETS** subdirectory.

! If the error occurred during execution of a dataset:

   ! Copy the file **INPUT.DAT** onto the floppy disk that contains the dataset file. This file is located in the **CAP88PC** directory. This must be done before any other datasets are executed since this file is overlayed each time the execute option is selected on the main menu.

! Go to the CAP88PC directory and check to see if anything has been written to the file **ERROR.FIL**. If this file contains any error messages, copy the file to the floppy disk containing the dataset file.

! Send the floppy disk, along with any other information that might be helpful in resolving the problem, to:

Barry Parks
EPA Office Of Radiation Programs
Las Vegas Facility
P.O. Box 98517
Las Vegas, NV 89193-8517
Phone (702) 798-2443 FTS 545-2443

Chapter 5

DEFAULT FILE CHANGES

5.1 PURPOSE OF DEFAULT FILE

The DEFAULT.DAT file contains various types of default data for CAP88-PC. The file is divided into two segments. The first segment contains default values that can, with great caution, be changed by the user. The second segment contains permanent defaults which are values that must **never** be changed by the user since any changes would corrupt the assessments.

5.1.1 User Changeable Defaults

The defaults contained in the DEFAULT.DAT file for meteorological data, inhalation and ingestion rates, water use and agricultural productivity are the values approved by EPA to demonstrate compliance as required by 40 CFR 61.93(a).

> **CAUTION: Any modification to the DEFAULT.DAT file must be approved by EPA if the modified parameters are used to demonstrate compliance per 40 CFR 61.93(a).**

There may be users who, in rare instances, might need to change one or more of these values for a specific purpose. The user, however, should be fully aware that these values must only be changed when and if the user fully understands the full impact that the change(s) will have upon the assessments run with the user specified values.

> **CAUTION: If any of these values are changed without full knowledge of the impact of the change(s), the resulting assessments could be invalid for the intended purpose.**

5.1.2 Permanent Defaults

The default values found in the second segment of the file contains defaults that must not be changed by the user. These values are contained in the DEFAULT.DAT file so that if directed by EPA, applicable defaults can be easily changed within this file and promptly disseminated to all users. This will preclude the necessity of modifying program code and disseminating new executable programs.

5.2 CHANGEABLE DEFAULTS

5.2.1 Variable Names and Descriptions

The following is a list of variable names whose values can be changed by the user. Also included are their units of measure, default values and a brief description. The variable names here will match the names you will see in the DEFAULT.DAT file. They are grouped in categories such as meteorological, agricultural, etc.

VARIABLE	UNITS	DEFAULT	DESCRIPTION
		Meteorological Defaults	
TG	^{N}K/m	.0728 .1090 .1455	Vertical temperature gradient for Pasquill categories E, F, and G (three element array)
		Default Rates	
BRTHRT	cm^3/hr	9.167E+5	Inhalation rate of man
DD1		0.5	Fraction of radioactivity retained on leafy vegetables and produce after washing
UF	kg/yr	85.0	Ingestion rate of meat by man
UL	kg/yr	18.0	Ingestion rate of leafy vegetables by man
UM	liter/yr	112.0	Ingestion rate of milk by man
UV	kg/yr	176.0	Ingestion rate of produce by man
		Water Defaults	
DILFAC	cm	1.0	Depth of water for dilution for water immersion doses
USEFAC		0.0	Fraction of time spent swimming

Agricultural Defaults

FSUBG		1.0	Fraction of produce ingested grown in garden of interest
FSUBL		1.0	Fraction of leafy vegetables grown in garden of interest
FSUBP		0.4	Fraction of year animals graze on pasture
FSUBS		0.43	Fraction of daily feed that is pasture grass when animal grazes on pasture
LAMW	hr^{-1}	2.9E-3	Removal rate constant for physical loss by weathering
MSUBB	kg	200.0	Muscle mass of animal at slaughter
P	kg/m^2	215.0	Effective surface density of soil, dry weight (assumes 15 cm plow layer)
QSUBF	kg/day	15.6	Consumption rate of contaminated feed or forage by an animal (dry weight)
R1		0.57	Fallout interception fraction-pasture
R2		0.2	Fallout interception fraction-vegetables
TAUBEF		3.81E-3	Fraction of animal herd slaughtered per day
TSUBE1	hr	720.0	Period of exposure during growing season--pasture grass
TSUBE2	hr	1440.0	Period of exposure during growing season--crops or leafy vegetables
TSUBF	day	2.0	Transport time: animal feed-milk-man

TSUBH1	hr	0.0	Time delay--ingestion of pasture grass by animals
TSUBH2	hr	2160.0	Time delay--ingestion of stored feed by animals
TSUBH3	hr	336.0	Time delay--ingestion of leafy vegetables by man
TSUBH4	hr	336.0	Time delay--ingestion of produce by man
TSUBS	day	20.0	Average time from slaughter of meat animal to consumption
VSUBM	liter/day	11.0	Milk production of cow
YSUBV1	kg/m^2	0.28	Agricultural productivity by unit area (grass-cow-milk-man pathway)
YSUBV2	kg/m^2	0.716	Agricultural productivity by unit area (produce or leafy vegetables ingested by man)
TSUBB	yr	100.0	Period of long-term buildup for activity in soil

<u>Miscellaneous Input Values</u>

ILOC		0	Direction index of the single location used for individual calculations
JLOC		0	Distance index of the single location used for individual calculations
PLOC		100.0	The percentile of the total risk to use in choosing the location for the exposure array used for the individual tables. When ILOC and JLOC are both 0, PLOC is used.
GSCFAC		0.5	A scaling factor used to correct ground surface dose factors for surface roughness

5.2.2   Changing Default Values

The DEFAULT.DAT file is located in the CAP88PC directory of the drive you have
chosen to load the system on. Go to this directory. Before you change anything in this
file, you may want to make a copy of the original DEFAULT.DAT file giving it a different
extension or save it on a floppy disk so that it can be easily retrieved.

Access DEFAULT.DAT (an ASCII file) using a word processor or a text editor. Find the
variable name whose value you want to change and simply replace the default value
with the value you want to use. The following are some conditions the user needs to be
aware of.

!   Additional digits can be included, exponential notation can be used in
         place of decimal numbers and decimal numbers can replace
         exponential notation. Integer values should remain integers.

!   Do not delete any variables. The program will not abort but either zero or
         some unpredictable value will be used which will invalidate the assessment
         results.

!   Do not move the variables around. They must remain in the original
         order and category. Each category begins with an Ampersand (&)
         followed by four or more descriptive characters. Each category ends
         with an &END. The &END must follow the last variable in the category
         or be on a line by itself immediately following the last variable.

!   The beginning of a category must be at the beginning of a line and
         there must be one or more spaces separating it from the first variable
         in the category.

!   Do not change the order or delete any of the categories. If the order is
         changed or any category is eliminated the CAP88-PC system will
         abort and/or produce totally invalid assessment results.

!   Additional lines can be added and variables moved from one line to
         another as long as the order of the variables does not change.

!   There are no required number of spaces between variables but the
         variables must be separated by commas. A comma is not required
         between the last variable in a category and &END.

!   Be sure not to eliminate the equal (=) sign between the variable and
         the value or values in the case of an array. The variable TG is a three
         element array; therefore, TG is followed by a single = sign which is
         then followed by three values separated by commas. TG(1) will

contain .0728, TG(2) and TG(3) will contain the next two values
respectively. If any or all of these values should ever be changed, be
sure the values are entered in the correct order.

! Change only the variables listed in 5.2.1 (Variable Names and
Descriptions). Do not alter in any way the variables and values in the
categories that follow the &INPUT category.

Save the user altered file into DEFAULT.DAT after making sure that you have saved
the original DEFAULT.DAT so that it will not be destroyed by your altered file. The new
file is then ready to be used with the CAP88-PC System.

5.2.3   Restoring DEFAULT.DAT Values

When an assessment is executed The DEFAULT.DAT file is checked for changes. If
changes have been made to defaults listed in Section 5.2.1, the changes will be printed
to the screen (Figure 5-1) including the description, the original default value and the
user specified value. After all changes have been printed to the screen, the user is
given the opportunity to reset **all defaults** back to their original values with a response
of Y or N. It is not possible to reset individual values at this point. Individual changes
can only be made directly accessing the DEFAULT.DAT file using a text editor or word
processor as described in Section 5.2.2.

```
                    W A R N I N G !

  The Following Default Values Have Been Changed,
  DO NOT USE these changes unless you fully understand
  the EFFECTS of these Changes:


These changes CANNOT BE USED to demonstrate compliance
per 40 CFR 61.93 unless specifically approved by EPA.

          Inhalation Rate of Man

       Changed From:  9.1670E+05

                 To:  8.5300E+05

   Resetting of individual defaults cannot be done here.
   CHANGE ALL DEFAULTS Back to their Original Values?
                    Y/N:
```

Figure 5-1. Default WARNING Message

If the user elects to have all defaults reset, all defaults will be overwritten with the original
defaults. The overwritten DEFAULT.DAT file will look a little different from the original file;

however, the only actual difference will be the spacing of the variables. The variable names and values will be closer together using less lines.

5.2.4 Alternative DEFAULT.DAT Files

The user may want to create alternative default files with user specified values. Before initiating the CAP88-PC system the user would copy the default file they need for a given run into DEFAULT.DAT.

WARNING: CAP88-PC must have a DEFAULT.DAT file available in order for it to run.

It is not possible to alter any of the specified default values once CAP88-PC has been initiated except to reset all defaults to their original values. Therefore, when a user needs alternative default values it is the user's responsibility to assure that the appropriate alternative DEFAULT.DAT file is available when CAP88-PC is initiated.

When a DEFAULT.DAT file containing user altered default values is used, there will be a CAUTION message on the beginning page of the SYNOPSIS Report stating that defaults have been changed. The specific changes will be listed on the following page including the default description, the original default value, and the user specified value. This will alert the originators and anyone using the outputs that defaults have been changed and what changes have been made.

5.3 PERMANENT DEFAULTS

The DEFAULT.DAT file contains defaults that must not be changed by the user. All defaults beginning with &ORGAN through the end of the file must contain the original default values which can only be changed at the direction of EPA.

```
Permanent Defaults that MUST NOT BE ALTERED by the user
have been changed.   They will be RESET to prevent CAP88-PC
from producing invalid results.
```

Figure 5-2. Reset of Permanent Defaults Message

If any of the permanent defaults are changed, except at the direction of EPA, the CAP88-PC system will detect those changes and reset them to their original values. If this should happen a message will be printed to the screen informing the user that these permanent defaults have been reset (Figure 5-2). If the user has changed default values defined as changeable by the user, the system will not reset those user changeable values except at the direction of the user.

Chapter 6

SAMPLE ASSESSMENT

6.1   CAP88-PC SAMPLE INPUT SCREENS

The following screens contain the data used to generate a sample assessment as an
example for the user. This sample assessment was generated using the CAP88-PC
screen interface and the outputs are the outputs generated by executing this assessment
from the main menu. The following screens are the data entry/selection screens used to
generate the assessment.

```
                                                    ┌──────────────────┐
                                                    │ Reactive Metals  │
                           FACILITY INFORMATION     └──────────────────┘

                      Dataset Date:   March 10, 1992 2:13 pm
            Facility:  Reactive Metals

            Address:  Address

               City:  Ashtabula          State:  Ohio

                Zip:             -

      emission year:  1986

    Source category:  DOE Facilities

           Comments:  Reactive Metals -- Population Run


       <Esc> Quit      < F2> Screen Menu      <PgUp/PgDn> Prev/Next
```

```
                                                            ┌─────────────────┐
                                                            │ Reactive Metals │
                                                            └─────────────────┘
                         RUN INFORMATION


                              Run type:     Population

                    Popultion file to use:  RMICOMPY

                   Generate genetic effects:   Yes

         Create Dose and Risk Factor file?     Yes

         Create Concentration Table file?      Yes

                 Crete Chi/Q Table file?       Yes
```

<Esc>Quit   <F2>Screen Menu   <PgUp/PgDn>Prev/Next   Space> List Box

```
                                                            ┌─────────────────┐
                                                            │ Reactive Metals │
                                                            └─────────────────┘
                         METEOROLOGICAL DATA


                   Wind file to use:     ERI0610

                   Annual precipitation:   89.    (cm/y)

              Annual ambient temperature:  1o.    (°C)

                        Height of lid:   8        (m)
```

<Esc>Quit   < F2>Screen Menu   <PgUp/PgDn>Prev/Next   <Space> List Box

```
                      SOURCE DATA                      ┌──────────────────┐
                                                       │ Reactive Metals  │
                                                       └──────────────────┘

     Source type: Stack              Number of sources:    6


     Source #:    1          2          3          4          5          6


     Height:  15.24      5.24       5.24       5.24       .62        0.06
      (m)

   Diameter:  .41        46         58         36         25         3
      (m)
 Plume rise: Momentum            Enter exit velocity (meters/sec)
                                      for each source.


              13.5       9.25       19.54      3.79       .94        15.04


 <Esc> Quit     <F2> Screen Menu     <PgUp/Dn>     Prev/Next     <Space> Change
```

```
                                                       ┌──────────────────┐
                                                       │ Reactive Metals  │
                                                       └──────────────────┘

                        AGRICULTURAL DATA


            Source: Urban        Vegetable      Milk         Beef

      Fraction home produced:     .076          .0          .008


  Fraction from assessment area:  .924          1.0         .992


         Fraction imported:       .0            .0          .0



         Beef cattle density:   2.030E-01    (#/km$^2$ )

         Milk cattle density:   4.560E-02    (#/km$^2$ )

      Land fraction cultivated
         for vegetable crops:   1.700E-02


 <Esc> Quit  <F2> Screen Menu    <PgUp/Dn> Prev/Next   <Space> Change
```

```
                                                    ┌──────────────────┐
                                                    │  Reactive Metals │
                                                    │                  │
                    RADIONUCLIDE LIST

            Nuclide


          ▶  U-234
             U-235
             U-236
             U-238

             [     ]


             Number of nuclides: 4

<Esc>Quit  <F2>Scr Menu  <PgUp/Dn>Prev/Next  <Space> List Box  <Delete> Del
```

```
                                                    ┌──────────────────┐
                                                    │  Reactive Metals │
                                                    │                  │
                       RELEASE DATA


            Source #:     <1>  2  3  4  5  6


            Nuclide          Ci/y


            U-234          2.30E-4
            U-235          1.73E-6
            U-236          0.
            U-238          2.38E-4

<Esc>Quit  <F2> Scr Menu   <PgUp/Dn> Prev/Next   <F3> ncrement Source #
```

```
Source #: 1 <2> 3 4 5 6

Nuclide  Ci/y

U-234    3.21E-4
U-235    2.33E-6
U-236    0.
U-238    3.21E-4
```

```
Source #: 1 2 <3> 4 5 6

Nuclide  Ci/y

U-234    3.18E-9
U-235    7.94E-7
U-236    0.
U-238    3.96E-4
```

```
Source #: 1 2 3 <4> 5 6

Nuclide  Ci/y

U-234    9.6E-13
U-235    2.4E-9
U-236    0.
U-238    1.2E-7
```

```
Source #:  1 2 3 4 <5> 6

Nuclide  Ci/y

U-234    0.
U-235    5.48E-6
U-236    0.
U-238    7.56E-4
```

```
Source #: 1 2 3 4 5 <6>

Nuclide  Ci/y

U-234    2.69E-8
U-235    3.4E-5
U-236    1.79E-6
U-238    3.55E-3
```

SIZE & CLASS DATA

Nuclide	Size	Class
U-234	1.0	Year
U-235	1.0	Year
U-236	1.0	Year
U-238	1.0	Year

<Esc>Quit   <F2>Scr Menu   <PgUp/Dn> Prev/Next <Space> Change

2   CAP88-PC SAMPLE OUTPUT

The following pages contain the output for a sample assessment. The following are a listing of all the possible outputs generated by CAP88PC.

Synopsis Report: The following document is the Synopsis Report generated by the sample assessment. The Synopsis Report contains a composite of the most generally used information generated by the assessment.

General Data: This file contains input data plus other general data. Includes radionuclide-dependent variables, radionuclide-independent variables, agricultural data, and Radon working levels.

Weather Data: This file contains the wind speeds and stability classes.

Dose and Risk Conversion Factors: This file contains: ingestion, inhalation, air immersion, and ground surface dose conversion factors; absolute health risk, years of life loss, and risk equivalent conversion factors for cancers due to ingestion, inhalation, air immersion, and ground surface exposure; and genetic dose conversion factors for ingestion, inhalation, air immersion, and ground surface exposures.

   Note: This sample output contains only the dose and risk factors for U-234 to conserve space.

Dose and Risk Equivalent Summary: This file contains the summaries of calculated exposures and risks, broken down by organ, pathway, radionuclide, and cancer.

Concentration Tables: This file contains the concentration tables generated by the AIRDOS code.

   Note: This sample output contains only a representative sample to conserve space.

Chi/Q Table: A table of χ/Q values for each radionuclide in the assessment.

6.2.1   <u>Synopsis Report</u>

                          C A P 8 8 - P C

                           Version 1.00

              Clean Air Act Assessment Package - 1988

                    S Y N O P S I S   R E P O R T

                  Non-Radon Population Assessment
                    Mar 11, 1992   8:11 am

       Facility: Reactive Metals
        Address: Address
           City: Ashtabula
          State: OH   Zip:

                    Effective Dose Equivalent
                          (mrem/year)
                   _____

                            7.48E-01
                   _____

     At This Location: 310 Meters East Northeast
      Source Category: DOE Facilities
          Source Type: Stack
        Emission Year: 1986

       Comments: Reactive Metals -- Population Run

        Dataset Name: Reactive Metals
        Dataset Date: Mar 10, 1992   2:13 pm
           Wind File: WNDFILES\ERI0610.WND
     Population File: POPFILES\RMICOMPY.POP

MAXIMALLY EXPOSED INDIVIDUAL

Location of the individual: 310 Meters East Northeast
Lifetime Fatal Cancer Risk: 1.00E-05

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)	Collective Population person-rem/y
GONADS	4.33E-04	5.53E-03
BREAST	7.33E-04	6.23E-03
R MAR	6.25E-03	1.54E-01
LUNGS	6.19E+00	1.01E+01
THYROID	3.88E-04	5.41E-03
ENDOST	7.97E-02	2.04E+00
RMNDR	7.64E-03	1.81E-01
EFFEC	7.48E-01	1.35E+00

FREQUENCY DISTRIBUTION OF LIFETIME FATAL CANCER RISKS

Risk Range	Number of People	Number of People In This Risk Range Or Higher	Deaths/Year In This Risk Range	Deaths/Year In This Risk Range Or Higher
1.0E+00 TO 1.0E-01	0	0	0.00E+00	0.00E+00
1.0E-01 TO 1.0E-02	0	0	0.00E+00	0.00E+00
1.0E-02 TO 1.0E-03	0	0	0.00E+00	0.00E+00
1.0E-03 TO 1.0E-04	0	0	0.00E+00	0.00E+00
1.0E-04 TO 1.0E-05	1	1	1.42E-07	1.42E-07
1.0E-05 TO 1.0E-06	1049	1050	3.66E-05	3.68E-05
LESS THAN 1.0E-06	1399124	1400174	2.05E-04	2.42E-04

RADIONUCLIDE EMISSIONS DURING THE YEAR 1986

Nuclide	Class	Amad	Source #1 Ci/y	Source #2 Ci/y	Source #3 Ci/y	Source #4 Ci/y	Source #5 Ci/y	Source #6 Ci/y	TOTAL Ci/y
U-234	Y	1.00	2.4E-04	3.2E-04	3.2E-09	9.6E-13	0.0E+00	2.7E-08	5.6E-04
U-235	Y	1.00	1.7E-06	2.3E-06	7.9E-07	2.4E-09	5.5E-06	3.4E-05	4.4E-05
U-236	Y	1.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.8E-06	1.8E-06
U-238	Y	1.00	2.4E-04	3.2E-04	4.0E-04	1.2E-07	7.6E-04	3.6E-03	5.3E-03

SITE INFORMATION

```
        Temperature:      10 degrees C
        Precipitation:    89 cm/y
        Mixing Height:    800 m
```

SOURCE INFORMATION

Source Number:	1	2	3	4	5	6
Stack Height (m):	15.24	15.24	15.24	15.24	7.62	10.06
Diameter (m):	0.41	0.46	0.58	0.36	0.25	0.30
Plume Rise Momentum (m/s): (Exit Velocity)	1.35E+01	9.25E+00	1.95E+01	3.79E+00	7.94E+00	1.50E+01

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.076	0.000	0.008
Fraction From Assessment Area:	0.924	1.000	0.992
Fraction Imported:	0.000	0.000	0.000

Beef Cattle Density:	2.03E-01
Milk Cattle Density:	4.56E-02
Land Fraction Cultivated for Vegetable Crops:	1.70E-02

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POPULATION DATA

Distance (m)

Direction	310	810	1500	2500	3500	4500	7500
N	0	0	0	1043	0	0	0
NNW	0	6	0	113	0	0	0
NW	0	0	1987	0	0	0	0
WNW	0	0	0	2218	0	0	0
W	0	0	0	2435	3014	288	183
WSW	0	0	421	810	0	293	1108
SW	0	0	0	0	2435	0	1688
SSW	0	0	0	4350	407	4223	3024
S	0	0	0	0	2002	0	534
SSE	0	0	101	0	0	0	0
SE	0	0	0	0	0	0	974
ESE	0	0	0	851	0	0	125
E	0	0	0	780	0	89	793
ENE	1	0	0	55	0	0	0
NE	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0

Distance (m)

Direction	15000	25000	35000	45000	55000	70000
N	0	0	0	0	0	0
NNW	0	0	0	0	0	0
NW	0	0	0	0	0	0
WNW	0	0	0	0	0	0
W	380	0	0	0	0	0
WSW	779	15354	8786	48943	63357	319944
SW	3376	3448	7591	6999	23331	187240
SSW	3059	3396	3128	6847	8940	27255
S	8224	2252	2388	5752	7858	140074
SSE	984	1792	3659	3759	7416	80933
SE	1388	2021	3148	5123	4351	14935
ESE	3161	827	3252	3712	25127	15531
E	265	1693	5397	1338	11236	17820
ENE	14641	6332	5986	13324	45833	150138
NE	0	0	0	0	0	0
NNE	0	0	0	0	0	0

6.2.2   General Data

                    C A P 8 8 - P C

                    Version 1.00

          Clean Air Act Assessment Package - 1988

                  G E N E R A L   D A T A

             Non-Radon Population Assessment
                  Mar 11, 1992   8:11 am

     Facility: Reactive Metals
      Address: Address
         City: Ashtabula
        State: OH   Zip:

     Source Category: DOE Facilities
         Source Type: Stack
      Emission Year: 1986

     Comments: Reactive Metals -- Population Run

       Dataset Name: Reactive Metals
       Dataset Date: Mar 10, 1992   2:13 pm
          Wind File: WNDFILES\ERI0610.WND
    Population File: POPFILES\RMICOMPY.POP

                  VALUES FOR RADIONUCLIDE-DEPENDENT PARAMETERS
_____

| | | Particle | Scavenging | Dry Deposition |
| | Clearance | Size | Coefficient | Velocity |
Nuclide	Class	(microns)	(per second)	(m/s)
U-234	Y	1.0	8.90E-06	1.80E-03
U-235	Y	1.0	8.90E-06	1.80E-03
U-236	Y	1.0	8.90E-06	1.80E-03
U-238	Y	1.0	8.90E-06	1.80E-03

_____

VALUES FOR RADIONUCLIDE-DEPENDENT PARAMETERS

_____

| | DECAY CONSTANT (PER DAY) | | | TRANSFER COEFFICIENT | |
Nuclide	Radio-active (1)	Surface	Water	Milk (2)	Meat (3)
U-234	0.00E+00	5.48E-05	0.00E+00	6.00E-04	2.00E-04
U-235	0.00E+00	5.48E-05	0.00E+00	6.00E-04	2.00E-04
U-236	0.00E+00	5.48E-05	0.00E+00	6.00E-04	2.00E-04
U-238	0.00E+00	5.48E-05	0.00E+00	6.00E-04	2.00E-04

FOOTNOTES: (1) Effective radioactive decay constant in plume;
                set to zero if less than 1.0E-2

            (2) Fraction of animal's daily intake of nuclide
                which appears in each L of milk (days/L)

            (3) Fraction of animal's daily intake of nuclide
                which appears in each kg of meat (days/kg)

_____

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VALUES FOR RADIONUCLIDE-DEPENDENT PARAMETERS

_____

| Nuclide | CONCENTRATION UPTAKE FACTOR | | GI UPTAKE FRACTION | |
	Forage (1)	Edible (2)	Inhalation	Ingestion
U-234	8.50E-03	1.71E-03	2.00E-03	2.00E-01
U-235	8.50E-03	1.71E-03	2.00E-03	2.00E-01
U-236	8.50E-03	1.71E-03	2.00E-03	2.00E-01
U-238	8.50E-03	1.71E-03	2.00E-03	2.00E-01

FOOTNOTES: (1) Concentration factor for uptake of nuclide from soil for
                pasture and forage (in pCi/kg dry weight per pCi/kg dry soil)

            (2) Concentration factor for uptake of nuclide from soil by edible
                parts of crops (in pCi/kg wet weight per pCi/kg dry soil)

_____

NUMBER OF BEEF CATTLE

Distance (meters)

Direction	310	810	1500	2500	3500	4500	7500
N	2	2	12	20	28	36	299
NNW	2	2	12	20	28	36	299
NW	2	2	12	20	28	36	299
WNW	2	2	12	20	28	36	299
W	2	2	12	20	28	36	299
WSW	2	2	12	20	28	36	299
SW	2	2	12	20	28	36	299
SSW	2	2	12	20	28	36	299
S	2	2	12	20	28	36	299
SSE	2	2	12	20	28	36	299
SE	2	2	12	20	28	36	299
ESE	2	2	12	20	28	36	299
E	2	2	12	20	28	36	299
ENE	2	2	12	20	28	36	299
NE	2	2	12	20	28	36	299
NNE	2	2	12	20	28	36	299

Distance (meters)

Direction	15000	25000	35000	45000	55000	70000
N	1196	1993	2790	3587	4384	11161
NNW	1196	1993	2790	3587	4384	11161
NW	1196	1993	2790	3587	4384	11161
WNW	1196	1993	2790	3587	4384	11161
W	1196	1993	2790	3587	4384	11161
WSW	1196	1993	2790	3587	4384	11161
SW	1196	1993	2790	3587	4384	11161
SSW	1196	1993	2790	3587	4384	11161
S	1196	1993	2790	3587	4384	11161
SSE	1196	1993	2790	3587	4384	11161
SE	1196	1993	2790	3587	4384	11161
ESE	1196	1993	2790	3587	4384	11161
E	1196	1993	2790	3587	4384	11161
ENE	1196	1993	2790	3587	4384	11161
NE	1196	1993	2790	3587	4384	11161
NNE	1196	1993	2790	3587	4384	11161

NUMBER OF MILK CATTLE

Distance (meters)

Direction	310	810	1500	2500	3500	4500	7500
N	0	1	3	4	6	8	67
NNW	0	1	3	4	6	8	67
NW	0	1	3	4	6	8	67
WNW	0	1	3	4	6	8	67
W	0	1	3	4	6	8	67
WSW	0	1	3	4	6	8	67
SW	0	1	3	4	6	8	67
SSW	0	1	3	4	6	8	67
S	0	1	3	4	6	8	67
SSE	0	1	3	4	6	8	67
SE	0	1	3	4	6	8	67
ESE	0	1	3	4	6	8	67
E	0	1	3	4	6	8	67
ENE	0	1	3	4	6	8	67
NE	0	1	3	4	6	8	67
NNE	0	1	3	4	6	8	67

Distance (meters)

Direction	15000	25000	35000	45000	55000	70000
N	269	448	627	806	985	2507
NNW	269	448	627	806	985	2507
NW	269	448	627	806	985	2507
WNW	269	448	627	806	985	2507
W	269	448	627	806	985	2507
WSW	269	448	627	806	985	2507
SW	269	448	627	806	985	2507
SSW	269	448	627	806	985	2507
S	269	448	627	806	985	2507
SSE	269	448	627	806	985	2507
SE	269	448	627	806	985	2507
ESE	269	448	627	806	985	2507
E	269	448	627	806	985	2507
ENE	269	448	627	806	985	2507
NE	269	448	627	806	985	2507
NNE	269	448	627	806	985	2507

AREA OF VEGETABLE CROP PRODUCTION (M**2)

Distance (meters)

Direction	310	810	1500	2500	3500	4500	7500
N	1.3E+03	2.1E+03	1.0E+04	1.7E+04	2.3E+04	3.0E+04	2.5E+05
NNW	1.3E+03	2.1E+03	1.0E+04	1.7E+04	2.3E+04	3.0E+04	2.5E+05
NW	1.3E+03	2.1E+03	1.0E+04	1.7E+04	2.3E+04	3.0E+04	2.5E+05
WNW	1.3E+03	2.1E+03	1.0E+04	1.7E+04	2.3E+04	3.0E+04	2.5E+05
W	1.3E+03	2.1E+03	1.0E+04	1.7E+04	2.3E+04	3.0E+04	2.5E+05
WSW	1.3E+03	2.1E+03	1.0E+04	1.7E+04	2.3E+04	3.0E+04	2.5E+05
SW	1.3E+03	2.1E+03	1.0E+04	1.7E+04	2.3E+04	3.0E+04	2.5E+05
SSW	1.3E+03	2.1E+03	1.0E+04	1.7E+04	2.3E+04	3.0E+04	2.5E+05
S	1.3E+03	2.1E+03	1.0E+04	1.7E+04	2.3E+04	3.0E+04	2.5E+05
SSE	1.3E+03	2.1E+03	1.0E+04	1.7E+04	2.3E+04	3.0E+04	2.5E+05
SE	1.3E+03	2.1E+03	1.0E+04	1.7E+04	2.3E+04	3.0E+04	2.5E+05
ESE	1.3E+03	2.1E+03	1.0E+04	1.7E+04	2.3E+04	3.0E+04	2.5E+05
E	1.3E+03	2.1E+03	1.0E+04	1.7E+04	2.3E+04	3.0E+04	2.5E+05
ENE	1.3E+03	2.1E+03	1.0E+04	1.7E+04	2.3E+04	3.0E+04	2.5E+05
NE	1.3E+03	2.1E+03	1.0E+04	1.7E+04	2.3E+04	3.0E+04	2.5E+05
NNE	1.3E+03	2.1E+03	1.0E+04	1.7E+04	2.3E+04	3.0E+04	2.5E+05

Distance (meters)

Direction	15000	25000	35000	45000	55000	70000
N	1.0E+06	1.7E+06	2.3E+06	3.0E+06	3.7E+06	9.3E+06
NNW	1.0E+06	1.7E+06	2.3E+06	3.0E+06	3.7E+06	9.3E+06
NW	1.0E+06	1.7E+06	2.3E+06	3.0E+06	3.7E+06	9.3E+06
WNW	1.0E+06	1.7E+06	2.3E+06	3.0E+06	3.7E+06	9.3E+06
W	1.0E+06	1.7E+06	2.3E+06	3.0E+06	3.7E+06	9.3E+06
WSW	1.0E+06	1.7E+06	2.3E+06	3.0E+06	3.7E+06	9.3E+06
SW	1.0E+06	1.7E+06	2.3E+06	3.0E+06	3.7E+06	9.3E+06
SSW	1.0E+06	1.7E+06	2.3E+06	3.0E+06	3.7E+06	9.3E+06
S	1.0E+06	1.7E+06	2.3E+06	3.0E+06	3.7E+06	9.3E+06
SSE	1.0E+06	1.7E+06	2.3E+06	3.0E+06	3.7E+06	9.3E+06
SE	1.0E+06	1.7E+06	2.3E+06	3.0E+06	3.7E+06	9.3E+06
ESE	1.0E+06	1.7E+06	2.3E+06	3.0E+06	3.7E+06	9.3E+06
E	1.0E+06	1.7E+06	2.3E+06	3.0E+06	3.7E+06	9.3E+06
ENE	1.0E+06	1.7E+06	2.3E+06	3.0E+06	3.7E+06	9.3E+06
NE	1.0E+06	1.7E+06	2.3E+06	3.0E+06	3.7E+06	9.3E+06
NNE	1.0E+06	1.7E+06	2.3E+06	3.0E+06	3.7E+06	9.3E+06

VALUES FOR RADIONUCLIDE-INDEPENDENT PARAMETERS
_____

    HUMAN INHALATION RATE
        Cubic centimeters/hr   9.17E+05

    SOIL PARAMETERS
        Effective surface density (kg/sq m, dry weight)
            (Assumes 15 cm plow layer)   2.15E+02

    BUILDUP TIMES
        For activity in soil (years)   1.00E+02
        For radionuclides deposited on ground/water (days)   3.65E+04

    DELAY TIMES
        Ingestion of pasture grass by animals (hr)   0.00E+00
        Ingestion of stored feed by animals (hr)   2.16E+03
        Ingestion of leafy vegetables by man (hr)   3.36E+02
        Ingestion of produce by man (hr)   3.36E+02
        Transport time from animal feed-milk-man (day)   2.00E+00
        Time from slaughter to consumption (day)   2.00E+01

    WEATHERING
        Removal rate constant for physical loss (per hr)   2.90E-03

    CROP EXPOSURE DURATION
        Pasture grass (hr)   7.20E+02
        Crops/leafy vegetables (hr)   1.44E+03

    AGRICULTURAL PRODUCTIVITY
        Grass-cow-milk-man pathway (kg/sq m)   2.80E-01
        Produce/leafy veg for human consumption (kg/sq m)   7.16E-01

    FALLOUT INTERCEPTION FRACTIONS
        Vegetables   2.00E-01
        Pasture   5.70E-01

    GRAZING PARAMETERS
        Fraction of year animals graze on pasture   4.00E-01
        Fraction of daily feed that is pasture grass
            when animal grazes on pasture   4.30E-01

_____

VALUES FOR RADIONUCLIDE-INDEPENDENT PARAMETERS
_____

```
ANIMAL FEED CONSUMPTION FACTORS
     Contaminated feed/forage (kg/day, dry weight)        1.56E+01

DAIRY PRODUCTIVITY
     Milk production of cow (L/day)                       1.10E+01

MEAT ANIMAL SLAUGHTER PARAMETERS
     Muscle mass of animal at slaughter (kg)              2.00E+02
     Fraction of herd slaughtered (per day)               3.81E-03

DECONTAMINATION
     Fraction of radioactivity retained after washing
          for leafy vegetables and produce                5.00E-01

FRACTIONS GROWN IN GARDEN OF INTEREST
     Produce ingested                                     1.00E+00
     Leafy vegetables ingested                            1.00E+00

INGESTION RATIOS:
     IMMEDIATE SURROUNDING AREA/TOTAL WITHIN AREA
          Vegetables                                      7.60E-02
          Meat                                            8.00E-03
          Milk                                            0.00E+00

MINIMUM INGESTION FRACTIONS FROM OUTSIDE AREA
     (Actual fractions of food types from outside area can
     be greater than the minimum fractions listed below.)
          Vegetables                                      0.00E+00
          Meat                                            0.00E+00
          Milk                                            0.00E+00

HUMAN FOOD UTILIZATION FACTORS
     Produce ingestion (kg/y)                             1.76E+02
     Milk ingestion (L/y)                                 1.12E+02
     Meat ingestion (kg/y)                                8.50E+01
     Leafy vegetable ingestion (kg/y)                     1.80E+01

SWIMMING PARAMETERS
     Fraction of time spent swimming                      0.00E+00
     Dilution factor for water (cm)                       1.00E+00
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_____

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6.2.3 <u>Weather Data</u>

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

W E A T H E R   D A T A

Non-Radon Population Assessment
Mar 11, 1992   8:11 am

```
Facility:  Reactive Metals
 Address:  Address
    City:  Ashtabula
   State:  OH                        Zip:


Source Category:  DOE Facilities
    Source Type:  Stack
  Emission Year:  1986


Comments:  Reactive Metals -- Population Run


   Dataset Name:  Reactive Metals
   Dataset Date:  Mar 10, 1992    2:13 pm
      Wind File:  WNDFILES\ERI0610.WND
Population File:  POPFILES\RMICOMPY.POP
```

HARMONIC AVERAGE WIND SPEEDS (WIND TOWARDS)
_____

Pasquill Stability Class
_____

Dir	A	B	C	D	E	F	G	Wind Frequency
N	0.000	1.604	3.331	5.143	3.476	1.682	0.000	0.209
NNW	0.000	2.155	3.457	5.642	3.428	1.447	0.000	0.062
NW	0.000	1.419	3.287	4.170	2.960	1.379	0.000	0.023
WNW	0.000	1.411	3.521	2.913	2.808	1.339	0.000	0.017
W	0.000	1.947	2.876	3.063	2.945	1.497	0.000	0.027
WSW	0.000	2.155	3.027	4.395	3.265	1.684	0.000	0.040
SW	2.572	2.270	4.147	4.744	3.252	1.729	0.000	0.048
SSW	0.000	3.024	4.142	4.556	3.354	1.655	0.000	0.030
S	2.277	3.077	4.005	4.249	3.360	1.443	0.000	0.052
SSE	2.572	3.147	3.829	4.534	3.466	1.573	0.000	0.042
SE	2.572	3.172	3.644	4.878	3.132	1.376	0.000	0.044
ESE	2.226	2.954	4.350	5.494	3.271	1.455	0.000	0.068
E	2.572	3.009	4.745	5.729	3.578	1.697	0.000	0.104
ENE	0.000	2.971	4.181	5.376	3.382	1.632	0.000	0.072
NE	0.000	2.552	4.025	5.045	3.368	1.584	0.000	0.068
NNE	2.572	1.594	3.776	5.389	3.458	1.834	0.000	0.094

_____

ARITHMETIC AVERAGE WIND SPEEDS (WIND TOWARDS)
_____

Pasquill Stability Class
_____

Dir	A	B	C	D	E	F	G
N	0.000	2.657	4.044	6.318	3.709	2.164	0.000
NNW	0.000	2.803	3.936	7.070	3.664	1.972	0.000
NW	0.000	2.029	3.920	5.893	3.145	1.904	0.000
WNW	0.000	2.203	3.867	3.990	2.939	1.861	0.000
W	0.000	2.912	3.519	3.980	3.126	2.018	0.000
WSW	0.000	2.803	3.804	5.374	3.500	2.165	0.000
SW	2.572	3.009	4.935	5.907	3.486	2.196	0.000
SSW	0.000	3.392	4.733	5.611	3.591	2.145	0.000
S	2.472	3.618	4.428	5.250	3.598	1.969	0.000
SSE	2.572	3.596	4.179	5.681	3.700	2.082	0.000
SE	2.572	3.642	4.056	5.992	3.354	1.901	0.000
ESE	2.452	3.516	4.815	6.619	3.507	1.980	0.000
E	2.572	3.732	5.230	6.747	3.801	2.175	0.000
ENE	0.000	3.344	4.692	6.433	3.619	2.128	0.000
NE	0.000	3.138	4.688	6.231	3.605	2.090	0.000
NNE	2.572	2.688	4.417	6.536	3.692	2.261	0.000

_____

FREQUENCIES OF STABILITY CLASSES (WIND TOWARDS)
_____

Pasquill Stability Class
_____

Dir	A	B	C	D	E	F	G
N	0.0000	0.0071	0.0543	0.6142	0.1552	0.1693	0.0000
NNW	0.0000	0.0063	0.0385	0.7396	0.1142	0.1014	0.0000
NW	0.0000	0.0228	0.0701	0.5830	0.1338	0.1902	0.0000
WNW	0.0000	0.0226	0.0654	0.4320	0.2044	0.2756	0.0000
W	0.0000	0.0199	0.0622	0.4993	0.1925	0.2262	0.0000
WSW	0.0000	0.0098	0.0659	0.6985	0.1422	0.0835	0.0000
SW	0.0006	0.0138	0.1167	0.7377	0.0944	0.0369	0.0000
SSW	0.0000	0.0333	0.1654	0.6880	0.0675	0.0458	0.0000
S	0.0034	0.1078	0.2034	0.5935	0.0565	0.0354	0.0000
SSE	0.0007	0.1436	0.1686	0.5927	0.0617	0.0327	0.0000
SE	0.0016	0.1095	0.1666	0.6510	0.0465	0.0249	0.0000
ESE	0.0022	0.0526	0.1581	0.7362	0.0274	0.0234	0.0000
E	0.0003	0.0199	0.1260	0.7958	0.0423	0.0156	0.0000
ENE	0.0000	0.0127	0.0724	0.7863	0.0823	0.0463	0.0000
NE	0.0000	0.0103	0.0585	0.7746	0.1024	0.0542	0.0000
NNE	0.0003	0.0083	0.0537	0.7261	0.1064	0.1051	0.0000
TOT	0.0005	0.0298	0.0944	0.6871	0.1003	0.0878	0.0000

_____

ADDITIONAL WEATHER INFORMATION

```
         Average Air Temperature:    10.0 degrees C
                                    283.2 K
                    Precipitation:    89.0 cm/y
                       Lid Height:     800 meters
        Surface Roughness Length:    0.010 meters
      Height Of Wind Measurements:    10.0 meters
              Average Wind Speed:    5.347 m/s

         Vertical Temperature Gradients:
              STABILITY E       0.073 k/m
              STABILITY F       0.109 k/m
              STABILITY G       0.146 k/m
```

6.2.4 Dose and Risk Conversion Factors

C A P 8 8 – P C

Version 1.00

Clean Air Act Assessment Package - 1988

D O S E   A N D   R I S K   C O N V E R S I O N   F A C T O R S

Non-Radon Population Assessment
Mar 11, 1992   8:11 am


```
   Facility:  Reactive Metals
    Address:  Address
       City:  Ashtabula
      State:  OH            Zip:


Source Category:  DOE Facilities
    Source Type:  Stack
  Emission Year:  1986


Comments:  Reactive Metals -- Population Run


   Dataset Name:  Reactive Metals
   Dataset Date:  Mar 10, 1992   2:13 pm
      Wind File:  WNDFILES\ERI0610.WND
Population File:  POPFILES\RMICOMPY.POP
```

DOSE AND RISK FACTOR UNITS

The units for each type of dose rate conversion factor are
shown below, by pathway:

    Pathway   Units
    _____   _____

    Ingestion   millirem/picoCurie

    Inhalation   millirem/picoCurie

    Immersion   millirem-cubic centimeter/microCurie-year

    Surface   millirem-square centimeter/microCurie-year

Risks for internal exposures (inhalation and ingestion) are the
lifetime risk of premature death in a birth cohort of 100,000
people for a 1 picoCurie/year intake rate, where the average
lifetime is 70.7565 years. This is simplified to lifetime risk
per 100,000 picoCuries.

The units for each type of risk conversion factor are
shown below, by pathway:

    Pathway   Units
    _____   _____

    Ingestion   lifetime risk/100,000 picoCuries

    Inhalation   lifetime risk/100,000 picoCuries

    Immersion   lifetime risk-cubic centimeter/100,000 picoCurie-years

    Surface   lifetime risk-square centimeter/100,000 picoCurie-years

```
                   ************************
                   *   NUCLIDE  U-234     *
                   ************************
```

DOSE RATE CONVERSION FACTORS

Organ	Ingestion	Inhalation	Air Immersion	Ground Surface
GONADS	3.851E-05	9.854E-06	8.140E+05	7.067E+02
BREAST	3.851E-05	9.987E-06	2.046E+06	3.585E+03
R MAR	1.031E-03	2.576E-04	2.760E+05	9.139E+01
LUNGS	3.851E-05	1.099E+00	4.107E+05	1.735E+02
THYROID	3.851E-05	9.852E-06	6.068E+05	2.305E+02
ENDOST	1.625E-02	4.059E-03	7.104E+05	2.949E+02
RMNDR	1.396E-03	3.763E-04	3.777E+05	1.251E+02
EFFEC	1.051E-03	1.321E-01	7.456E+05	7.996E+02

GENETIC EFFECT DOSE RATE CONVERSION FACTORS

	Ingestion	Inhalation	Air Immersion	Ground Surface
TESTES	1.058E-03	2.278E-04	2.442E+07	2.120E+04
OVARIES	1.058E-03	2.280E-04	9.102E+06	3.408E+03
AVERAGE	1.058E-03	2.279E-04	1.676E+07	1.230E+04

RISK CONVERSION FACTORS

Cancer	Ingestion	Inhalation	Air Immersion	Ground Surface
LEUKEMIA	1.006E-04	2.329E-05	8.742E-02	2.895E-05
BONE	8.532E-05	1.952E-05	1.257E-02	5.219E-06
THYROID	6.663E-07	1.543E-07	2.760E-02	1.048E-05
BREAST	5.605E-06	1.274E-06	8.014E-01	1.404E-03
LUNG	7.126E-06	1.761E-01	2.036E-01	8.603E-05
STOMACH	5.173E-06	1.344E-06	1.096E-01	3.621E-05
BOWEL	7.559E-06	4.292E-06	5.172E-02	1.577E-05
LIVER	5.015E-06	1.123E-06	1.212E-01	3.269E-05
PANCREAS	3.500E-06	7.735E-07	6.471E-02	2.715E-05
URINARY	3.044E-04	6.699E-05	4.689E-02	1.258E-05
OTHER	4.280E-06	9.461E-07	7.915E-02	3.321E-05

GENETIC EFFECT RISK CONVERSION FACTORS

	Ingestion	Inhalation	Air Immersion	Ground Surface
AVERAGE	3.657E-11	7.892E-12	4.358E+00	3.198E-03

6.2.5   <u>Dose and Risk Equivalent Summaries</u>

```
                    C A P 8 8 - P C

                    Version 1.00

        Clean Air Act Assessment Package - 1988




D O S E   A N D   R I S K   E Q U I V A L E N T   S U M M A R I E S

                Non-Radon Population Assessment
                Mar 11, 1992   8:11 am



      Facility:  Reactive Metals
       Address:  Address
          City:  Ashtabula
         State:  OH          Zip:


      Source Category:  DOE Facilities
          Source Type:  Stack
        Emission Year:  1986


      Comments:  Reactive Metals -- Population Run


        Dataset Name:  Reactive Metals
        Dataset Date:  Mar 10, 1992   2:13 pm
           Wind File:  WNDFILES\ERI0610.WND
     Population File:  POPFILES\RMICOMPY.POP
```

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)	Collective Population (person-rem/y)
GONADS	4.33E-04	5.53E-03
BREAST	7.33E-04	6.23E-03
R MAR	6.25E-03	1.54E-01
LUNGS	6.19E+00	1.01E+01
THYROID	3.88E-04	5.41E-03
ENDOST	7.97E-02	2.04E+00
RMNDR	7.64E-03	1.81E-01
EFFEC	7.48E-01	1.35E+00

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)	Collective Population (person-rem/y)
INGESTION	3.82E-03	1.34E-01
INHALATION	7.44E-01	1.22E+00
AIR IMMERSION	5.10E-09	7.98E-09
GROUND SURFACE	2.18E-04	4.98E-04
INTERNAL	7.48E-01	1.35E+00
EXTERNAL	2.18E-04	4.98E-04
TOTAL	7.48E-01	1.35E+00

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclides	Selected Individual (mrem/y)	Collective Population (person-rem/y)
U-234	5.54E-02	1.38E-01
U-235	6.32E-03	1.10E-02
U-236	2.56E-04	4.39E-04
U-238	6.87E-01	1.20E+00
TOTAL	7.48E-01	1.35E+00

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk	Total Collective Population Fatal Cancer Risk (Deaths/y)
LEUKEMIA	7.91E-09	2.69E-06
BONE	4.23E-09	1.55E-06
THYROID	1.19E-10	1.50E-08
BREAST	2.36E-09	1.72E-07
LUNG	9.98E-06	2.31E-04
STOMACH	7.62E-10	1.10E-07
BOWEL	1.70E-09	1.77E-07
LIVER	6.89E-10	9.44E-08
PANCREAS	4.51E-10	7.35E-08
URINARY	1.51E-08	5.60E-06
OTHER	5.52E-10	8.98E-08
TOTAL	1.00E-05	2.42E-04

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk	Total Collective Population Fatal Cancer Risk (Deaths/y)
INGESTION	2.10E-08	1.04E-05
INHALATION	9.99E-06	2.31E-04
AIR IMMERSION	1.18E-13	2.61E-12
GROUND SURFACE	4.93E-09	1.59E-07
INTERNAL	1.00E-05	2.42E-04
EXTERNAL	4.93E-09	1.59E-07
TOTAL	1.00E-05	2.42E-04

PATHWAY GENETIC RISK SUMMARY
(Collective Population)

Pathway	Genetic Risk (person-rem/y)
INGESTION	6.32E-04
INHALATION	1.36E-05
AIR IMMERSION	7.18E-09
GROUND SURFACE	3.83E-04
INTERNAL	6.45E-04
EXTERNAL	3.83E-04
TOTAL	1.03E-03

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk	Total Collective Population Fatal Cancer Risk (Deaths/y)
U-234	7.36E-07	2.44E-05
U-235	8.58E-08	1.99E-06
U-236	3.40E-09	7.77E-08
U-238	9.19E-06	2.15E-04
TOTAL	1.00E-05	2.42E-04

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

Distance (m)

Direction	310	810	1500	2500	3500	4500	7500
N	0.0E+00	0.0E+00	0.0E+00	1.8E-01	0.0E+00	0.0E+00	0.0E+00
NNW	0.0E+00	2.2E-01	0.0E+00	4.4E-02	0.0E+00	0.0E+00	0.0E+00
NW	0.0E+00	0.0E+00	5.4E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
WNW	0.0E+00	0.0E+00	0.0E+00	2.6E-02	0.0E+00	0.0E+00	0.0E+00
W	0.0E+00	0.0E+00	0.0E+00	3.4E-02	2.0E-02	1.4E-02	6.7E-03
WSW	0.0E+00	0.0E+00	6.3E-02	2.9E-02	0.0E+00	1.2E-02	5.6E-03
SW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.6E-02	0.0E+00	5.0E-03
SSW	0.0E+00	0.0E+00	0.0E+00	1.7E-02	1.0E-02	6.9E-03	3.2E-03
S	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.6E-02	0.0E+00	5.1E-03
SSE	0.0E+00	0.0E+00	4.7E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
SE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.9E-03
ESE	0.0E+00	0.0E+00	0.0E+00	2.9E-02	0.0E+00	0.0E+00	5.4E-03
E	0.0E+00	0.0E+00	0.0E+00	4.2E-02	0.0E+00	1.7E-02	7.8E-03
ENE	7.5E-01	0.0E+00	0.0E+00	3.9E-02	0.0E+00	0.0E+00	0.0E+00
NE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NNE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

Distance (m)

Direction	15000	25000	35000	45000	55000	70000
N	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NNW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
WNW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
W	2.5E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
WSW	2.1E-03	1.0E-03	6.6E-04	4.8E-04	3.7E-04	2.6E-04
SW	1.9E-03	9.0E-04	5.9E-04	4.3E-04	3.4E-04	2.5E-04
SSW	1.2E-03	6.0E-04	4.0E-04	3.0E-04	2.4E-04	1.9E-04
S	1.9E-03	9.0E-04	5.9E-04	4.3E-04	3.4E-04	2.4E-04
SSE	1.4E-03	7.1E-04	4.7E-04	3.5E-04	2.8E-04	2.1E-04
SE	1.4E-03	7.0E-04	4.7E-04	3.5E-04	2.8E-04	2.1E-04
ESE	2.0E-03	9.4E-04	6.1E-04	4.4E-04	3.4E-04	2.5E-04
E	2.8E-03	1.3E-03	8.6E-04	6.1E-04	4.7E-04	3.4E-04
ENE	2.7E-03	1.3E-03	8.3E-04	5.9E-04	4.5E-04	3.1E-04
NE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NNE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

COLLECTIVE EFFECTIVE DOSE EQUIVALENT (person rem/y)
(All Radionuclides and Pathways)

_____

Distance (m)

_____

Direction	310	810	1500	2500	3500	4500	7500
N	0.0E+00	0.0E+00	0.0E+00	1.9E-01	0.0E+00	0.0E+00	0.0E+00
NNW	0.0E+00	1.3E-03	0.0E+00	5.0E-03	0.0E+00	0.0E+00	0.0E+00
NW	0.0E+00	0.0E+00	1.1E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00
WNW	0.0E+00	0.0E+00	0.0E+00	5.7E-02	0.0E+00	0.0E+00	0.0E+00
W	0.0E+00	0.0E+00	0.0E+00	8.2E-02	6.2E-02	4.1E-03	1.2E-03
WSW	0.0E+00	0.0E+00	2.7E-02	2.3E-02	0.0E+00	3.5E-03	6.2E-03
SW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.8E-02	0.0E+00	8.5E-03
SSW	0.0E+00	0.0E+00	0.0E+00	7.3E-02	4.1E-03	2.9E-02	9.7E-03
S	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.2E-02	0.0E+00	2.7E-03
SSE	0.0E+00	0.0E+00	4.7E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00
SE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.8E-03
ESE	0.0E+00	0.0E+00	0.0E+00	2.5E-02	0.0E+00	0.0E+00	6.7E-04
E	0.0E+00	0.0E+00	0.0E+00	3.3E-02	0.0E+00	1.5E-03	6.2E-03
ENE	7.5E-04	0.0E+00	0.0E+00	2.1E-03	0.0E+00	0.0E+00	0.0E+00
NE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NNE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

_____

Distance (m)

_____

Direction	15000	25000	35000	45000	55000	70000
N	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NNW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
WNW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
W	9.6E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
WSW	1.6E-03	1.6E-02	5.8E-03	2.4E-02	2.3E-02	8.2E-02
SW	6.3E-03	3.1E-03	4.5E-03	3.0E-03	7.9E-03	4.6E-02
SSW	3.7E-03	2.0E-03	1.3E-03	2.1E-03	2.2E-03	5.0E-03
S	1.5E-02	2.0E-03	1.4E-03	2.5E-03	2.6E-03	3.4E-02
SSE	1.4E-03	1.3E-03	1.7E-03	1.3E-03	2.1E-03	1.7E-02
SE	2.0E-03	1.4E-03	1.5E-03	1.8E-03	1.2E-03	3.1E-03
ESE	6.2E-03	7.7E-04	2.0E-03	1.6E-03	8.6E-03	3.9E-03
E	7.5E-04	2.3E-03	4.6E-03	8.2E-04	5.3E-03	6.0E-03
ENE	4.0E-02	8.2E-03	5.0E-03	7.9E-03	2.1E-02	4.7E-02
NE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NNE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

_____

AVERAGE COLLECTIVE GENETIC DOSE EQUIVALENT
(person rem)
(All Radionuclides and Pathways)

							Distance (m)
Direction	310	810	1500	2500	3500	4500	7500
N	0.0E+00	0.0E+00	0.0E+00	2.9E-03	0.0E+00	0.0E+00	0.0E+00
NNW	0.0E+00	1.9E-05	0.0E+00	8.4E-05	0.0E+00	0.0E+00	0.0E+00
NW	0.0E+00	0.0E+00	1.7E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00
WNW	0.0E+00	0.0E+00	0.0E+00	1.0E-03	0.0E+00	0.0E+00	0.0E+00
W	0.0E+00	0.0E+00	0.0E+00	1.4E-03	1.2E-03	8.8E-05	3.6E-05
WSW	0.0E+00	0.0E+00	4.2E-04	4.3E-04	0.0E+00	8.2E-05	2.0E-04
SW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.4E-04	0.0E+00	3.0E-04
SSW	0.0E+00	0.0E+00	0.0E+00	1.5E-03	1.0E-04	8.7E-04	4.5E-04
S	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.3E-04	0.0E+00	1.0E-04
SSE	0.0E+00	0.0E+00	8.1E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00
SE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.6E-04
ESE	0.0E+00	0.0E+00	0.0E+00	4.7E-04	0.0E+00	0.0E+00	2.4E-05
E	0.0E+00	0.0E+00	0.0E+00	5.9E-04	0.0E+00	3.4E-05	1.9E-04
ENE	1.0E-05	0.0E+00	0.0E+00	3.8E-05	0.0E+00	0.0E+00	0.0E+00
NE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NNE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

Distance (m)

Direction	15000	25000	35000	45000	55000	70000
N	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NNW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
WNW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
W	5.0E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
WSW	1.0E-04	1.7E-03	9.0E-04	4.8E-03	6.1E-03	3.0E-02
SW	4.3E-04	3.7E-04	7.7E-04	6.9E-04	2.2E-03	1.8E-02
SSW	3.5E-04	3.4E-04	3.0E-04	6.5E-04	8.4E-04	2.5E-03
S	1.1E-03	2.5E-04	2.5E-04	5.7E-04	7.6E-04	1.3E-02
SSE	1.2E-04	1.9E-04	3.7E-04	3.7E-04	7.1E-04	7.6E-03
SE	1.7E-04	2.1E-04	3.1E-04	5.0E-04	4.1E-04	1.4E-03
ESE	4.2E-04	9.2E-05	3.4E-04	3.7E-04	2.4E-03	1.5E-03
E	4.0E-05	2.0E-04	5.9E-04	1.4E-04	1.1E-03	1.7E-03
ENE	2.1E-03	7.3E-04	6.4E-04	1.4E-03	4.5E-03	1.4E-02
NE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NNE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

Distance (m)

Direction	310	810	1500	2500	3500	4500	7500
N	0.0E+00	0.0E+00	0.0E+00	2.5E-06	0.0E+00	0.0E+00	0.0E+00
NNW	0.0E+00	3.0E-06	0.0E+00	5.9E-07	0.0E+00	0.0E+00	0.0E+00
NW	0.0E+00	0.0E+00	7.2E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
WNW	0.0E+00	0.0E+00	0.0E+00	3.5E-07	0.0E+00	0.0E+00	0.0E+00
W	0.0E+00	0.0E+00	0.0E+00	4.5E-07	2.7E-07	1.9E-07	8.9E-08
WSW	0.0E+00	0.0E+00	8.5E-07	3.8E-07	0.0E+00	1.6E-07	7.4E-08
SW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.1E-07	0.0E+00	6.6E-08
SSW	0.0E+00	0.0E+00	0.0E+00	2.3E-07	1.3E-07	9.2E-08	4.2E-08
S	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.2E-07	0.0E+00	6.7E-08
SSE	0.0E+00	0.0E+00	6.2E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
SE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.1E-08
ESE	0.0E+00	0.0E+00	0.0E+00	3.9E-07	0.0E+00	0.0E+00	7.1E-08
E	0.0E+00	0.0E+00	0.0E+00	5.6E-07	0.0E+00	2.3E-07	1.0E-07
ENE	1.0E-05	0.0E+00	0.0E+00	5.1E-07	0.0E+00	0.0E+00	0.0E+00
NE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NNE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

Distance (m)

Direction	15000	25000	35000	45000	55000	70000
N	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NNW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
WNW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
W	3.3E-08	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
WSW	2.8E-08	1.3E-08	8.1E-09	5.7E-09	4.2E-09	2.7E-09
SW	2.4E-08	1.1E-08	7.2E-09	5.1E-09	3.8E-09	2.6E-09
SSW	1.6E-08	7.3E-09	4.7E-09	3.4E-09	2.5E-09	1.8E-09
S	2.4E-08	1.1E-08	7.2E-09	5.1E-09	3.8E-09	2.6E-09
SSE	1.8E-08	8.8E-09	5.6E-09	4.0E-09	3.0E-09	2.1E-09
SE	1.8E-08	8.7E-09	5.5E-09	3.9E-09	3.0E-09	2.1E-09
ESE	2.5E-08	1.2E-08	7.4E-09	5.2E-09	3.9E-09	2.7E-09
E	3.7E-08	1.7E-08	1.1E-08	7.5E-09	5.5E-09	3.8E-09
ENE	3.6E-08	1.7E-08	1.0E-08	7.2E-09	5.3E-09	3.5E-09
NE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NNE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

COLLECTIVE FATAL CANCER RATE (deaths/y)
(All Radionuclides and Pathways)

_____

Distance (m)

_____

Direction	310	810	1500	2500	3500	4500	7500
N	0.0E+00	0.0E+00	0.0E+00	3.6E-05	0.0E+00	0.0E+00	0.0E+00
NNW	0.0E+00	2.5E-07	0.0E+00	9.5E-07	0.0E+00	0.0E+00	0.0E+00
NW	0.0E+00	0.0E+00	2.0E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00
WNW	0.0E+00	0.0E+00	0.0E+00	1.1E-05	0.0E+00	0.0E+00	0.0E+00
W	0.0E+00	0.0E+00	0.0E+00	1.6E-05	1.2E-05	7.7E-07	2.3E-07
WSW	0.0E+00	0.0E+00	5.0E-06	4.4E-06	0.0E+00	6.6E-07	1.2E-06
SW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.2E-06	0.0E+00	1.6E-06
SSW	0.0E+00	0.0E+00	0.0E+00	1.4E-05	7.7E-07	5.5E-06	1.8E-06
S	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.1E-06	0.0E+00	5.1E-07
SSE	0.0E+00	0.0E+00	8.9E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
SE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.0E-07
ESE	0.0E+00	0.0E+00	0.0E+00	4.6E-06	0.0E+00	0.0E+00	1.3E-07
E	0.0E+00	0.0E+00	0.0E+00	6.2E-06	0.0E+00	2.8E-07	1.2E-06
ENE	1.4E-07	0.0E+00	0.0E+00	4.0E-07	0.0E+00	0.0E+00	0.0E+00
NE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NNE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

_____

Distance (m)

_____

Direction	15000	25000	35000	45000	55000	70000
N	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NNW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
WNW	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
W	1.8E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
WSW	3.0E-07	2.8E-06	1.0E-06	4.0E-06	3.8E-06	1.2E-05
SW	1.2E-06	5.5E-07	7.7E-07	5.0E-07	1.3E-06	6.8E-06
SSW	6.7E-07	3.5E-07	2.1E-07	3.3E-07	3.2E-07	6.8E-07
S	2.8E-06	3.6E-07	2.4E-07	4.1E-07	4.2E-07	5.1E-06
SSE	2.6E-07	2.2E-07	2.9E-07	2.1E-07	3.2E-07	2.4E-06
SE	3.6E-07	2.5E-07	2.5E-07	2.8E-07	1.8E-07	4.4E-07
ESE	1.1E-06	1.4E-07	3.4E-07	2.7E-07	1.4E-06	5.8E-07
E	1.4E-07	4.1E-07	8.2E-07	1.4E-07	8.8E-07	9.6E-07
ENE	7.4E-06	1.5E-06	8.8E-07	1.4E-06	3.4E-06	7.4E-06
NE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
NNE	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

_____

6.2.6 Concentration Tables

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

C O N C E N T R A T I O N   T A B L E S

Non-Radon Population Assessment
Mar 11, 1992   8:11 am

```
Facility:  Reactive Metals
 Address:  Address
    City:  Ashtabula
   State:  OH                          Zip:


Source Category:  DOE Facilities
    Source Type:  Stack
  Emission Year:  1986


Comments:  Reactive Metals -- Population Run


   Dataset Name:  Reactive Metals
   Dataset Date:  Mar 10, 1992   2:13 pm
      Wind File:  WNDFILES\ERI0610.WND
Population File:  POPFILES\RMICOMPY.POP
```

                         ESTIMATED RADIONUCLIDE CONCENTRATIONS
                         AT VARIOUS LOCATIONS IN THE ENVIRONMENT
_____

			Air	Dry	Wet	Ground
			Concentration	Deposition	Deposition	Deposition
Wind	Distance			Rate	Rate	Rate
Toward	(meters)	Nuclide	(pCi/m3)	(pCi/m2/s)	(pCi/m2/s)	(pCi/m2/s)
N	310	U-234	1.4E-04	2.5E-11	7.6E-12	3.2E-11
N	310	U-235	1.8E-05	3.3E-12	6.0E-13	3.9E-12
N	310	U-236	7.2E-07	1.3E-13	2.4E-14	1.5E-13
N	310	U-238	2.1E-03	3.8E-10	7.2E-11	4.5E-10
N	810	U-234	6.7E-05	1.2E-11	2.9E-12	1.5E-11
N	810	U-235	7.4E-06	1.3E-12	2.3E-13	1.6E-12
N	810	U-236	3.0E-07	5.4E-14	9.3E-15	6.3E-14
N	810	U-238	8.6E-04	1.5E-10	2.7E-11	1.8E-10
N	1500	U-234	3.4E-05	6.2E-12	1.6E-12	7.7E-12
N	1500	U-235	3.2E-06	5.7E-13	1.2E-13	7.0E-13
N	1500	U-236	1.3E-07	2.3E-14	4.9E-15	2.8E-14
N	1500	U-238	3.7E-04	6.7E-11	1.4E-11	8.2E-11
N	2500	U-234	1.7E-05	3.1E-12	9.2E-13	4.0E-12
N	2500	U-235	1.5E-06	2.7E-13	7.2E-14	3.4E-13
N	2500	U-236	6.0E-08	1.1E-14	2.9E-15	1.4E-14
N	2500	U-238	1.7E-04	3.1E-11	8.5E-12	4.0E-11
N	3500	U-234	1.1E-05	1.9E-12	6.4E-13	2.6E-12
N	3500	U-235	8.9E-07	1.6E-13	5.1E-14	2.1E-13
N	3500	U-236	3.6E-08	6.5E-15	2.0E-15	8.5E-15
N	3500	U-238	1.0E-04	1.9E-11	6.0E-12	2.5E-11
N	4500	U-234	7.5E-06	1.3E-12	4.9E-13	1.8E-12
N	4500	U-235	6.2E-07	1.1E-13	3.9E-14	1.5E-13
N	4500	U-236	2.5E-08	4.5E-15	1.6E-15	6.1E-15
N	4500	U-238	7.3E-05	1.3E-11	4.6E-12	1.8E-11
N	7500	U-234	3.6E-06	6.4E-13	2.9E-13	9.3E-13
N	7500	U-235	2.9E-07	5.2E-14	2.2E-14	7.4E-14
N	7500	U-236	1.2E-08	2.1E-15	9.0E-16	3.0E-15
N	7500	U-238	3.4E-05	6.1E-12	2.7E-12	8.8E-12
N	15000	U-234	1.4E-06	2.4E-13	1.3E-13	3.8E-13
N	15000	U-235	1.1E-07	1.9E-14	1.1E-14	3.0E-14
N	15000	U-236	4.4E-09	7.8E-16	4.2E-16	1.2E-15
N	15000	U-238	1.3E-05	2.3E-12	1.2E-12	3.5E-12
N	25000	U-234	6.1E-07	1.1E-13	7.2E-14	1.8E-13
N	25000	U-235	4.8E-08	8.7E-15	5.6E-15	1.4E-14
N	25000	U-236	1.9E-09	3.5E-16	2.3E-16	5.8E-16
N	25000	U-238	5.7E-06	1.0E-12	6.7E-13	1.7E-12
N	35000	U-234	3.8E-07	6.9E-14	4.9E-14	1.2E-13
N	35000	U-235	3.0E-08	5.4E-15	3.9E-15	9.3E-15
N	35000	U-236	1.2E-09	2.2E-16	1.6E-16	3.8E-16
N	35000	U-238	3.6E-06	6.5E-13	4.6E-13	1.1E-12
N	45000	U-234	2.6E-07	4.8E-14	3.7E-14	8.4E-14
N	45000	U-235	2.1E-08	3.7E-15	2.9E-15	6.6E-15
N	45000	U-236	8.4E-10	1.5E-16	1.2E-16	2.7E-16
N	45000	U-238	2.5E-06	4.4E-13	3.4E-13	7.9E-13
N	55000	U-234	1.9E-07	3.4E-14	2.8E-14	6.2E-14
N	55000	U-235	1.5E-08	2.6E-15	2.2E-15	4.8E-15
N	55000	U-236	5.9E-10	1.1E-16	8.9E-17	2.0E-16

                                          6-40

ESTIMATED RADIONUCLIDE CONCENTRATIONS
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

Wind Toward	Distance (meters)	Nuclide	Air Concentration (pCi/m3)	Dry Deposition Rate (pCi/m2/s)	Wet Deposition Rate (pCi/m2/s)	Ground Deposition Rate (pCi/m2/s)
N	55000	U-238	1.7E-06	3.1E-13	2.6E-13	5.7E-13
N	70000	U-234	1.1E-07	1.9E-14	1.9E-14	3.8E-14
N	70000	U-235	8.2E-09	1.5E-15	1.5E-15	3.0E-15
N	70000	U-236	3.3E-10	5.9E-17	6.1E-17	1.2E-16
N	70000	U-238	9.7E-07	1.8E-13	1.8E-13	3.6E-13
NNW	310	U-234	4.1E-05	7.3E-12	2.0E-12	9.3E-12
NNW	310	U-235	5.2E-06	9.3E-13	1.6E-13	1.1E-12
NNW	310	U-236	2.1E-07	3.7E-14	6.3E-15	4.4E-14
NNW	310	U-238	6.0E-04	1.1E-10	1.8E-11	1.3E-10
NNW	810	U-234	1.8E-05	3.2E-12	7.5E-13	3.9E-12
NNW	810	U-235	1.8E-06	3.3E-13	5.9E-14	3.9E-13
NNW	810	U-236	7.4E-08	1.3E-14	2.4E-15	1.6E-14
NNW	810	U-238	2.1E-04	3.8E-11	7.0E-12	4.5E-11
NNW	1500	U-234	8.5E-06	1.5E-12	4.0E-13	1.9E-12
NNW	1500	U-235	7.7E-07	1.4E-13	3.1E-14	1.7E-13
NNW	1500	U-236	3.1E-08	5.6E-15	1.3E-15	6.9E-15
NNW	1500	U-238	9.0E-05	1.6E-11	3.7E-12	2.0E-11
NNW	2500	U-234	4.2E-06	7.5E-13	2.4E-13	9.8E-13
NNW	2500	U-235	3.5E-07	6.3E-14	1.9E-14	8.2E-14
NNW	2500	U-236	1.4E-08	2.6E-15	7.5E-16	3.3E-15
NNW	2500	U-238	4.1E-05	7.5E-12	2.2E-12	9.7E-12
NNW	3500	U-234	2.5E-06	4.6E-13	1.7E-13	6.2E-13
NNW	3500	U-235	2.1E-07	3.8E-14	1.3E-14	5.1E-14
NNW	3500	U-236	8.6E-09	1.5E-15	5.3E-16	2.1E-15
NNW	3500	U-238	2.5E-05	4.5E-12	1.5E-12	6.0E-12
NNW	4500	U-234	1.8E-06	3.2E-13	1.3E-13	4.5E-13
NNW	4500	U-235	1.5E-07	2.6E-14	1.0E-14	3.6E-14
NNW	4500	U-236	5.9E-09	1.1E-15	4.0E-16	1.5E-15
NNW	4500	U-238	1.7E-05	3.1E-12	1.2E-12	4.3E-12
NNW	7500	U-234	8.4E-07	1.5E-13	7.4E-14	2.3E-13
NNW	7500	U-235	6.8E-08	1.2E-14	5.8E-15	1.8E-14
NNW	7500	U-236	2.7E-09	4.9E-16	2.3E-16	7.3E-16
NNW	7500	U-238	8.0E-06	1.4E-12	6.9E-13	2.1E-12
NNW	15000	U-234	3.1E-07	5.6E-14	3.5E-14	9.1E-14
NNW	15000	U-235	2.5E-08	4.5E-15	2.7E-15	7.2E-15
NNW	15000	U-236	1.0E-09	1.8E-16	1.1E-16	2.9E-16
NNW	15000	U-238	2.9E-06	5.3E-13	3.3E-13	8.5E-13
NNW	25000	U-234	1.4E-07	2.5E-14	1.9E-14	4.4E-14
NNW	25000	U-235	1.1E-08	2.0E-15	1.5E-15	3.4E-15
NNW	25000	U-236	4.4E-10	7.9E-17	6.0E-17	1.4E-16
NNW	25000	U-238	1.3E-06	2.3E-13	1.8E-13	4.1E-13
NNW	35000	U-234	8.6E-08	1.5E-14	1.3E-14	2.9E-14
NNW	35000	U-235	6.7E-09	1.2E-15	1.0E-15	2.2E-15
NNW	35000	U-236	2.7E-10	4.9E-17	4.1E-17	9.0E-17
NNW	35000	U-238	8.0E-07	1.4E-13	1.2E-13	2.7E-13
NNW	45000	U-234	5.9E-08	1.1E-14	9.8E-15	2.0E-14
NNW	45000	U-235	4.6E-09	8.3E-16	7.7E-16	1.6E-15

6.2.7 <u>Chi/Q Tables</u>

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

C H I / Q   T A B L E S

Non-Radon Population Assessment
Mar 11, 1992   8:11 am

```
 Facility:  Reactive Metals
  Address:  Address
     City:  Ashtabula
    State:  OH                        Zip:


Source Category:  DOE Facilities
    Source Type:  Stack
  Emission Year:  1986


Comments:  Reactive Metals -- Population Run


   Dataset Name:  Reactive Metals
   Dataset Date:  Mar 10, 1992    2:13 pm
      Wind File:  WNDFILES\ERI0610.WND
Population File:  POPFILES\RMICOMPY.POP
```

GROUND-LEVEL CHI/Q VALUES FOR U-234
CHI/Q TOWARD INDICATED DIRECTION (SEC/CUBIC METER)

_____

Distance (meters)

_____

Dir	310	810	1500	2500	3500	4500	7500
N	7.699E-06	3.790E-06	1.942E-06	9.700E-07	5.999E-07	4.219E-07	2.012E-07
NNW	2.293E-06	9.905E-07	4.792E-07	2.344E-07	1.438E-07	1.006E-07	4.748E-08
NW	1.013E-06	4.951E-07	2.625E-07	1.326E-07	8.210E-08	5.760E-08	2.721E-08
WNW	7.953E-07	4.661E-07	2.616E-07	1.346E-07	8.374E-08	5.890E-08	2.785E-08
W	1.291E-06	6.738E-07	3.526E-07	1.771E-07	1.095E-07	7.690E-08	3.643E-08
WSW	1.829E-06	7.302E-07	3.258E-07	1.540E-07	9.334E-08	6.496E-08	3.056E-08
SW	2.194E-06	7.609E-07	3.130E-07	1.426E-07	8.516E-08	5.877E-08	2.735E-08
SSW	1.421E-06	4.762E-07	1.984E-07	9.091E-08	5.434E-08	3.746E-08	1.739E-08
S	2.600E-06	8.050E-07	3.276E-07	1.483E-07	8.798E-08	6.030E-08	2.783E-08
SSE	2.004E-06	6.115E-07	2.459E-07	1.107E-07	6.552E-08	4.487E-08	2.078E-08
SE	2.082E-06	6.291E-07	2.511E-07	1.126E-07	6.656E-08	4.552E-08	2.098E-08
ESE	2.868E-06	8.737E-07	3.492E-07	1.569E-07	9.298E-08	6.373E-08	2.939E-08
E	4.197E-06	1.316E-06	5.162E-07	2.299E-07	1.360E-07	9.332E-08	4.310E-08
ENE	2.927E-06	1.053E-06	4.480E-07	2.076E-07	1.248E-07	8.651E-08	4.048E-08
NE	2.895E-06	1.082E-06	4.676E-07	2.182E-07	1.316E-07	9.134E-08	4.282E-08
NNE	3.605E-06	1.485E-06	6.917E-07	3.332E-07	2.036E-07	1.424E-07	6.751E-08

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Distance (meters)

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Dir	15000	25000	35000	45000	55000	70000
N	7.633E-08	3.445E-08	2.167E-08	1.493E-08	1.052E-08	5.933E-09
NNW	1.762E-08	7.808E-09	4.843E-09	3.303E-09	2.314E-09	1.322E-09
NW	1.014E-08	4.374E-09	2.712E-09	1.836E-09	1.261E-09	6.708E-10
WNW	1.041E-08	4.439E-09	2.754E-09	1.858E-09	1.263E-09	6.494E-10
W	1.366E-08	5.998E-09	3.738E-09	2.544E-09	1.760E-09	9.520E-10
WSW	1.130E-08	5.161E-09	3.206E-09	2.201E-09	1.566E-09	9.432E-10
SW	9.896E-09	4.557E-09	2.806E-09	1.924E-09	1.383E-09	8.755E-10
SSW	6.266E-09	2.858E-09	1.758E-09	1.203E-09	8.616E-10	5.360E-10
S	9.980E-09	4.550E-09	2.802E-09	1.919E-09	1.377E-09	8.662E-10
SSE	7.518E-09	3.475E-09	2.151E-09	1.481E-09	1.070E-09	6.822E-10
SE	7.491E-09	3.427E-09	2.105E-09	1.442E-09	1.038E-09	6.636E-10
ESE	1.042E-08	4.735E-09	2.890E-09	1.972E-09	1.419E-09	9.067E-10
E	1.526E-08	7.015E-09	4.274E-09	2.921E-09	2.116E-09	1.385E-09
ENE	1.474E-08	6.715E-09	4.136E-09	2.830E-09	2.024E-09	1.254E-09
NE	1.566E-08	7.119E-09	4.391E-09	3.005E-09	2.143E-09	1.315E-09
NNE	2.527E-08	1.156E-08	7.225E-09	4.980E-09	3.548E-09	2.102E-09

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GROUND-LEVEL CHI/Q VALUES FOR U-235
CHI/Q TOWARD INDICATED DIRECTION (SEC/CUBIC METER)

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Distance (meters)

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Dir	310	810	1500	2500	3500	4500	7500
N	1.296E-05	5.250E-06	2.271E-06	1.049E-06	6.311E-07	4.380E-07	2.045E-07
NNW	3.684E-06	1.305E-06	5.490E-07	2.509E-07	1.502E-07	1.038E-07	4.806E-08
NW	1.665E-06	7.038E-07	3.107E-07	1.441E-07	8.650E-08	5.979E-08	2.758E-08
WNW	1.416E-06	6.933E-07	3.146E-07	1.471E-07	8.855E-08	6.127E-08	2.823E-08
W	2.225E-06	9.480E-07	4.147E-07	1.919E-07	1.153E-07	7.978E-08	3.695E-08
WSW	2.903E-06	9.027E-07	3.618E-07	1.624E-07	9.662E-08	6.664E-08	3.089E-08
SW	3.301E-06	8.824E-07	3.363E-07	1.479E-07	8.720E-08	5.981E-08	2.756E-08
SSW	2.078E-06	5.590E-07	2.150E-07	9.473E-08	5.581E-08	3.821E-08	1.754E-08
S	3.653E-06	9.320E-07	3.530E-07	1.541E-07	9.016E-08	6.137E-08	2.802E-08
SSE	2.803E-06	7.027E-07	2.639E-07	1.147E-07	6.708E-08	4.565E-08	2.093E-08
SE	2.906E-06	7.171E-07	2.682E-07	1.165E-07	6.800E-08	4.623E-08	2.110E-08
ESE	4.023E-06	9.941E-07	3.726E-07	1.622E-07	9.497E-08	6.472E-08	2.957E-08
E	6.041E-06	1.471E-06	5.440E-07	2.361E-07	1.384E-07	9.449E-08	4.334E-08
ENE	4.447E-06	1.253E-06	4.883E-07	2.169E-07	1.284E-07	8.834E-08	4.084E-08
NE	4.476E-06	1.302E-06	5.126E-07	2.286E-07	1.356E-07	9.338E-08	4.321E-08
NNE	5.707E-06	1.903E-06	7.819E-07	3.547E-07	2.122E-07	1.468E-07	6.847E-08

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Distance (meters)

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Dir	15000	25000	35000	45000	55000	70000
N	7.662E-08	3.423E-08	2.150E-08	1.479E-08	1.041E-08	5.818E-09
NNW	1.763E-08	7.740E-09	4.792E-09	3.265E-09	2.287E-09	1.298E-09
NW	1.013E-08	4.319E-09	2.673E-09	1.807E-09	1.240E-09	6.534E-10
WNW	1.040E-08	4.374E-09	2.708E-09	1.825E-09	1.240E-09	6.302E-10
W	1.368E-08	5.937E-09	3.692E-09	2.510E-09	1.735E-09	9.293E-10
WSW	1.133E-08	5.137E-09	3.188E-09	2.186E-09	1.555E-09	9.312E-10
SW	9.911E-09	4.544E-09	2.795E-09	1.915E-09	1.376E-09	8.683E-10
SSW	6.274E-09	2.846E-09	1.749E-09	1.196E-09	8.560E-10	5.306E-10
S	9.977E-09	4.525E-09	2.784E-09	1.905E-09	1.367E-09	8.576E-10
SSE	7.522E-09	3.460E-09	2.140E-09	1.472E-09	1.063E-09	6.763E-10
SE	7.486E-09	3.409E-09	2.093E-09	1.432E-09	1.031E-09	6.581E-10
ESE	1.042E-08	4.714E-09	2.874E-09	1.960E-09	1.410E-09	8.993E-10
E	1.527E-08	7.000E-09	4.261E-09	2.911E-09	2.108E-09	1.377E-09
ENE	1.476E-08	6.688E-09	4.114E-09	2.814E-09	2.011E-09	1.241E-09
NE	1.568E-08	7.086E-09	4.365E-09	2.985E-09	2.128E-09	1.300E-09
NNE	2.538E-08	1.152E-08	7.188E-09	4.949E-09	3.523E-09	2.073E-09

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Chapter 7

CONVERTING WEATHER DATA WITH THE GETWIND UTILITY

7.1   PURPOSE

GETWIND is a utility program that allows users to customize CAP88-PC by supplying their own meteorological data, in stability array (STAR) format, to the selection of weather data files. A listing of weather data provided with CAP88-PC is provided in Appendix D. Users are encouraged to use site-specific weather data.

See Appendix B for an example of the STAR (Stability Array) format. The file SAMPLE.STR, which is included with CAP88-PC, also contains a copy of this STAR format file. This file can be used as a guide for creating meteorological files in STAR format.

7.2   PROGRAM INPUT

The user must supply the program with the name of the file that contains the STAR formatted meteorological data and the name of the file that will contain the converted STAR data (the CAP88-PC wind data file).

It is assumed that all the data files used by this program reside in the same directory as GETWIND. For this reason space is provided for only 12 characters name with a three character extension. Create or copy your file containing the STAR formatted meteorological data to your directory which contains GETWIND and run the program.

All valid DOS file names are accepted by the program, subject to the length restriction. However, file names must end with the extension ".WND", and be copied to the CAP88PC\WNDFILES subdirectory on your hard disk, in order to be recognized by CAP88-PC.

7.3   PROGRAM OUTPUT

Converted STAR wind data is written to the file specified by the user. It is a valid CAP88-PC wind file and can be chosen as a wind data file from the list box which is available in the Meteorological Data screen, provided a copy of the file is made to the CAP88PC\WNDFILES subdirectory on your hard disk.

7.4   RUNNING GETWIND

Use DOS to get into the directory where the GETWIND.EXE program resides. Make sure that a copy of the file to be converted for use by CAP88-PC resides in this same directory.

To run the program, type:

     GETWIND <**Enter**>

The following message appears:

<div align="center">

THIS PROGRAM CONVERTS STAR FORMAT WIND DATA

TO AIRDOS-EPA FORMAT

FILE WHICH CONTAINS THE WIND DATA TO BE CONVERTED:

<CNTRL> BREAK   TO ABORT

</div>

Enter the name of the file and press <enter>. If you have entered a valid DOS file name and the file can be found in the current directory, the following message is then displayed:

     FILE TO CONTAIN THE AIRDOS FORMATTED WIND DATA
     MUST HAVE THE EXTENSION.WND

Enter the name of the file that will contain the converted meteorological data. This is the file that you will be able to select in the list box located in the Meteorological Data input screen. If the file name already exists, the following message is displayed on the screen:

     WARNING OUTPUT FILE ALREADY EXISTS
     DO YOU WANT TO OVERWRITE IT? (Y/N):

Enter <**Y**> or <**y**> to overwrite the file. Press any other key to allow you to enter another file name.

While the data is being read and converted, informative messages are displayed on the screen. When the program is finished you will be returned to DOS.

Pressing <**ctrl**> <**break**> together at any time will cause the program to abort, and you will be returned to DOS.

7.5   ERROR MESSAGES

FILE NAME CANNOT BE GREATER THAN 12 CHARACTERS
PRESS ANY KEY TO CONTINUE

If you type in a file name that has more than 12 characters, the above message is displayed. A DOS file name can only have eight characters followed by a '.' and a three character extension. Think of a shorter file name and enter it again.

ERROR INPUT FILE DOES NOT EXIST...
PRESS ANY KEY TO CONTINUE

If the name of the input file which contains the meteorological data cannot be found in the current directory, the above message is displayed. Make sure you have spelled the name of the file correctly, and that it is located in the current directory.

FILE EXTENSION MUST BE .WND
PRESS ANY KEY TO CONTINUE

If the name of the file entered that is to contain the converted meteorological data does not end in '.wnd', the above message is displayed. All CAP88-PC ind data files must have the file extension '.wnd'. These are the only files that will be displayed for selection in the list box in the Meteorological Data input screen. Retype the file name and make sure the file extension is '.wnd'.

Chapter 8

MATHEMATICAL MODELS

The purpose of this chapter is to present the mathematical models and equations used in CAP88-PC for environmental transport and estimation of dose and risk. In order to facilitate comparison of the programs with the theoretical model by interested users, the actual variable names used in the CAP88-PC FORTRAN code have been included in brackets, where applicable, following the explanation of the mathematical symbols used in the formulas.

8.1   ENVIRONMENTAL TRANSPORT

CAP88-PC incorporates a modified version of the AIRDOS-EPA (Mo79) program to calculate environmental transport. Relevant portions of this document are reproduced here, as referenced.

8.1.1   Plume Rise

CAP88-PC calculates plume rise in the subroutine CONCEN using either Rupp's equation (Ru48) for momentum dominated plume rise, or Briggs' equations (Br69) for hot buoyant plumes (Mo79). CAP88-PC also accepts user-supplied values for plume rise for each Pasquill stability class. The plume rise, Δh, is added to the actual physical stack height, h [PH], to determine the effective stack height, H. The plume centerline is shifted from the physical height, h, to H as it moves downwind. The plume centerline remains at H unless gravitational settling of particulates produces a downward tilt, or until meteorological conditions change.

Rupp's equation for momentum dominated plumes is:

$$\Delta h = \frac{1.5\ vd}{\mu} \qquad \text{(Equation 1)}$$

where:

   Δh   =   plume rise [PR]
   v   =   effluent stack gas velocity (m/sec) [VEL]
   d   =   inside stack diameter (m) [DIA]
   μ   =   wind velocity (m/sec) [U]

CAP88-PC models Briggs' buoyant plume rise for stability categories A, B, C, and D with:

$$\Delta h = \frac{1.6 \, F^{1/3} \, x^{2/3}}{\mu} \qquad \text{(Equation 2)}$$

where:

Δh = plume rise [PR]
F = $3.7 \times 10^{-5} \, Q_H$
Q_H = heat emission from stack gases (cal/sec) [QH]
x = downwind distance (m)
μ = wind speed (m/sec) [U]

This equation is valid until the downwind distance is approximately ten times the stack height, 10h, where the plume levels off. For downwind distances greater than 10h, the equation used is:

$$\Delta h = \frac{1.6 \, F^{1/3} \, (10h)^{2/3}}{\mu} \qquad \text{(Equation 3)}$$

Equation (2) is also used to a distance of $X = 2.4 \, \mu S^{-\frac{1}{2}}$ for stable categories E, F, and G, beyond which the plume is assumed to level off. For higher values of x, the stability parameter, S, is used in the equation:

$$\Delta h = 2.9(F/\mu S)^{1/3} \qquad \text{(Equation 4)}$$

in which:

S = $(g/T_a)(\partial T_a/\partial z + \Gamma)$ (Equation 5)
g = gravitational acceleration (m/sec^2)
T_a = air temperature ($^\circ$K) [TEMPERATURE]
$\partial T_a/\partial z$ = vertical temperature gradient ($^\circ$K/m) [TG]
z = vertical distance above stack (m)
Γ = adiabatic lapse rate of atmosphere (0.0098°K/m)

The value of the vertical temperature gradient, $\partial T_a/\partial z$, is positive for stable categories. In CAP88-PC, $\partial T_a/\partial z$ values are:

7.280E-02 $^\circ$K/m for Pasquill category E
1.090E-01 $^\circ$K/m for Pasquill category F
1.455E-01 $^\circ$K/m for Pasquill category G

The true-average wind speed for each Pasquill stability category is used in CAP88-PC to estimate plume rise, as it is greater than the reciprocal-averaged wind

speed, and produces a smaller, more conservative plume rise. This procedure does not risk underestimating the significant contribution of relatively calm periods to downwind nuclide concentrations which could result from direct use of a plume rise calculated for each separate wind-speed category. This procedure avoids calculating an infinite plume rise when wind speed is zero (during calms), since both momentum and buoyancy plume rise equations contain wind speed in the denominator (Mo79).

CAP88-PC also accepts user-supplied plume rise values, for situations where actual measurements are available or the supplied equations are not appropriate. For example, plume rises of zero may be used to model local turbulence created by building wakes.

8.1.2   Plume Dispersion

Plume dispersion is modeled in the subroutine CONCEN with the Gaussian plume equation of Pasquill (Pa61, Mo79), as modified by Gifford:

$$\chi = \frac{Q}{2\pi\sigma_y\sigma_z\mu}\exp[-\tfrac{1}{2}(y/\sigma_y)^2]\{\exp[-\tfrac{1}{2}((z-H)/\sigma_z)^2]+\exp[-\tfrac{1}{2}((z+H)/\sigma_z)^2]\}$$

(Equation 6)

where:

χ	=	concentration in air (chi) at x meters downwind, y meters crosswind, and z meters above ground (Ci/m^3) [ACON]
Q	=	Release rate from stack (Ci/sec) [REL]
μ	=	wind speed (m/sec) [U]
σ_y	=	horizontal dispersion coefficient (m)
σ_z	=	vertical dispersion coefficient (m)
H	=	effective stack height (m)
y	=	crosswind distance (m)
z	=	vertical distance (m)

The downwind distance x comes into Equation (6) through σ_y and σ_z, which are functions of x as well as the Pasquill atmospheric stability category applicable during emission from the stack. CAP88-PC converts χ in Equation (6) and other plume dispersion equations from units of curies per cubic meter to units of picocuries per cubic centimeter.

Annual-average meteorological data sets usually include frequencies for several wind-speed categories for each wind direction and Pasquill atmospheric stability category. CAP88-PC uses reciprocal-averaged wind speeds in the atmospheric dispersion equations, which permit a single calculation for each wind-speed category.

Equation (6) is applied to ground-level concentrations in air at the plume centerline by setting y and z to zero, which results in:

$$\chi \quad = \quad \frac{Q}{\pi\,\sigma_y\,\sigma_z\,\mu}\ \exp[-\tfrac{1}{2}(H/\sigma_z)^2] \qquad \text{(Equation 7)}$$

The average ground-level concentration in air over a sector of 22.5° can be approximated by the expression:

$$\chi_{ave} \quad = \quad f\chi \qquad\qquad \text{(Equation 8)}$$

where f is the integral of the exponential expression:

$$\exp[-\tfrac{1}{2}(y/\sigma_y)^2]$$

in Equation (6) from a value of y equals zero to infinity divided by y_s, the value of y at the edge of the 22.5° sector, which is the value of the downwind distance, x, multiplied by the tangent of half the sector angle. The expression is:

$$f \quad = \quad \frac{\int_0^\infty \exp[-(0.5/\sigma_y^2)y^2]\,dy}{y_s} \qquad\qquad \text{(Equation 9)}$$

The definite integral in the numerator of Equation (9) is evaluated as

$$\sigma_y\,(\pi/2)^{\frac{1}{2}} \qquad\qquad \text{(Equation 10)}$$

Since $y_s = x\,\tan(11.25°)$,

$$f \quad = \quad \frac{6.300836\,\sigma_y}{x} \qquad\qquad \text{(Equation 11)}$$

The equation for sector-averaged ground level concentration in air is therefore:

$$\chi \quad = \quad \frac{Q}{0.15871\,\pi\,x\,\sigma_z\,\mu}\ \exp[-\tfrac{1}{2}(H/\sigma_z)^2] \qquad\qquad \text{(Equation 12)}$$

This method of sector-averaging compresses the plume within the bounds of each of the sixteen 22.5° sectors for unstable Pasquill atmospheric stability categories in which horizontal dispersion is great enough to extend significantly beyond the sector edges. It is not a precise method, however, because the integration over

the y-axis, which is perpendicular to the downwind direction, x, involves increasing values for x as y is increased from zero to infinity.

An average lid for the assessment area is provided as part of the input data. The lid is assumed not to affect the plume until x becomes equal to $2x_L$, where x_L is the value of x for which $\sigma_z = 0.47$ times the height of the lid (Tu69). For values of x greater than $2x_L$, vertical dispersion is restricted and radionuclide concentration in air is assumed to be uniform from ground to lid.

The average concentration between ground and lid, which is the ground-level concentration in air for values of x greater than $2x_L$, may be expressed by:

$$\chi_{ave} = \frac{\int_0^\infty \chi \, dz}{L}$$

(Equation 13)

where χ is taken from Equation (6) and L is lid height. The value of H in Equation (6) may be set at zero since χ_{ave} is not a function of the effective stack height.

The resulting simplified expression may be evaluated for constant x and y values (σ_y and σ_z held constant) by using a definite integral similar to that in Equation (10):

$$\chi_{ave} = \frac{\int_0^\infty \frac{Q}{\pi \, \sigma_y \, \sigma_z \, \mu} \exp(-z^2/2\sigma_z^2)\exp(-y^2/2\sigma_y^2) \, dz}{L}$$

(Equation 14)

The result is:

$$\chi_{ave} = \frac{Q}{2.5066 \, \sigma_y \, L \, \mu} \exp(-y^2/2\sigma_y^2)$$

(Equation 15)

One obtains the sector-averaged concentration at ground level by replacing the exponential expression containing y by f in Equation (11):

$$\chi_{ave} = \frac{Q}{0.397825 \, x \, L \, \mu}$$

(Equation 16)

It should be noted at this point that for values of the downwind distance greater than $2x_L$ dispersion, as expressed in Equation (16), no longer can be said to be

represented by the Pasquill equation. The model is simply a uniform distribution with a rectangle of dimensions LID and 2x tan (11.25°).

Gravitational settling is handled by tilting the plume downward after it has leveled off at height H by subtracting $V_g x/\mu$ from H in the plume dispersion equations. For CAP88-PC V_g is set at the default value of zero and cannot be changed by the user.

8.1.3   Dry Deposition

Dry deposition is modeled in the subroutine CONCEN as being proportional to the ground-level concentration of the radionuclide (Mo79):

$$R_d \quad = \quad V_d \, X$$

where:

R_d =   surface deposition rate (pCi/cm^2-sec)
V_d =   deposition velocity (cm/sec) [VD]
X =   ground-level concentration (chi) in air (pCi/cm^3) [ACON]

Although V_d has units of velocity, it is only a proportionality constant and is usually higher than the actual, measured velocity of radionuclides falling to the ground. The proportionality constant must include deposition from fallout interception by foliage, which subsequently falls to the ground and so adds to ground deposition. Defaults for deposition velocity used by CAP88-PC are 3.5E-2 m/sec for Iodine, 1.8E-3 m/sec for particulates and zero for gases.

8.1.4   Precipitation Scavenging

The deposition rate from precipitation scavenging (Mo79), which occurs when rain or snow removes particles from the plume, is modeled in CONCEN with:

$$R_s \quad = \quad \Phi \, X_{ave} \, L$$

where:

R_s =   surface deposition rate (pCi/cm^2-sec)
Φ =   scavenging coefficient (sec^{-1}) [SC]
X_{ave} =   average concentration in plume up to lid height (pCi/cm^3)
            [ACON]
L =   lid height (tropospheric mixing layer) (cm) [LID]

The scavenging coefficient, Φ (in sec^{-1}), is calculated in CAP88-PC by multiplying the rainfall rate, [RR] (in cm/yr), by 1E-7 yr/cm-sec.

8.1.5 Plume Depletion

Radionuclides are depleted from the plume by precipitation scavenging, dry deposition and radioactive decay. Depletion is accounted for by substituting a reduced release rate, Q^1, for the original release rate Q for each downwind distance x (Sl68). The ratio of the reduced release rate to the original is the depletion fraction. The overall depletion fraction used in CAP88-PC is the product of the depletion fractions for precipitation scavenging, dry deposition and radioactive decay.

For precipitation scavenging the depletion fraction for each downwind distance (x) is:

$$\frac{Q^1}{Q} = e^{-\Phi t}$$

where:

Φ = scavenging coefficient (sec^{-1}) [SC]
t = time (sec) required for the plume to reach the downwind distance x

The depletion fraction for dry deposition is derived by using Equation (6) with z set to zero for ground-level concentrations, and subtracting the quantity $(V_g x)/U$ from H for a tilted plume (Va68, Mo79):

$$\frac{Q^1}{Q} = \exp\left\{-(2/\pi)^{1/2} \frac{V_d}{\mu} \int_0^x \frac{\exp[-(H-V_g x/\mu)^2/2\sigma_z^2]}{\sigma_z} \, dx\right\}$$

where:

V_d = deposition velocity (m/sec) [VD]
μ = wind speed (m/sec) [U]
σ_z = vertical dispersion coefficient (m)
V_g = gravitational velocity (m/sec) [VG]
H = effective stack height (m)
x = downwind distance (m)

The integral expression must be evaluated numerically. Values for the vertical dispersion coefficient σ_z are expressed as functions of x in the form x^D/F where D and F are constants with different values for each Pasquill atmospheric stability category, to facilitate integrations over x.

Values for the depletion fraction for cases where V_g is zero are obtained from the subroutine QY in CAP-88. Subroutine QY obtains depletion fractions for the conditions V_d = 0.01 m/sec and μ = 1 m/sec for each Pasquill stability category from the data file REFA.DAT. This file contains values for release heights (meters) of:

1, 1.5, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12.5, 15, 17.5, 20, 25, 30, 35, 40, 50, 60, 70, 80, 90, 100, 120, 140, 160, 180, 200, 240, 260, 300 and 400.

and for downwind distances (meters) of:

35, 65, 100, 150, 200, 300, 400, 500, 650, 800, 1,000, 1,500, 2,000, 4,000, 7,000, 10,000, 25,000, 60,000, 90,000, and 200,000.

The stored depletion fractions were calculated numerically with a Simpson's rule routine. QY uses a linear interpolation to produce a fraction for the required downwind value, release height and Pasquill category for V_d = 0.01 m/sec and μ = 1 m/sec. The value is then converted to the appropriate value for the actual deposition velocity and wind speed by use of the equation:

$$(Q^1/Q)_2 \quad = \quad (Q^1/Q)_1{}^{100\ V_d/\mu}$$

in which subscript 2 refers to the desired value and subscript 1 refers to the value for V_d = 0.01 m/sec and μ = 1 m/sec.

For downwind distances greater than $2x_L$ where Equation 15 applies to the ground-level concentrations in air, the depletion is modeled with (Mo79):

$$\frac{Q^1_{x}}{Q^1_{2x_L}} \quad = \quad \exp[-V_d(x - 2x_L)/L\ \mu\ ]$$

which shows the reduced release rates at distances x and $2x_L$, respectively.

The depletion fraction for radioactive decay is:

$$\frac{Q^1}{Q} \quad = \quad e^{-\lambda_r t}$$

where:

λ_r = effective decay constant in plume [ANLAM]
t = time required for plume travel

The decay constant used is referred to as the "effective decay constant" since it is not the true radiological decay constant in all cases. For example, if a radionuclide is a short-lived decay product in equilibrium with a longer-lived parent, the effective decay constant would be equal to the true radiological decay constant of the parent.

The atmospheric dispersion equations use the reciprocal-averaged wind speed, but neither this value nor the true average wind speed can adequately be used to calculate reduced release rates to account for radiological decay and scavenging losses because averaging of exponential terms is required. CAP88-PC uses an approximate calculational method for this purpose which establishes three wind speeds (1 m/sec, the average wind speed, and 6 m/sec) to simulate the actual wind-speed spectrum for each specific wind direction and Pasquill category. The wind speeds 1 and 6 m/sec were chosen because they approximate the upper and lower bounds in most meteorological data sets.

If f_1, f_2 and f_3 are designated as the time fractions for the three wind speeds, then:

$$f_1 + (\mu_a f_2) + 6f_3 = \mu_a,$$

$$f_1 + (f_2/\mu_a) + f_3/6 = 1/\mu_r$$
and
$$f_1 + f_2 + f_3 = 1$$

where:

μ_a = Arithmetic-average wind speed [UDAV]
μ_r = Reciprocal-average wind speed [UDCAT]

Solving the three simultaneous equations yields:

$$f_1 = 1 - f_2 - f_3$$

$$f_2 = \frac{(7/6) - (\mu_a/6) - (1/\mu_r)}{(7/6) - (\mu_a/6) - (1/\mu_a)}$$

$$f_3 = \frac{(\mu_a - 1)(1 - f_2)}{5}$$

The depletion fraction to account for radioactive decay is then approximated by:

$$f_1 \exp(-\lambda_r x) + f_2 \exp[-\lambda_r(x/\mu_a)] + f_3 \exp[-\lambda_r(x/6)]$$

where:

λ_r =   effective decay constant in plume (sec^{-1}) [ANLAM]
μ_a =   Arithmetic-average wind speed   [UDAV]
x   =   downwind distance (m)

For precipitation scavenging losses, the depletion fraction is:

$f_1 \exp(-\Phi x) + f_2 \exp[-\Phi(x/\mu_a)] + f_3 \exp[-\Phi(x/6)]$

where Φ is the scavenging coefficient (sec^{-1}).

The overall depletion fraction is calculated by multiplying the depletion fraction for dry deposition by the fraction for radioactive decay and precipitation scavenging.

8.1.6   Dispersion Coefficients

Horizontal and vertical dispersion coefficients (σ_y and σ_z) used for dispersion calculation in CONCEN and for depletion fraction determination in QY are taken from recommendations by G.A. Briggs of the Atmospheric Turbulence and Diffusion Laboratory at Oak Ridge, Tennessee (Mo79, Gi76). The coefficients are different functions of the downwind distance x for each Pasquill stability category for open-country conditions, as shown:

Pasquill category	σ_y (m)	σ_z (m)
A	$0.22\ x\ (1+0.0001x)^{-\frac{1}{2}}$	$0.20\ x$
B	$0.16\ x\ (1+0.0001x)^{-\frac{1}{2}}$	$0.12\ x$
C	$0.11\ x\ (1+0.0001x)^{-\frac{1}{2}}$	$0.08\ x\ (1+0.0002x)^{-\frac{1}{2}}$
D	$0.08\ x\ (1+0.0001x)^{-\frac{1}{2}}$	$0.06\ x\ (1+0.0015x)^{-\frac{1}{2}}$
E	$0.06\ x\ (1+0.0001x)^{-\frac{1}{2}}$	$0.03\ x\ (1+0.0003x)^{-1}$
F	$0.04\ x\ (1+0.0001x)^{-\frac{1}{2}}$	$0.016\ x\ (1+0.0003x)^{-1}$
G	calculated by subtracting half the difference between values for categories E and F from the value for category F.	

where:
x   =   downwind distance

CAP88-PC uses the functions in the form of

$$\sigma_y = x^A /C$$
$$\sigma_z = x^D /F$$

to facilitate integrations over x. Values for A, C, D, and F for each stability category and downwind distance are stored in a data statement.

8.1.7 Area Sources

Uniform area sources are modeled in CAP88-PC using a method described by Mills and Reeves, as modified by Christopher Nelson, EPA, and implemented by Culkowski and Patterson (Mo79). The method transforms the original area source into an annular segment with the same area. The transformation is dependent on the distance between the centroid of the area source and the receptor. At large distances (where the distance/diameter ratio is 2.5), the area source is modeled as a point source; at close distances it becomes a circular source centered at the receptor. A point source model is also used if the area source is 10 meters in diameter or less.

The principle of reciprocity is used to calculate the effective chi/Q. The problem is equivalent to interchanging source and receptor and calculating the mean chi/Q from a point source to one or more sector segments according to the angular width of the transformed source. The mean value of chi/Q for each sector segment is estimated by calculating chi/Q at the distance which would provide the exact value of the mean if the variation in chi/Q were proportional to $r^{-1.5}$ for distances from the point source to location within the sector segment. The chi/Q for the entire transformed source is the sum of the chi/Q values for each sector weighted by the portion of the total annular source contained in that sector.

8.1.8 Carbon-14 and Tritium

Special consideration is given to the radionuclides hydrogen-3 (tritium), carbon-14, and radon-222. The specific activity of tritium in air is calculated for an absolute humidity of 8 mg/m3. The specific activity of atmospheric carbon-14 is calculated for a carbon dioxide concentration of 330 ppm by volume. Concentrations of these nuclides in vegetation are calculated on the assumption that the water and carbon content in vegetation are from the atmosphere and have the same specific activity as in the atmosphere. Drinking water is assumed to be one percent (1%) tritiated.

8.1.9   Rn-222 Working Levels

The radon decay product concentration (in working level units) is estimated using an equilibrium fraction that varies as a function of travel time, assuming a wind speed of 3.5 meters/second, with a final equilibrium fraction of 0.7.

Equilibrium fractions for radon decay products are calculated as a function of downwind distance, starting at 0.267 at 150 meters and reaching a final equilibrium fraction of 0.698 at 19,551 meters. Equilibrium fractions for specific distances are calculated by linear interpolation, using this table:

Distance (meters)	Equilibrium Fraction
150	.267
200	.273
250	.276
300	.278
400	.284
500	.289
600	.293
800	.302
1000	.311
1500	.331
2000	.349
2500	.366
3000	.382
4000	.414
5000	.443
6000	.471
8000	.522
10000	.566
15000	.650
19551	.698

8.1.10   Ground Surface Concentrations

Ground surface and soil concentrations are calculated for those nuclides subject to deposition due to dry deposition and precipitation scavenging. The deposition accumulation time, [TSUBB], is assumed to be 100 years. This value corresponds to establishing a 100-year cutoff for the time following a release when any significant intake or external exposure associated with deposition on soil might take place.

Ingrowth from a parent radionuclide is calculated using a decay product ingrowth factor. The ingrowth factor is the ratio of the decay product concentration resulting from a unit deposition rate of the parent and the decay product respectively. The factors are for a 100 year accumulation time and a removal rate from soil of 2 percent per year.

8.2   DOSE AND RISK ESTIMATES

CAP88-PC uses a modified version of DARTAB (ORNL5692) and a database of dose and risk factors generated by RADRISK (ORNL7105, ORNL7745) for estimating dose and risk. Relevant portions of these documents are reproduced here, as referenced.

Dose and risk conversion factors include the effective dose equivalent calculated with the weighting factors in ICRP Publication Number 26 (ICRP26). Risk factors are based on lifetime risk from lifetime exposure with a nominal value of 4E-4 fatal cancers/rem (EPA89). Dose and risk factors are provided for the pathways of ingestion and inhalation intake, ground level air immersion and ground surface irradiation. Factors are further broken down by particle size [SIZE], clearance class [CLEARANCE_CLASS] and gut-to-blood [GI_ING and GI_INH] transfer factors. These factors are stored in a database for use by the program.

For assessments where Rn-222 decay products are not considered, estimates of dose and risk are made by combining the inhalation and ingestion intake rates, air and ground surface concentrations with the appropriate dose and risk conversion factors. CAP88-PC lists the dose and risk to the maximum individual and the collective population. CAP88-PC calculates dose to the gonads, breast, red marrow, lungs, thyroid, and endosteum in addition to the 50 year effective dose equivalent. Risks are estimated for these cancers: leukemia, bone, thyroid, breast, lung, stomach, bowel, liver, pancreas and urinary. Doses and risks can be further tabulated as a function of radionuclide, pathway, location and organ.

For assessments of Rn-222 decay products, CAP88-PC calculates working levels, not concentrations of specific radionuclides. A working level [WLEVEL] is defined as any combination of short-lived radon decay products in 1 liter of air that will result in the ultimate emission of 1.3×10^5 MeV of alpha particle energy. CAP88-PC calculates risk, but not dose, from the working level calculations. Risk to the maximum individual and the collective population are tabulated.

For each assessment, CAP88-PC tabulates the frequency distribution of risk, that is, the number of people at various levels of risk (lifetime risk). The risk categories are divided into powers of ten, from 1 in ten to one in a million. The number of health effects are also tabulated for each risk category.

8.2.1 Air Immersion

Individual dose is calculated for air immersion with the general equation:

$$\frac{E_{ij}(k) \; DF_{ijl} \; K_j}{P(k)}$$

where:

$E_{ij}(k)$	=	exposure rate, person-pCi/cm^3 [EXPP]
DF_{ijl}	=	Dose rate factor, mrem/nCi-yr/m^3 [DOSE]
$P(k)$	=	number of exposed people [POP]
K_j	=	0.001 nCi/pCi x 1,000,000 cm^3/m^3 (proportionality factor) [FAC]

Risk is calculated similarly, by substituting the risk conversion factor, RISK, for DOSE. The risk conversion factor is in units of risk/nCi-yr/m^3 .

8.2.2 Surface Exposure

Individual dose is calculated for ground surface exposure with the general equation:

$$\frac{E_{ij}(k) \; DF_{ijl} \; K_j}{P(k)}$$

where:

$E_{ij}(k)$	=	exposure rate, person-pCi/cm^2 [EXPP]
DF_{ijl}	=	Dose rate factor, mrem/nCi-yr/m^2 [DOSE]
$P(k)$	=	number of exposed people [POP]
K_j	=	0.001 nCi/pCi x 10,000 cm^2/m^2 (proportionality factor) [FAC]

Risk is calculated by substituting the risk conversion factor, RF_{ijl} [RISK], for DF_{ijl} [DOSE]. The risk conversion factor is in units of risk/nCi-yr/m^2 .

8.2.3 Ingestion and Inhalation

Individual dose is calculated for the ingestion and inhalation exposure pathway with the general equation:

$$\frac{E_{ij}(k) \; DF_{ijl} \; K_j}{P(k)}$$

where:

$E_{ij}(k)$ =   exposure rate, person-pCi/cm^3 [EXPP]

DF_{ijl} =   Dose rate factor, mrem/nCi-yr/m^3 [DOSE]

$P(k)$ =   number of exposed people   [POP]

K_j =   0.001 nCi/pCi x 1,000,000 cm^3/m^3 (proportionality factor)   [FAC]

Risk is calculated by substituting the risk conversion factor, RISK (risk/nCi), for DOSE.

8.2.4   Maximally-Exposed Individual

Doses for the maximally-exposed individual in population runs are estimated by CAP88-PC for the location, or sector-segment in the radial assessment grid, of highest risk where at least one individual actually resides. The effective dose equivalent for the maximally-exposed individual is tabulated in mrem/yr for a 50 year exposure. Risk is estimated as total lifetime risk for a lifetime exposure [AGEX] of 70.7565 years.

8.2.5   Collective Population

Collective population dose and risk are found by summing, for all sector segments, the intake and exposure rates multiplied by the appropriate dose or risk conversion factors (ORNL5692). Collective population dose is reported by person-Rem/yr (not millirem), and collective risk is reported in deaths/yr. Note that collective risk is reported as annual risk, while maximally-exposed individual risk is reported as lifetime risk.

Chapter 9

REFERENCES

Be86   "Comparison of AIRDOS-EPA Predictions of Ground-Level Airborne
            Radionuclide Concentrations to Measured Values", S.K. Beal and S.C.
            Cohen, S. Cohen and Associates, 8200 Riding Ridge Place, McLean,
            VA 22102, H.J. Chmelynski, Jack Faucett Associates, Suite 200, 7300
            Pearl St., Bethesda, MD 20814, B.S. Parks and J. Hardin, U.S.
            Environmental Protection Agency, Washington, D.C. 20460, 1986.

Br69   Briggs, G.A., "Plume Rise, AEC Critical Review Series", TID-25075,
            1969.

EPA89   EPA 520/1-89-005 Risk Assessment Methodology: Draft
            Environmental Impact Statement for Proposed NESHAPS for
            Radionuclides, Volume 1, Background Information Document, United
            States Environmental Protection Agency, Office of Radiation
            Programs, Washington, D.C. 20460, February 1989.

Gi76   Gifford, F.A., Jr., "Turbulent diffusion-typing schemes: A review",
            Nuclear Safety 17(1):68-86, 1976.

ICRP26   International Commission on Radiological Protection,
            Recommendations of the International Commission on Radiological
            Protection, ICRP Publication 26, Ann. ICRP, 1, (1), Pergamon Press,
            1977.

Mo79   Moore, R.E., Baes, C.F.III, McDowell-Boyer, L.M., Watson, A.P.,
            Hoffman, F.O., Pleasant, J.C., Miller, C.W., "AIRDOS-EPA: A
            Computerized Methodology for Estimating Environmental
            Concentrations and Dose to Man from Airborne Releases of
            Radionuclides", (Reprint of ORNL-5532), EPA 520/1-79-009, U.S.
            EPA Office of Radiation Programs, Washington, D.C., 20460.

ORNL5952   ORNL-5952: PREPAR: A User-Friendly Preprocessor to Create
            AIRDOS-EPA Input Data Sets, Oak Ridge National Laboratory, Oak
            Ridge, Tennessee.

ORNL7745   ORNL-7745: Estimates of Health Risk From Exposure to Radioactive
            Pollutants, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

ORNL7105   ORNL/TM-7105: A Combined Methodology for Estimating Dose Rates and Health Effects From Exposures to Radioactive Pollutants, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

ORNL5692   ORNL-5692/DE81030434 DARTAB: A Program to Combine Airborne Radionuclide Environmental Exposure Data With Dosimetric Health Effect Data to Generate Tabulations of Predicted Health Impact, Oak Ridge National Laboratory, Oak Ridge, Tennessee, November 1981.

Pa61   Pasquill, F., "The Estimation of the Dispersion of Windborne Material", Meteorology Magazine, 90:33, 1961.

Ru48   Rupp, E.M., Beall, S.E., Bornwasser, L.P., Johnson, D.H., "Dilution of Stack Gases in Cross Winds", USAEC Report AECD-1811 (CE-1620), Clinton Laboratories, 1948.

Sl68   Slade, D.H. (ed.), "Meteorology and Atomic Energy - 1968", U.S. Atomic Energy Commission/Division of Technical Information, USAED TID-24190, 1968.

Tu69   Turner, D.B. "Workbook of Atmospheric Dispersion Estimates", Air Pollution Control Administration, Cincinnati, Ohio, 1969.

Va68   Van der Hoven, I., "Deposition of particles and gasses", pp. 202-208, In Slade, D. (ed.), Meteorology and Atomic Energy - 1968, U.S. Atomic Energy Commission, USAED TID-24190.

Appendix A

VALID RADIONUCLIDES

AC-225	CE-141	I-122	NI-63	PU-241	SN-125
AC-227	CE-143	I-123	NI-65	PU-242	SN-126
AC-228	CE-144	I-125	NP-237	PU-243	SR-89
AG-109M	CF-252	I-129	NP-238	PU-244	SR-90
AG-110	CM-242	I-130	NP-239	RA-223	SR-91
AG-110M	CM-243	I-131	NP-240	RA-224	SR-92
AG-111	CM-244	I-132	NP-240M	RA-225	TB-160
AM-241	CM-245	I-133	O-15	RA-226	TC-97
AM-242	CM-246	I-134	P-32	RA-228	TC-99
AM-242M	CM-247	I-135	PA-231	RB-86	TC-99M
AM-243	CM-248	IN-113M	PA-233	RB-87	TC-101
AR-41	CO-57	IN-115	PA-234	RB-88	TE-125M
AS-76	CO-58	IN-115M	PA-234M	RB-89	TE-127
AT-217	CO-60	IR-192	PB-209	RB-90	TE-127M
BA-133	CR-51	K-40	PB-210	RB-90M	TE-129
BA-133M	CS-134	KR-83M	PB-211	RE-187	TE-129M
BA-137M	CS-134M	KR-85	PB-212	RH-103M	TE-131
BA-139	CS-135	KR-85M	PB-214	RH-105	TE-131M
BA-140	CS-136	KR-87	PD-107	RH-105M	TE-132
BA-141	CS-137	KR-88	PD-109	RH-106	TE-133
BA-142	CS-138	KR-89	PM-147	RN-219	TE-133M
BE-10	CS-139	KR-90	PM-148	RN-220	TE-134
BE-7	CU-64	LA-140	PM-148M	RN-222	TH-227
BI-210	EU-152	LA-141	PM-149	RU-97	TH-228
BI-211	EU-152M	LA-142	PM-151	RU-103	TH-229
BI-212	EU-154	MN-54	PO-210	RU-105	TH-230
BI-213	EU-155	MN-56	PO-211	RU-106	TH-231
BI-214	EU-156	MO-93	PO-212	S-35	TH-232
BR-82	F-18	MO-99	PO-213	SB-124	TH-234
BR-83	FE-55	N-13	PO-214	SB-125	TL-207
BR-84	FE-59	NA-22	PO-215	SB-126	TL-208
BR-85	FR-221	NA-24	PO-216	SB-126M	TL-209
C-11	FR-223	NB-93M	PO-218	SB-127	U-232
C-14	GA-67	NB-94	PR-143	SC-46	U-233
C-15	GD-152	NB-95	PR-144	SE-79	U-234
CA-41	H-3	NB-95M	PR-144M	SM-147	U-235
CD-113	HF-181	NB-97	PU-236	SM-151	U-236
CD-113M	HG-203	NB-97M	PU-238	SM-153	U-237
CD-115	HO-166	ND-147	PU-239	SN-113	U-238
CD-115M	HO-166M	NI-59	PU-240	SN-123	U-240

W-181	XE-125	XE-133M	XE-138	Y-91M	ZN-69
W-185	XE-127	XE-135	Y-90	Y-92	ZN-69M
W-187	XE-131M	XE-135M	Y-90M	Y-93	ZR-93
XE-122	XE-133	XE-137	Y-91	ZN-65	ZR-95
XE-123					

STAR FILE FORMAT

This is a **ST**ability **AR**ay (**STAR**) file. It shows the frequencies of occurrence that the wind is blowing **FROM** a particular direction, at a particular stability, at a particular speed. GETWIND converts the star array to a WIND file which shows wind blowing **TOWARD** (not **FROM**) particular directions. The frequencies are in x.xxxxx format, unspaced. The format is:

```
column         1  :       Blank
              2-4 :       Wind Direction
               5  :       Blank
               6  :       Stability Category
               7  :       Blank
               8  :       Start of the Wind Speed Categories (knots)
            8-14  :       Wind Speeds 1-3  (knots)
           15-21  :       Wind Speeds 4-6  (knots)
           22-28  :       Wind Speeds 7-10 (knots)
           29-35  :       Wind Speeds 11-16 (knots)
           36-42  :       Wind Speeds 17-21 (knots)
           43-49  :       Wind Speeds > 21  (knots)
  N   A     0.000080.000660.000000.000000.000000.00000
NNE   A     0.000160.000330.000000.000000.000000.00000
 NE   A     0.000160.000160.000000.000000.000000.00000
ENE   A     0.000080.000000.000000.000000.000000.00000
  E   A     0.000000.000000.000000.000000.000000.00000
ESE   A     0.000000.000000.000000.000000.000000.00000
 SE   A     0.000160.000160.000000.000000.000000.00000
SSE   A     0.000410.000490.000000.000000.000000.00000
  S   A     0.000160.000330.000000.000000.000000.00000
SSW   A     0.000330.000410.000000.000000.000000.00000
 SW   A     0.000740.000410.000000.000000.000000.00000
WSW   A     0.000570.000410.000000.000000.000000.00000
  W   A     0.000570.001070.000000.000000.000000.00000
WNW   A     0.000330.000330.000000.000000.000000.00000
 NW   A     0.000330.000570.000000.000000.000000.00000
NNW   A     0.000160.000490.000000.000000.000000.00000
  N   B     0.001860.001390.000250.000000.000000.00000
NNE   B     0.001800.000820.000000.000000.000000.00000
 NE   B     0.002130.000660.000000.000000.000000.00000
ENE   B     0.000410.000160.000000.000000.000000.00000
  E   B     0.000410.000160.000000.000000.000000.00000
ESE   B     0.000330.000820.000080.000000.000000.00000
```

```
SE    B    0. 000740. 001880. 000000. 000000. 000000. 00000
SSE   B    0. 001480. 002620. 000250. 000000. 000000. 00000
S     B    0. 001560. 002460. 000080. 000000. 000000. 00000
SSW   B    0. 001230. 001720. 000160. 000000. 000000. 00000
SW    B    0. 001390. 001800. 000330. 000000. 000000. 00000
WSW   B    0. 002130. 002130. 000740. 000000. 000000. 00000
W     B    0. 003120. 002300. 000160. 000000. 000000. 00000
WNW   B    0. 001880. 002460. 000330. 000000. 000000. 00000
NW    B    0. 001310. 003610. 000250. 000000. 000000. 00000
NNW   B    0. 002050. 003440. 000080. 000000. 000000. 00000
N     C    0. 003440. 003280. 000900. 000080. 000000. 00000
NNE   C    0. 002620. 001480. 000080. 000000. 000000. 00000
NE    C    0. 003120. 000820. 000080. 000000. 000000. 00000
ENE   C    0. 001390. 001070. 000160. 000000. 000000. 00000
E     C    0. 001070. 001310. 000250. 000000. 000000. 00000
ESE   C    0. 000570. 000820. 000900. 000000. 000000. 00000
SE    C    0. 001390. 002460. 002790. 000410. 000000. 00000
SSE   C    0. 001970. 005900. 004260. 000330. 000000. 00000
S     C    0. 001390. 005740. 001880. 000330. 000000. 00000
SSW   C    0. 001390. 002790. 001310. 000080. 000000. 00000
SW    C    0. 001800. 004430. 003770. 000490. 000000. 00000
WSW   C    0. 002210. 004020. 004260. 000820. 000000. 00000
W     C    0. 003940. 006310. 003360. 000330. 000000. 00000
WNW   C    0. 002700. 004840. 002380. 000080. 000000. 00000
NW    C    0. 003030. 005900. 003120. 000080. 000000. 00000
NNW   C    0. 003610. 006890. 001720. 000080. 000000. 00000
N     D    0. 010000. 013360. 007300. 001070. 000000. 00000
NNE   D    0. 005570. 007300. 002870. 000250. 000080. 00000
NE    D    0. 004590. 003200. 000570. 000160. 000000. 00000
ENE   D    0. 002870. 003770. 001070. 000160. 000000. 00000
E     D    0. 002210. 004430. 002460. 000660. 000000. 00000
ESE   D    0. 002790. 003280. 006560. 002950. 000570. 00008
SE    D    0. 002620. 007460. 025170. 015490. 001230. 00000
SSE   D    0. 002300. 013030. 026310. 010660. 000490. 00008
S     D    0. 002300. 010580. 011310. 005490. 000490. 00016
SSW   D    0. 004100. 007130. 005820. 005250. 001070. 00016
SW    D    0. 005410. 016070. 016560. 009840. 000980. 00016
WSW   D    0. 003030. 010250. 018850. 011390. 000660. 00000
W     D    0. 003850. 011230. 021310. 014020. 002210. 00016
WNW   D    0. 004100. 008940. 015830. 011230. 000740. 00016
NW    D    0. 007460. 013200. 019590. 011480. 000330. 00000
NNW   D    0. 011070. 013200. 014510. 003610. 000080. 00008
N     E    0. 007460. 014180. 001150. 000000. 000000. 00000
NNE   E    0. 006070. 011480. 000330. 000000. 000000. 00000
NE    E    0. 003770. 008120. 000250. 000000. 000000. 00000
```

```
ENE  E   0. 003940. 007210. 000250. 000000. 000000. 00000
  E  E   0. 004670. 012460. 000330. 000000. 000000. 00000
ESE  E   0. 003770. 007050. 001880. 000000. 000000. 00000
 SE  E   0. 002380. 011970. 008120. 000000. 000000. 00000
SSE  E   0. 002620. 009590. 004510. 000000. 000000. 00000
  S  E   0. 002380. 007130. 002460. 000000. 000000. 00000
SSW  E   0. 002460. 004260. 000980. 000000. 000000. 00000
 SW  E   0. 002620. 003940. 002300. 000000. 000000. 00000
WSW  E   0. 001390. 002790. 001800. 000000. 000000. 00000
  W  E   0. 002790. 009020. 003610. 000000. 000000. 00000
WNW  E   0. 003770. 010410. 002130. 000000. 000000. 00000
 NW  E   0. 006480. 012620. 003440. 000000. 000000. 00000
NNW  E   0. 010250. 018120. 003520. 000000. 000000. 00000
  N  F   0. 000410. 001070. 000000. 000000. 000000. 00000
NNE  F   0. 000570. 001970. 000000. 000000. 000000. 00000
 NE  F   0. 000980. 000900. 000000. 000000. 000000. 00000
ENE  F   0. 000330. 002210. 000000. 000000. 000000. 00000
  E  F   0. 001230. 001800. 000000. 000000. 000000. 00000
ESE  F   0. 000660. 001480. 000000. 000000. 000000. 00000
 SE  F   0. 000330. 000820. 000000. 000000. 000000. 00000
SSE  F   0. 000080. 000490. 000000. 000000. 000000. 00000
  S  F   0. 000160. 000250. 000000. 000000. 000000. 00000
SSW  F   0. 000160. 000000. 000000. 000000. 000000. 00000
 SW  F   0. 000000. 000080. 000000. 000000. 000000. 00000
WSW  F   0. 000160. 000080. 000000. 000000. 000000. 00000
  W  F   0. 000080. 000490. 000000. 000000. 000000. 00000
WNW  F   0. 000740. 001230. 000000. 000000. 000000. 00000
 NW  F   0. 000410. 001070. 000000. 000000. 000000. 00000
NNW  F   0. 000250. 001720. 000000. 000000. 000000. 00000
```

SAMPLE.STR is a sample file containing this data which can be found on the installation disk.

Appendix C

STATE AGRICULTURAL PRODUCTIVITY

The following values are Beef Cattle Densities, Milk Cattle Densities, and Vegetable Crop Food Fractions by state.

State	Beef	Milk	Vegetable
Alabama	1.520E-01	7.020E-03	4.160E-03
Alaska	0.000E+0	0.000E+0	0.000E+0
Arizona	1.270E-01	5.900E-03	1.460E-03
Arkansas	3.730E-02	2.800E-03	2.900E-03
California	8.810E-02	2.850E-02	1.180E-02
Colorado	1.130E-01	3.500E-03	1.390E-02
Connecticut	3.600E-02	2.500E-03	7.930E-03
Wash. D.C.	0.000E+0	0.000E+0	0.000E+0
Delaware	6.480E-02	2.720E-02	5.850E-02
Florida	1.280E-01	1.370E-02	6.920E-03
Georgia	1.430E-01	8.630E-03	2.170E-03
Hawaii	0.000E+0	0.000E+0	0.000E+0
Idaho	7.400E-01	3.140E-02	2.430E-02
Illinois	7.190E-02	8.560E-03	7.150E-02
Indiana	3.330E-01	2.160E-02	2.800E-02
Iowa	3.340E-01	2.800E-02	2.720E-02
Kansas	2.900E-01	8.000E-03	5.970E-02
Kentucky	2.650E-01	2.570E-02	3.980E-03
Louisiana	1.080E-01	9.620E-03	4.350E-02
Maine	2.900E-02	3.130E-02	4.960E-03
Maryland	1.090E-01	6.110E-02	1.110E-02
Massachusetts	7.650E-03	8.070E-03	5.970E-02
Michigan	7.900E-02	3.510E-02	1.700E-02
Minnesota	1.850E+0	4.880E-02	3.050E-02
Mississippi	3.430E-01	1.890E-02	8.140E-03
Missouri	1.750E-01	8.700E-03	1.070E-03
Montana	7.290E-02	9.270E-04	8.780E-03
Nebraska	1.020E-01	1.260E-02	6.320E-03
Nevada	1.180E-01	6.250E-03	6.290E-02
New Hampshire	3.500E-01	8.780E-03	2.390E-02
New Jersey	1.400E-02	1.580E-02	6.690E-02
New Mexico	4.250E-02	3.290E-02	1.820E-02
New York	4.130E-02	1.140E-03	1.380E-03
North Carolina	1.840E-02	5.650E-04	8.920E-03
North Dakota	5.830E-02	8.560E-02	1.880E-02
Ohio	2.030E-01	4.560E-02	1.700E-02
Oklahoma	2.680E-01	7.130E-03	2.800E-02
Oregon	4.560E-02	4.530E-03	1.590E-02

State	Beef	Milk	Vegetable
Pennsylvania	9.630E-02	6.460E-02	1.320E-02
Rhode Island	2.500E-02	2.300E-02	4.540E-02
South Carolina	8.870E-02	7.020E-03	1.840E-03
South Dakota	2.320E-01	8.850E-03	1.200E-02
Tennessee	2.110E-01	2.000E-03	2.720E-03
Texas	1.900E-01	5.300E-03	5.770E-03
Utah	2.840E-02	4.460E-03	1.830E-03
Vermont	1.310E-01	1.840E-02	8.700E-03
Virginia	4.710E-02	8.880E-02	1.080E-03
Washington	5.620E-02	1.500E-02	5.200E-02
West Virginia	1.810E-01	1.430E-01	1.789E-02
Wisconsin	6.230E-02	6.000E-03	1.160E-03
Wyoming	5.120E-02	5.790E-04	1.590E-03

Appendix D

WEATHER DATA LIBRARY

ALABAMA

HSV0544   Huntsville, AL   60/1-64/12

ARIZONA:

INW0314   Winslow, AZ   49/1-54/12
PNX0309   Phoenix, AZ   55/1-64/12

ARKANSAS:

LIT0516   Little Rock, AR   55/1-64/12
LIT0165   Little Rock, AR   72/2-73/2

CALIFORNIA:

BUR1051   Burbank, CA   60/1-64/12
LAX0304   Los Angeles, CA   64/5-69/4
LGB1052   Long Beach, CA   60/1-64/12
NZY0380   San Diego, CA   67/1-71/12
OAK0319   Oakland, CA   60/1-64/12
SAC0320   Sacramento, CA   66/1-70/12
SBA0313   Santa Barbara, CA   60/1-64/12
SNA1467   Santa Ana, CA   72/1-76/12
SUU0316   Fairfield/Travis CA   60/1-64/12

COLORADO:

DEN0618   Denver, CO   60/1-64/12
DEN0952   Denver, CO   70/1-74/12
EEE1420   Eagle Co., CO   76/1-76/12
GJT0476   Grand Junction, CO   60/1-64/12
PUB0564   Pueblo, CO   66/1-70/12

CONN:

BDL1262   Hartford, CT   55/1-64/12
BDR0558   Bridgeport, CT   65/1-69/12
NHZ0180   Brunswick, CT   60/1-69/12

DELAWARE

ILG1058   Wilmington, DE   60/1-64/12

DISTRICT OF COLUMBIA:

DCA1047   Washington, DC   68/1-73/12

FLORIDA:

MIA0979   Miami, FL   70/1-74/12
PBI0054   West Palm Beach, FL   70/1-70/12
TLH0663   Tallahassee, FL   60/1-64/12
TPA0662   Tampa, FL   60/1-64/12
TPA0915   Tampa, FL   69/1-73/12
MCO0838   Orlando, FL   74/1-74/12

GEORGIA:

AGS1018   Augusta, GA   70/1-74/12
AMB0771   Alma, GA   54/1-58/12
CSG0767   Columbus, GA   69/1-73/12

IDAHO:

BOI0653   Boise, ID   60/1-64/12
MLP1448   Mullan Pass, ID   50/1-54/12
PIH0359   Pocatello, ID   58/1-62/12

ILLINOIS:

MDW0675   Chicago/Midway, IL   73/1-73/12
MLI0269   Moline/Quad City IL   67/1-71/12
ORD0452   Chicago/OHare, IL   65/1-69/12
PIA0716   Peoria, IL   65/1-69/12
RAN0234   Rantoul/Chanute AFB IL 63/1-67/12
SPI0415   Springfield, IL   67/1-71/12

INDIANA:

EVV0406   Evansville, IN   60/1-64/12
FWA1156   Ft. Wayne, IN   60/1-64/12
IND1080   Indianapolis, IN   55/1-74/12
SBN0257   South Bend, IN   67/1-71/12

IOWA:

ALO0729	Waterloo, IA	60/1-64/12
DSM0753	Des Moines, IA	72/1-72/12

KANSAS:

FLV0561	Ft Leavenworth, KS	62/1-70/12
MKC1323	Kansas City, KS	67/1-71/12
TOP0534	Topeka, KS	63/1-72/12

KENTUCKY:

CVG0403	Covington, KY	58/1-62/12
CVG1916	Covington, KY	70/1-74/12
PAH0479	Paducah, KY	60/1-64/12

LOUISIANA:

BTR0169	Baton Rouge, LA	72/1-72/12
BTR0166	Baton Rouge, LA	55/1-64/12
NBG1379	New Orleans, LA	67/1-71/12

MARYLAND:

BAL1059	Baltimore, MD	69/1-73/12
FME1207	Ft Meade, MD	60/1-64/12
NHK1306	Patuxent River, MD	75/1-75/12

MASS:

BED0181	Bedford, MA	63/1-67/12
BOS0211	Boston/Logan, MA	67/1-71/12
CEF0182	Chicopee Falls MA	60/1-64/12
NZW1144	So. Weymouth, MA	70/1-74/12

MICHIGAN:

BTL1460	Battle Creek, MI	50/1-54/12
TVC0844	Traverse City, MI	74/1-74/12
MKG0251	Muskegon County, MI	67/1-71/12
YIP1061	Detroit, MI	63/10-68/9

MINNESOTA

MSP0267   Minneapolis/StPl MN   67/1-71/12

MISSOURI:

COU0170   Columbia, MO   64/1-68/12
STL0603   St. Louis, MO   60/1-64/12

MISSISSIPPI:

BIX0538   Biloxi, MS   60/1-64/12
CGM0670   Columbus, MS   66/1-70/12
SGF0178   Springfield, MS   66/1-70/12
JAN1169   Jackson, MS   55/1-64/12

MONTANA:

BIL0331   Billings, MT   67/1-71/12
BTM0357   Butte, MT   56/1-60/12

NEBRASKA:

LNK1142   Lincoln, NE   59/1-63/12
OMA0991   Omaha/Eppley, NB   55/1-64/12

NEVADA:

UCC1026   Yucca Flats, NV   61/12-64/11

NEW JERSEY

NEL0505   Lakehurst, NJ   68/1-72/12

NEW MEXICO:

ABQ0282   Albuquerque, NM   60/1-64/12
CNM1741   Carlsbad, NM   50/1-54/12
FMN0285   Farmington, NM   63/5-68/4
GNT1246   Grants, NM   54/1-54/12
SAF1184   Santa Fe, NM   50/1-54/12

NEW YORK:

ALB0523	Albany, NY	60/1-64/12
BUF0741	Buffalo, NY	73/1-73/12
HPN0429	White Plain, NY	49/1-53/12
IAG0905	Niagra Falls, NY	55/1-59/12
LEA0189	New York/LaGuardia	65/1-70/12
LEA0435	NY/Ft Totte, NY	65/1-69/12
ROC0598	Rochester, NY	55/1-64/12
SWF0185	Newburgh, NY	65/1-69/12

NORTH CAROLINA:

CLT0682	Charlotte, NC	69/1-73/12
FBG0075	Ft Bragg, NC	66/1-70/12
HAT0392	Cape Hatteras, NC	66/1-70/12
INT0531	Winston Salem, NC	60/1-64/12
NKT0106	Cherry Pt, NC	67/1-71/12
ILM0104	Wilmington, NC	66/1-70/12
RDU0083	Raleigh, NC	66/1-70/12

NORTH DAKOTA:

DIK0509	Dickinson, ND	60/1-64/12

OHIO:

CLE1140	Cleveland, OH	70/1-74/12
CMH0243	Columbus, OH	60/1-64/12
DAY0404	Dayton, OH	65/1-69/12
DAY1502	Dayton, OH	76/1-76/12
IBG0745	Perry, OH	49/1-49/12
TOL0990	Toledo, OH	60/1-64/12

OREGON

PDX0364	Portland, OR	67/1-71/12

PENNSYLVANIA:

AVP0499	Wilkes-Barre, PA	60/1-64/12
ERI0610	Erie, PA	64/1-73/12
HAR0631	Harrisburg, PA	64/1-64/12
RDG0184	Reading, PA	49/1-49/12

RHODE ISLAND:

PVD0560   Providence, RI   68/1-72/12

SOUTH CAROLINA:

CAE1371   Columbia, SC   56/1-75/12
FLO0600   Florence/Gilbert SC   60/1-64/12
GSP0528   Greenville/Sparta SC   68/1-72/12
MYR1027   Myrtle Beach, SC   66/1-70/12

SOUTH DAKOTA:

RAP0336   Rapid City, SD   67/1-71/12

TENNESSEE:

BNA0149   Nashville, TN   66/1-70/12
CHA0711   Chattanooga, TN   68/1-73/12
MEM0143   Memphis, TN   67/1-71/12
TRI1191   Bristol, TN   74/1-74/12
TYS1328   Knoxville, TN   55/1-64/12

TEXAS:

AMA0621   Amarillo, TX   55/1-64/12
CRP1459   Corpus Christi, TX   73/7-77/6
SAT0064   San Antonio, TX   60/1-64/12

UTAH:

HV40302   Hanksville, UT   49/1-54/12
SLC1411   Salt Lake City, UT   72/1-76/12

VIRGINIA:

IAD0398   Wash/Dulles, VA   66/1-70/12
GVE0824   Gordonsville, VA   56/1-60/12
ROA0526   Roanoke, VA   68/1-72/12

WASHINGTON:

GEG0360	Spokane, WA	67/1-71/12
MWH0486	Moses Lake, WA	61/1-65/12
YKM0484	Yakima, WA	50/1-54/12

WEST VIRGINIA:

| CRW0655 | Charleston, WV | 68/1-73/12 |
| HTS0019 | Huntington, WV | 67/1-71/12 |

WISCONSIN:

| EAU0715 | Eau Claire, WI | 69/1-73/12 |
| ERB0776 | Green Bay, WI | 64/1-73/12 |

WYOMING:

CPR0335	Casper, WY	67/1-71/12
LND1100	Lander, WY	70/1-74/12
RWL1261	Rawlins, WY	55/1-64/12
RKS1588	Rocky Springs, WY	71/1-75/12

Appendix E

DIFFERENCES WITH EARLIER VERSION OF AIRDOS-EPA/DARTAB

There are a few differences between CAP88-PC and earlier versions of AIRDOS, PREPAR and DARTAB. CAP88-PC is optimized for doing population assessments. Population arrays must always be supplied to the program as a file, using the same format as the mainframe version of CAP88. Sample population files are supplied with CAP88-PC, the user may modify the supplied files to reflect their own population distributions. Population files for the mainframe version of CAP88 may be downloaded in ASCII format and used with CAP88-PC. CAP88-PC is programmed to use the distances in the population array to determine the distances used to calculate concentrations, to eliminate human error. CAP88-PC only uses circular grids; square grids are not an option. Direct user input of concentrations is also not an option. Agricultural arrays are generated automatically, as a function of state-specific productivity data, requiring the user to supply only the State abbreviation or agricultural productivity values.

CAP88-PC is also modified to do either "Radon-only" or "Non-Radon" runs, to conform with the format of the 1988 Clean Air Act NESHAPS Rulemaking. "Radon-only" assessments, which only have Rn-222 in the source term, automatically include working level calculations; any other source term ignores working levels. Synopsis reports customized to both formats are automatically generated.

Organs and weighting factors are modified to follow the ICRP 26/30 Effective Dose Equivalent calculations, which eliminates flexibility on specifying organs and weighting factors. The calculation of deposition velocity and the default scavenging coefficient is also modified to incorporate current EPA policy.

Organs and Weighting Factors

Only 7 organs are valid for the new Effective Dose Equivalent. They are:

Organ	Weight
GONADS	0.25
BREAST	0.15
R MAR	0.12
LUNGS	0.12
THYROID	0.03
ENDOST	0.03
RMNDR	0.30

Only these 7 organs are valid. Changing the organs and weights will invalidate the results.

Population Arrays

Population arrays must now be entered only as a file. In the 1985 CAAC version of AIRDOS-EPA/DARTAB, population arrays could be entered as instream data in PREPAR.

Population files for the mainframe version of CAP88 may be downloaded in ASCII format and used with CAP88-PC. Sample population files are supplied with CAP88-PC, the user may modify the supplied files to reflect their own population distributions.

The distances at the top of the population file are used by CAP88-PC to determine the distances used in the assessment. This was programmed to eliminate human error in mis-matching the distances used to calculate concentrations with the distances used to generate the population array. Distances used for calculating concentrations are now automatically set in CAP88-PC so as to calculate concentrations for the midpoint of each sector.

Distances

In population assessments, distances for calculating concentrations (IDIST) are calculated automatically as a function of the distances in the population array file. CAP88-PC is written to only allow user assignments of IDIST for individual assessments.

Agricultural Arrays

Arrays of milk cattle, beef cattle and agricultural crop area are automatically generated by the CAP88-PC; the user is not required to supply the arrays. The arrays are generated to match the distances used in the population arrays supplied to the code, and use State-specific agricultural productivity values.   The state name (standard two letter abbreviation) must be provided to the variable STATE. Users are given the option to override the default agricultural productivity values.

Radon-Only Runs

Assessments for Radon-222 now automatically include Working Level calculations. CAP88-PC does this automatically; only a single source term of RN-222 may be used in this option. Input of any additional radionuclides, even Rn-220, will cause CAP88-PC to omit working level calculations.

Square Grids

Option 2 in earlier versions of AIRDOS-EPA allowed users to choose either a square (0) or circular grid (1). Since CAP88-PC requires a circular grid for population assessments, this option is not available.

Scavenging Coefficient

The subroutine SETSC (from PREPAR) is no longer used. The default scavenging coefficient (SC) is now calculated as a function of rainfall rate (RR). The formula used is: SC = RR * 1E-7

Users are given the option of overriding the default value.

Direct Input of Concentrations

In CAP88-PC, the user may not supply concentrations as input. The subroutine DIRECT has been removed.

Deposition Velocity

The subroutine SETVD is no longer used to calculate deposition velocity (VD). VD is set as follows:

Class	VD m/sec
Iodine	3.5E-2
Particulate	1.8E-3
Gas	0

Equilibrium Fractions

CAP88-PC has the capability to vary equilibrium fractions; previously they were set to a constant of 0.7. The new method varies the equilibrium fractions depending on the distance from the source. Linear interpolation is used to determine the equilibrium fractions for distances that do not match the set distances given. The equation is as follows:

$$EFY = EFX + ((EFZ - EFX) * ((Y - X) / (Z - X)))$$

Where you have X_____Y_____Z

X and Z are the set distances given and Y is the user given distance (between X and Z). The new method finds the equilibrium fraction for EFX, and EFZ is the SET_EQUIL_FRACTIONS corresponding to the set distances.

DOSMIC Subroutine

DOSMIC was modified to print only Working Levels. Working Levels are only output for RN-222. Checks are performed before DOSMIC is called to determine if Working Levels are needed.

Water Arrays

Arrays of water areas are not used in CAP88-PC.

NOMA fix

CAP88-PC uses a slightly different approach in calculating NOMA, following discovery of a potential error in the 1985 CAAC version of AIRDOS-EPA. In the earlier version, this error caused multiple point sources to be treated as an area source if the nuclides emitted from each stack had identical characteristics. This may cause some differences with previous assessments.

Wind Frequencies

The GETWND routine has been modified to accept wind speeds greater than 10 m/sec. Earlier versions would only accept wind speeds less than 10 m/sec, and there was a problem with some facilities, which had high wind speeds, generating overflow errors in the wind speed arrays.

In order to accommodate higher wind speeds, and remain compatible with existing wind data sets, precision limits force the calculations to truncate the last digit in the wind speed data. This may cause a slight variation in the determination of PERD, the wind frequency for each direction, due to roundup. This may cause a variation in concentrations as compared with earlier versions of PREPAR and AIRDOS.

Appendix F

POPULATION FILE FORMAT

Users are encouraged to use site-specific population arrays with CAP88-PC. Users who have been operating the CAP88 mainframe software may download their population files for use on the CAP88-PC system. In order for CAP88-PC to recognize the new population files, they must be copied to the \CAP88PC\POPFILES subdirectory, and the filename must have the .POP extension. They must be in the same format as the following file.

It is critical that all information be in the same exact locations with the "$" sign being in the first column of the first row of the file.

The population file name, latitude, and longitude on row 1 are information only for the purpose of verifying that the file desired is the file the user has selected.

NRADS is the number of distances within the population file. The value associated with NRADS must be in columns 68 and 69 of row 1 of the population file and the last digit must always found column 69 (right justified).

Distances begin in row 2 and all numbers are right justified. The number of distances found in the file will be the number specified by NRAD.   The distances are edge points of each sector (the midpoints used in the calculations will be calculated by the program) and are entered in the population file in kilometers. The CAP88 programs will multiply each distance by 1000 before calculating the midpoints and using them in the assessment. For example, the first distance in the file, .62 kilometers, will become 620 meters and the midpoint calculated from that will be 310 meters. There can be up to 20 distances, but the typical number of distances is 13.

The population values are entered with distances across (columns) and directions down (rows); however, each row will not be a new direction. There will be 20 distances for each direction (regardless of the number of distances specified in the population file). The extra distances (usually 7) will simply contain zero. There will always be 8 population values per row with the first value ending at column 10 and each subsequent value ending at multiples of 10 with the last value per row ending in column 80. This means that for the direction N, the population values will be contained on the first, second and part of the third row of the distance-direction population values. The first population value for the next direction, NNW, will be contained in columns 41 through 50 of the third row and subsequent values for direction NNW will be contained on the remaining part of the third row, the fourth and part of the fifth row. There are 16 directions in counterclockwise order starting with North.

The following is the population file RMICOMPY.POP used in the sample assessment.

```
$ RMICOMPY              LAT= 41.8900  LON= 80.7767  NSEC=16  NRADS=13
      .62       1.0       2.0       3.0       4.0       5.0      10.0      20.0
     30.0      40.0      50.0      60.0      80.0
       0.        0.        0.     1043.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        6.        0.      113.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.     1987.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.     2218.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.     2435.     3014.      288.      183.      380.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.      421.      810.
       0.      293.     1108.      779.    15354.     8786.    48943.    63357.
  319944.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.     2435.        0.     1688.     3376.
    3448.     7591.     6999.    23331.   187240.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.     4350.
     407.     4223.     3024.     3059.     3396.     3128.     6847.     8940.
   27255.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.     2002.        0.      534.     8224.
    2252.     2388.     5752.     7858.   140074.        0.        0.        0.
       0.        0.        0.        0.        0.        0.      101.        0.
       0.        0.        0.      984.     1792.     3659.     3759.     7416.
   80933.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.      974.     1388.
    2021.     3148.     5123.     4351.    14935.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.      851.
       0.        0.      125.     3161.      827.     3252.     3712.    25127.
   15531.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.      780.        0.       89.      793.      265.
    1693.     5397.     1338.    11236.    17820.        0.        0.        0.
       0.        0.        0.        0.        1.        0.        0.       55.
       0.        0.        0.    14641.     6332.     5986.    13324.    45833.
  150138.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.
```