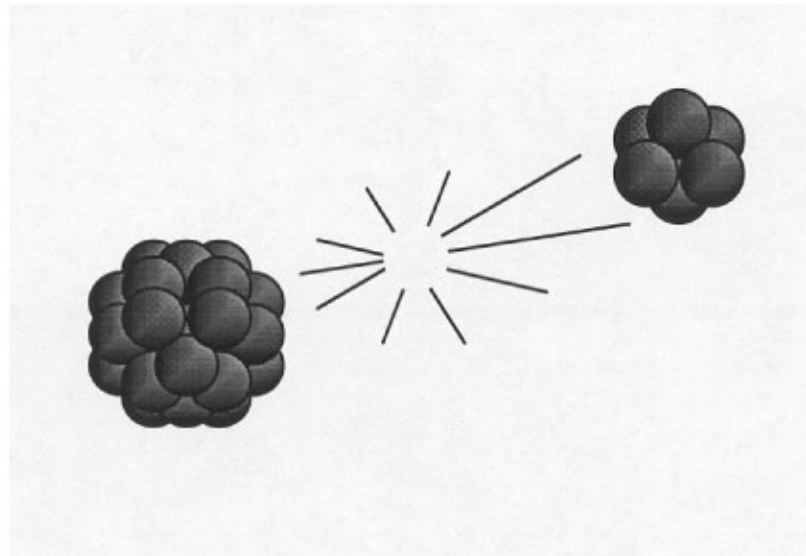




# UPDATED User's Guide For CAP88-PC

Version 2.0



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# CAP88-PC Version 2.0 UPDATED USER'S GUIDE

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## CHAPTER 1

### INTRODUCTION

#### 1.1 Background

On October 31, 1989 the Environmental Protection Agency (EPA) issued final rules for radionuclide emissions to air under 40 CFR 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 model 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. CAP88 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 DOS 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. The complete set of dose and risk factors used in CAP88 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. CAP88-PC version 1.0 was approved for demonstrating compliance with 40 CFR 61.93 (a) in February 1992.

CAP88-PC version 2.0 provides a framework for developing inputs to perform full-featured dose and risk assessments in a Windows environment for the purpose of demonstrating compliance with 40 CFR 61.93 (a). Version 2.0 includes some minor changes compared to the DOS version. The changes are: i) addition of decay chains for six radionuclides (Strontium, Zirconium, Ruthenium-103, Ruthenium-106, Cerium, and Plutonium), ii) correction of a minor error in the Uranium decay chain, and iii) correction of a typographical error in the concentration reports. CAP88-PC version 2.0 has been approved for demonstrating compliance with 40 CFR 61.93 (a) in October 1999.

### 1.3 Model Summary

CAP-88 PC uses a modified Gaussian plume equation to estimate the average dispersion of radionuclides released from up to six emitting 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 buoyant-driven plume.

Assessments are done for a circular grid of distances and directions for a radius of up to 80 kilometers (50 miles) around the facility. The Gaussian plume model 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.

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, which the user may modify 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 dose concentrations is also not an option. Population distances are used for calculating concentrations for the midpoint of each sector. Population distances are specified in the Population File or, for an Individual Assessment, on the Run Options tab form.

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.

Agricultural arrays of milk cattle, beef cattle and agricultural crop area are generated automatically, requiring the user to supply only the State name or agricultural productivity values. The arrays are generated to match the distances used in the population arrays supplied to the code, and use State-specific or user-supplied agricultural productivity values. The state name (standard two letter abbreviation) must be provided on the Facility Data tab form. Users are given the option to override the default agricultural productivity values by entering the data directly on the Agricultural Data tab form. If Alaska, Hawaii, or Washington, D.C. are selected, agricultural productivity values are set to zero and must be provided by the user.

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. Assessments for Radon-222 now automatically include Working Level calculations when 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.

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. Deposition velocity is set to  $3.5 \times 10^{-2}$  m/sec for Iodine,  $1.8 \times 10^{-3}$  m/sec for Particulate, and 0.0 m/sec for Gas. The default scavenging coefficient is calculated as a function of annual precipitation, which is input on the Meteorological Data tab form.

Only 7 organs are valid for the Effective Dose Equivalent. Changing the organs and weights will invalidate the results. They are Gonads 25 percent, Breast 15 percent, R MAR 12 percent, Lungs 12 percent, Thyroid 3 percent, ENDOST 3 percent, and Remainder 30 percent.

#### 1.4 Verification

The CAP88-PC programs represent one of 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 and Indoor Air has made comparisons between the predictions of annual-average ground-level concentration to actual environmental measurements, and found very good agreement. In the 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.

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.

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.

## CHAPTER 2

### GETTING STARTED

#### 2.1 Installation

The CAP88-PC Windows version can be downloaded either from EPA web site: <http://www.epa.gov/radiation/assessment/cap88.html> or from DOE web site: <http://www.er.gov/production/er-80/cap88>.

The CAP88-PC Version 2.0 installation program creates a program directory, with a default name of CAP88PC2, with several default subdirectories: DATA, DATASETS, OUTPUT, POPFILES, and WNDFILES. The CAP88-PC Version 2.0 installation program also writes the CAP88PCW.INI, NEWPOP.INI, NEWDOE.INI, NEWSTAR.INI, and NEWLTPOP.INI files to the Windows directory. The installation program does assume that the program directory and the Windows directory are on the same drive.

#### 2.2 Entering Data

The following is a procedure for entering appropriate data in CAP88-PC. Select New Dataset from the File Menu. Give the Dataset a descriptive Dataset Name and a Filename. The Dataset Name should be unique for each dataset, but this is not enforced by the program. The Dataset Name will appear in the Dataset List each time the Select Dataset form appears. The Dataset Filename should be unique as this name will be used to create a DOS text file to store the Dataset parameters. The Filename is limited to 8 characters and may not include a space, a pipe character (vertical dashes) or an asterisk, as these characters are not appropriate for DOS naming conventions. Two comment areas are provided for further documenting the dataset. These two 50-character text fields will be repeated on the first page of each Output Report file. Select OK to have the program create the file and open the 6-page tab form for data entry.

Select each tab form in turn and enter the appropriate data. The Page Down key may be used to change tab forms as each form is completed. If required data is missing when the dataset is saved (Save Dataset in the File Menu), the program will ask for the data to be entered. Save the dataset to the same filename or save the dataset to a new filename before executing CAP88-PC. From the Run Menu, select Execute CAP88-PC. Indicate the dataset to be executed. The input data and files are checked briefly, then the executable DOS programs are run. If your computer does not have enough memory to execute the DOS programs, select the option to create an INPUT.DAT file, exit Windows, and execute the programs from DOS. Upon successful execution, Output Report files will be created. These Output Report files can be viewed and printed using the Print Preview.

Required Data: On the Facility Data tab form, the State must be selected, as the agricultural density fractions on the Agricultural Data screen are linked to the State selected. CAP88 requires

that the input data include the location and filename of a valid Population File (Run Options tab form, for Run Type = Population) and a valid Wind File (Meteorological Data tab form). At least one nuclide must be entered (Nuclide Data tab form). The number of source tabs on the Nuclide Data tab form is controlled by the number of Sources entered on the Source Data tab form, so it is appropriate to enter and describe the emitting sources prior to entering nuclide data.

Sample Data: A sample Dataset (Reactive Metals), a sample Population File (RMIASHTA.POP) and a sample Wind File (ERIEPA.WND) have been provided. Do not select TESTDATA.POP as a Population File, as it is created with no population data and an error will occur when executing the CAP88 Model. Other sample Population Files and Wind Files may be extracted from compressed files using the Population File Library and the Wind File Library, respectively. These and other utility programs for modifying or creating Population Files and Wind Files can be found in the Execute Menu.

Many of the menu options appear on the floating/dockable Toolbar. Rest your cursor on the Toolbar icon to see the label for that icon. Use the mouse to select and drag the Toolbar to convenient locations.

Many data options appear as buttons or in drop down lists to facilitate and control data entry. Make appropriate selections to best describe the parameters of the scenario to be modeled. Most of the inputs will appear in appropriate Output Reports, to be evaluated in the context of the calculated data.

### 2.3 Windows 95 Issue

There is a known problem with running CAP88-PC Version 2.0 in a Windows 95 environment that requires user intervention. When a DOS program is executed (via a DOS 'shell'), the user must maximize and close the DOS shell window. This problem occurs:

1. ...when executing CAP88... In the Run Menu, select Execute, or select the CAP88-PC Molecule icon on the toolbar. Select the dataset which will be used to execute CAP88, then select the OK button. Input data will be checked for completeness, then the program shells out to DOS three times. Each time the user must maximize and close the DOS shell when the status box at the bottom on the user's screen shows "Done".

CAP88 involves executing three FORTRAN programs in DOS: DEFAULT.EXE, AIRDOS.EXE, and DARTAB.EXE. The DOS shell to each of the three programs must be closed at the end of execution.

There is a DOS shell status bar at the bottom of the Windows 95 screen. The DOS shell status bar will display the name of the FORTRAN program and the run status. When the first FORTRAN program is completed, the DOS shell window will show the name DEFAULT (the

FORTRAN program name) and the job status: Done. Click on the [up arrow] to maximize the window and click on the [x] in the upper right corner to close the DOS shell. This action must be repeated for the AIRDOS program and the DARTAB program, as their execution completes.

2. ...when executing the Stability Array/Wind File Generator program... When the user selects the Process button and provides the input and output filenames and selects the Run button, the DOS program STARDOE.EXE is executed. The DOS shell status bar will display the program name and the run status. When the job status shows Done, the user must maximize the window and close the DOS shell. Also, when the user selects the Create Wind File for CAP88-PC button, the DOS program WINDGET.EXE is executed. The user must again maximize the Status window and close the DOS shell.

## 2.4 Toolbar

CAP88-PC Version 2.0 is installed with a Floating and Dockable Toolbar. To Dock a Floating Toolbar, click and drag the toolbar to the top, bottom, left, or right sides of the screen. To Float a Docked Toolbar, click and drag the toolbar away from the edge of the screen. Most forms will appear below the toolbar, and the toolbar may need to be moved away from the form, or in most cases the form may be moved by clicking and dragging the top of the form. Some forms, notably the Common Dialog form which assists the user in locating a file or selecting a drive and directory, will appear on top of the toolbar. This form may be moved away from the toolbar, if necessary. The File, Run, and Help Menus will also appear over the toolbar. This should not be a problem.

The Help Menu has two toolbar-setting features. Toolbar On/Off will be checked on the left if the toolbar is on. The toolbar may be set off indefinitely and the program will not be affected. Use Reset Toolbar if the video resolution is changed such that a toolbar is no longer in the display screen even the Toolbar On/Off is checked (on).

## 2.5 Uninstall CAP88-PC Version 2.0

The Uninstall icon will uninstall only those files that were installed with CAP88-PC Version 2.0. Any extracted or created Population and Wind Files, as well as any Datasets and Output Files, will not be deleted. If the Uninstall icon has been removed, run the UNWISE.EXE program located in the CAP88-PC install directory.

## CHAPTER 3

### FILE MENU

#### 3.1 New Dataset

Open a New Dataset by providing descriptive information in the New Dataset Information form and selecting OK. A set of six tabbed forms appears to assist in the preparation of an input file (dataset) containing the data needed to execute CAP88-PC.

#### 3.2 Open Dataset

An existing dataset is selected and opened for review and modification. If the dataset name does not appear in the dataset list (down arrow), use the Maintenance option to locate and Restore an existing dataset.

#### 3.3 Close Dataset

Close the open dataset without making any changes. Data revisions for a current session are made to a copy of the dataset. If Close Dataset is selected, the dataset will not have been updated, possibly resulting in a loss of data. If a New Dataset was opened, it will have been created and added to the dataset list, but will not have any data revisions saved.

#### 3.4 Save Dataset

Save all data and any changes made to the opened dataset, using the filename of the opened dataset. The data entry tab forms are then closed. The user must save or close a dataset before the dataset may be used to execute the CAP88 Model (see Run/Execute).

#### 3.5 Save Dataset As

Save all data and any changes made to the opened dataset, using the filename provided by the user. This operation creates a new dataset and a new file. The filename must be unique, or the file with the same name may be overwritten, with user approval.

#### 3.6 Print Setup

This is a standard Windows form for reviewing and setting printer options. The Floating Toolbar can not be selected or moved when this form is open.

### 3.7 Print Preview

Select Print Preview to display and print CAP88-PC output reports. The output reports have the same filename as the dataset, but with CAP88-standard file extensions. Use the tabs on the Print Preview form to move from one report to another. Use the scroll bar to scroll down or up to view each report. When the Print Current View option is selected, the entire report shown in the tab window is printed. To print several reports at once, check the report boxes and choose the Print button.

### 3.8 Maintenance

There are two maintenance options, File Maintenance and List Maintenance. These options assist the user in archiving, deleting, restoring, and renaming Datasets, Population Files, and Wind Files, as well as maintain the lists that describe the Population Files and Wind Files.

### 3.9 File Maintenance

This menu item assists the user in archiving, deleting, restoring, and renaming Datasets, Population Files, and Wind Files. File Maintenance will perform the indicated operation and also maintain the file selection lists used in the data entry portion of the program. If the Windows File Manager is used to perform these operations, files selected from drop down lists may not be found.

### 3.10 List Maintenance

This menu item assists the user in maintaining Location Descriptions and Census Dates or Reference Dates, for Population Files and Wind Files, respectively. Select each file name and enter or revise descriptive information, then select OK to update the lists. If Cancel is selected, the lists will not be updated.

### 3.11 Convert SCR File

Use this option to locate, read, and reformat a dataset file (.SCR) that was created using the CAP88-PC Version 1 (DOS) program. CAP88-PC Version 2.0 stores and reads dataset files in the format of the INPUT.DAT file that is read by the FORTRAN programs comprising the CAP88 Model.

### 3.12 Create INPUT.DAT File

Some users will find difficulty executing the CAP88 FORTRAN programs from Windows (shell to DOS) due to the computer's memory constraints. The user may select this option to copy the selected dataset to a file named INPUT.DAT in the CAP88-PC working directory. (The working directory can be viewed in Windows by selecting the File/Properties menu item when the CAP88-PC 2.0 icon is highlighted.) The user can then exit Windows and, from DOS, change directory (CD) to the working directory and run the following programs to generate desired output (this order is mandatory for proper results):

DEFAULT,  
AIRDOS,  
DARTAB

After successful completion of these three programs, return to CAP88-PC Version 2.0 to view (Print Preview) the output files.

### 3.13 Exit

Close all files and exit the CAP88-PC Version 2.0 program. Any open Dataset must be saved or closed to exit the program properly.



## CHAPTER 4

### RUN MENU

#### 4.1 Execute

Run the CAP88 Model. 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 assessment), a Wind File, and at least one Radionuclide. If the preceding items are present, the program will execute the selected dataset by shelling out to DOS to run the FORTRAN programs DEFAULT, AIRDOS, and DARTAB. If one or more of the required data items are missing, a message will be displayed so you will know to modify the dataset accordingly. If, for some reason, a Population File or Wind File has been selected but no longer exists, a message will be displayed and the programs will not be executed. (Some users may not have the computer memory required to execute these DOS programs from Windows. See Create INPUT.DAT File for instructions.)

#### 4.2 Scan Population File Format

This menu item reads the indicated Population File and determines if the data is in proper format. No guarantees are made to the correctness of the data, though the distance increments are checked to be consecutively increasing.

The Population File Editor can be used to create or modify a Population File and maintain the proper file format. The Population file format should be as follows:

Row 1 should have a dollar sign (\$) in the first column. The location description, latitude, and longitude on row 1 are for information only to verify that the file desired is the file the user has selected. The number of distances associated with the population file must be in columns 68 and 69. The number of distances may be any integer between 2 and 20; single digit distances (2-9) should be in column 69.

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 edgepoints 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 sample 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. Only distances up to 80 kilometers should be used. The assessment is not valid for distances above 80 kilometers.

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.

#### 4.3 Population File Editor

This utility program assists the user in creating or displaying a Population File. An 'empty' Population File, TESTDATA.POP is provided as a template for building a properly formatted Population File. Any Population File intended for use with a CAP88-PC dataset should be able to be read, displayed, or printed by this program.

#### 4.4 Population File Library

This utility program provides Population Files that were distributed with CAP88-PC Version 1. The files in the library are stored in a compressed format. Choose a location from the grid by clicking (highlighting) the grid row and download the Population File by selecting the Extract button. The Extracted Population File is in the proper format to be used by CAP88-PC.

#### 4.5 Scan Wind File Format

This menu item reads the indicated Wind File and determines if the data is in the proper format. No guarantees are made as to the correctness of the data, though the sum of frequencies is checked. Frequencies should sum to 1.0000, within a tolerance of 0.0005 for rounding. The format of a Wind File is as follows:

Record 1 - three hexadecimal file marks are written by the GETWIND program. This record is ignored.

Record 2 - average wind speed (not used). [0000.00000]

Record 3 - wind direction frequency totals for each of the 16 wind directions. [0.0000] The numbers on this record should sum to 1.0000 within a tolerance of .0005 for rounding.

Records 4 through 10 - each record has 16 reciprocal-averaged wind speeds, for each of the 7 stability categories. [0.000]

Records 11 through 17 - each record has 16 true-averaged wind speeds, for each of the 7 stability categories. [0.000]

Records 18 through 33 - each record has frequencies for the 7 stability categories, for each of the 16 wind directions. [00000.0000] The numbers on these 16 records should sum to 1.0000 within a tolerance of .0005 for rounding.

#### 4.6 Wind File Library

This utility program provides Wind File data for many National Weather Service (NWS) stations in a compressed format. The Wind File Library also contains the meteorological data issued with CAP88-PC Version 1. Choose a weather station from the grid by clicking (highlighting) the grid row and download the station file by selecting the Extract button. The Extracted Wind File is in the proper format to be used by CAP88-PC.

#### 4.7 Stability Array/Wind File Generator

The STAR Distribution Program assists the user in extracting and processing National Climatic Data Center (NCDC) or site-specific meteorological data based on several popular methods. Each of the processing methods creates a Stability Array file (.STR) that is then used to create a Wind File for input to CAP88-PC. If the user is not an experienced meteorologist-modeler, it is strongly suggested that the user work with a meteorologist-modeler to prepare NCDC or on-site meteorological data for input to CAP88-PC.

There are 96 records in the Stability Array file, one for each of the 16 wind directions (N, NNE, NE, ENE, E, ESE, SE, SSE, S, SSW, SW, WSW, W, WNW, NW, and NNW) and Stability Category (A-F). Sixteen records are entered for Stability Category A, then Stability Category B, etc., through Stability Category F. Stability Classes used for CAP88-PC are: A - extremely unstable, B - unstable, C - slightly unstable, D - neutral, E - slightly stable, and F - stable.

All records are of the same format. The total of all the frequencies entered on the 96 records should add to 1.00000 within a tolerance of .05 percent. The format of a Stability Array (STAR) record follows:

Column 1 is blank.

Columns 2-4 contain the wind direction, right justified (E would be in column 4, and NE would be in columns 3 and 4). Column 5 is blank.

Column 6 contains the Stability Category, A through F.

Column 7 is blank.

Columns 8-14 contains the frequency for winds 1-3 knots (for example 0.00041).

Columns 15-21 contains the frequency for winds 4-6 knots.

Columns 22-28 contains the frequency for winds 7-10 knots.

Columns 29-35 contains the frequency for winds 11-16 knots.  
Columns 36-42 contains the frequency for winds 17-21 knots.  
Columns 43-49 contains the frequency for winds greater than 21 knots.

Once a Stability Array file has been created, use the button Create Wind File for CAP88-PC to run the program which converts the STAR file to a Wind File for input to CAP88-PC. A common dialog box will appear for the user to identify the STAR file to be converted. The Create Wind File options runs the program WINDGET.EXE. WINDGET.EXE is identical to the GETWIND.EXE program used by CAP88-PC Version 1, but is now compatible with the filenames and pathnames provided by the call from a Windows program.

For the format of a Wind File, see Scan Wind File Format.

## CHAPTER 5

### NEW DATASET INFORMATION

#### 5.1 New Dataset Information Form

Use this form to locate, name, and describe the Dataset to be created. A New Dataset is created, even if the user later Closes a file without saving changes.

##### *Drive, Dataset*

Select a drive that the new dataset will be copied to. The current drive is suggested. Choosing a network drive or a floppy drive that will not always be available to the program will create an error if the drive is not found when the dataset is selected again for modification or execution.

##### *Directory, Dataset*

Select a directory that the New Dataset will be copied to. The datasets subdirectory in the program directory is suggested. Change the directory chosen by double-clicking on the main directory and selecting the desired subdirectory.

##### *Name, Dataset*

Enter a Dataset Name, up to 20 characters; do not use apostrophes or double quotes. This name will appear in the drop down list on the Select Dataset screen, and in the label of the data entry tabbed forms. The Dataset Name should be descriptive enough to allow accurate selection of a Dataset.

##### *Filename, Dataset*

Enter a Dataset Filename, up to 8 characters. This filename must not contain any spaces, piping (vertical dashes), or asterisks, as these are not valid for DOS naming conventions. This filename must be unique in the directory in which it will be created.

##### *Comment, Dataset*

(Optional) Enter Comments, up to 50 characters. Do not use an apostrophe or double quotes, all other characters and spaces are allowed. The Comments should accurately describe the assessment scenario.

##### *Comment Additional, Dataset*

(Optional) Enter Comments, up to 50 additional characters. Do not use an apostrophe or double quotes, all other characters and spaces are allowed. The Comments should accurately describe the assessment scenario.

##### *Cancel Button*

Select the Cancel button to exit the New Dataset form without creating a new Dataset.

*OK Button*

Select the OK button to create the New Dataset with the parameters defined. The New Dataset Information form will be closed and the CAP88-PC data input tab forms will appear.

## CHAPTER 6

### SELECT DATASET INFORMATION

#### 6.1 Select Dataset Form

Use this form to select a dataset for the desired operation. Except for the Dataset Name List, all other fields on this form are read-only and will be filled with appropriate data when a dataset is selected.

##### *Name List, Dataset*

Click on the down arrow to display the list of datasets recognized by CAP88-PC. Select a dataset name from the list by clicking once on the name. To add a dataset to the Dataset Name list, either Open a New Dataset or use the File Maintenance function to Restore an existing Dataset.

##### *Cancel Button, Select Dataset*

Close the Select Dataset form, without performing the desired operation.

##### *OK Button, Select Dataset*

Use the selected dataset for the desired operation. The Select Dataset form will be closed and the CAP88-PC data input tab forms will appear.

## CHAPTER 7

### PRINT/VIEW

#### 7.1 Print/View

Use this form to view CAP88-PC Output Reports and select which reports, if any, will be printed.

##### *Tabs, Output Report*

Click on these tabs to change the CAP88-PC Output Report being displayed. If a tab is missing, that report was not created, or was deleted from the directory. Return to the Run Option tab of the data entry form to view report selection information. If necessary, select a new report option (Yes/No), save the data, and re-execute CAP88-PC.

##### *Print Check Boxes , Output Report*

Select the boxes next to the report names for reports to be printed (in their entirety). An X will appear in the selected box. Click again to remove the X and un-select a report. The selected reports will not be sent to a printer until the Print button is selected.

##### *Print Current View Button*

Print the entire CAP88-PC Output Report shown in the view window. Partial reports cannot be printed with this viewer. If partial reports are desired, another text editor may be used to view and print relevant portion of the report.

##### *Cancel Button, Print Preview*

Close the Print Preview form.

##### *Print Button*

Any Output Reports for the dataset that have an X in the check box will be printed (in their entirety).



## CHAPTER 8

### MAINTENANCE OPERATION

#### 8.1 File Maintenance Operations Form

The File Maintenance Operations described below will perform the operation described - as well as - maintain the lists supported by CAP88-PC Version 2.0. Warning: Using the Windows File Manager to perform these operations will result in the program lists not being maintained. Files deleted using the Windows File Manager will not be found when selected from the Dataset list, the Population File list, or the Wind File list. Files renamed or copied using the Windows File Manager will not appear in the Dataset list, Population File list, or the Wind File list until Restored using this option.

##### *Archive, Delete, Restore, Rename*

Select the operation to be performed. Archive will copy the selected file(s) to a location (diskette, directory, etc.) indicated by the user and remove the filename from any lists maintained by the CAP88-PC Version 2.0 program. Archive does not compress the files (all CAP88-PC files, excluding Output Reports, are rather small text files). Delete will erase file(s) from the location selected and removes the filename(s) from the Dataset list, Population File list, or Wind File list, as appropriate. Restore copies file(s) from another location and adds the filename(s) to the Dataset list, Population File list, or Wind File list, as appropriate. Restore checks each filename to be restored for uniqueness, and will ask before overwriting a file with the same name. Rename changes the name of the file indicated by the user and revises the Dataset list, Population File list, or Wind File list, as appropriate. For example, the user may wish to rename Wind Files extracted from the Wind File Library to change the filename from the Station ID to a city or location name that is more easily recognizable.

##### *Select Type of File for File Maintenance Operation*

Selection of the Dataset file type will allow the user to select an existing dataset from the Dataset Name list. Selection of the Dataset file type will also perform the identical operation on any Output Report files that exist for the Dataset. Selection of the Population File type will remove from, add to or revise the Population File list when files are deleted, restored, or renamed. Selection of the Wind File type will remove from, add to or revise the Wind File list when files are deleted, restored, or renamed. Use the List Maintenance option to revise file descriptions and date information for the Population Files or Wind Files.

##### *Cancel Button, Select Maintenance Operation*

Closes the Select Maintenance Operation form.

##### *OK Button, Select Maintenance Operation*

If both a File Maintenance Operation and a File Type have been selected, the OK button will submit the request and the appropriate form will appear for selecting the particular file to be altered. If either the File Maintenance Option or the File Type has not been selected, an error message will appear.

## 8.2 Select File

Select a file from the current directory or Locate a file in another directory.

### *Population File Directory*

Choose this option if the Population File appears in the Population File list in the current directory. The current directory is a subdirectory named Popfiles that is subordinate to the directory that CAP88-PC Version 2.0 was installed to.

### *Custom Population File*

Choose this option to locate a Population File in a directory other than the Popfiles subdirectory. The user is provided a form to select a drive, directory, and filename for the desired file.

### *Population File List*

If the Population File resides in the Population File Directory, a Population File list will be displayed and a Population File may be chosen from that list. If the Population File is not in the default directory, then select the Locate button to choose the drive and directory of the desired file.

### *Wind File Directory*

Choose this option if the Wind File appears in the Wind File list in the current directory. The current directory is a subdirectory named Wndfiles that is subordinate to the directory that CAP88-PC Version 2.0 was installed to.

### *Custom Wind File*

Choose this option to locate a Wind File in a directory other than the Wndfiles subdirectory. The user is provided a form to select a drive, directory, and filename for the desired file.

### *Wind File List*

If the Wind File resides in the Wndfiles subdirectory, a Wind File list will be displayed and a Wind File may be chosen from that list. If the Wind File is not in the current directory, then select the Locate button to choose the drive and directory of the desired file.

### *Cancel Button*

Close the Select File form.

### *OK Button*

If a filename appears on this form, the next archive form will appear. If no file has been selected, an error message will appear.

### 8.3 Save File As Form

Change the name of the file if desired. The name of the selected file appears at the top of the form.

#### *Dataset Filename*

Filenames are limited to 8 alphanumeric characters and exclude blanks, asterisks, and pipe (vertical dashes) characters.

#### *Population Filename*

Filenames are limited to 8 alphanumeric characters and exclude blanks, asterisks, and pipe (vertical dashes) characters.

#### *Wind Filename*

Filenames are limited to 8 alphanumeric characters and exclude blanks, asterisks, and pipe (vertical dashes) characters.

#### *Cancel Button*

Close the Save File As form.

#### *OK Button*

Perform the desired operation.

### 8.4 Change List Information Form

Use this form to enter list information for both the Population File list and the Wind File list. **NO CHANGES ARE MADE UNTIL THE OK BUTTON IS SELECTED**, at which time both the Population File list and the Wind File list are updated. If changes are made and the Cancel button is selected, **THE LISTS WILL NOT BE UPDATED**.

#### *Population File Directory*

Choose this option to change the list of Population File information (description and census date) for files in the Popfiles subdirectory.

#### *Population File List*

Select the down arrow to display and select the Population File description and census date to be displayed and altered.

#### *Population File Description*

Enter a location description, limited to 36 characters, that will identify the Population File.

*Population File Census Date*

Enter the year that the population assessment was performed.

*Wind File Directory*

Choose this option to change the list of Wind File information (description and reference dates) for files in the Wndfiles subdirectory.

*Wind File List*

Select the down arrow to display and select the Wind File description and reference dates to be displayed and altered.

*Wind File Description*

Enter a weather station description, limited to 36 characters, that will identify the Wind File.

*Wind File Period of Record*

Enter the year(s) that meteorological data was collected for frequency distribution analysis.

*Cancel Button*

Close the Change List Information form, WITHOUT updating either the Population or Wind File lists.

*OK Button*

Close the Change List Information form, after updating both the Population File list and the Wind File list.

## CHAPTER 9

### DATASET DATA

#### 9.1 Facility Data

The Facility Data tab form is used to describe the facility and time period to be modeled. On the Facility Data tab form, a State must be selected from the list provided. The State selected will determine the agricultural values used on the Agricultural Data Tab Form. After all known Facility Information is entered, use the Page Down key to advance to the next tab form.

##### *Facility Name (Optional)*

The Facility Name is used for identification purposes only. The Facility Name appears on each Output Report.

##### *Address Line 1(Optional)*

The Facility Address (line 1) appears on each Output Report

##### *Address Line 2(Optional)*

The Facility Address (line 2) appears on each Output Report

##### *City (Optional)*

The City that the Facility is located in or near appears on each Output Report.

##### *State Name (Required)*

The State name is required because it is used by the program to establish values for agricultural arrays of beef cattle, milk cattle, and crop production according to EPA-accepted state-wide averages. A state name must have been selected for an assessment to be executed. State names are chosen from a list box, which appears when you click on the down arrow when the state field is selected. 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. Selection of Hawaii, Alaska, or the District of Columbia will result in zeros being loaded on the Agricultural Data tab form.

##### *Zip Code (Optional)*

Enter the Zip Code and Zip Plus 4 Code, if known.

##### *Emission Year (Optional)*

Choose the year in which the radionuclide emissions occurred from the drop down list. If a year is desired that is not in the drop down list, use a database file editor to add the year to the file YEAR.DBF.

### *Source Category (Optional)*

The Source Category is for information only. No particular category is enforced at this time.

### *Comments Line 1(Optional)*

Comments (line 1) are restricted to 50 characters and appear on the first page of each Output Report. Comments also appear on the Select Dataset form for additional identification of the dataset.

### *Comments Line 2(Optional)*

Comments (line 2) are restricted to 50 characters and appear on the first page of each Output Report. Comments also appear on the Select Dataset form for additional identification of the dataset.

## 9.2 Run Options

The Run Options tab form is used to describe the population to be assessed and select optional output tables and reports. CAP88-PC Version 2.0 uses population arrays in the same format as the mainframe CAP88 program. A sample population assessment is provided with CAP88-PC Version 2.0. Other population assessments may be downloaded from the Population File Library. Users are encouraged to create their own population arrays using the Population File Editor supplied with the CAP88-PC Version 2.0 program. Census data or population survey data should be obtained for the facility and area to be modeled.

### *Assessment Run Type*

The Assessment Run Type must be selected to determine the source of the population data. If an Individual Assessment is chosen, the midpoint distances for the assessment areas must be entered. If a Population Assessment is chosen, the data will be read in from a Population File. The Population File may be selected from the drop down list.

### *Population File Directory*

A Population File is required for a Population Assessment Run Type. The Population File Editor in the Run Menu can be used to generate a Population File in the proper format. Also, a sample population assessment may be downloaded from the Population File Library. The distances entered in the Population File are endpoint distances and are converted to midpoint distances by CAP88-PC. Population Files can be located and maintained in the Popfiles subdirectory, or can be selected from another directory by choosing the Custom Population File option.

### *Custom Population File*

If the Population File resides anywhere except in the Popfiles subdirectory, choose this option and select the Locate button to locate and select the Population File for the assessment. To get a Custom Population File into the Population File Directory, use the File Maintenance option to Restore a Population File, then use the List Maintenance option to record the population

description or location and census date (year of population estimation, adjustment or assessment).

#### *Population File Location*

Enter the drive, directory, and filename of the desired Population File or select the Locate button to browse the drives and directories to locate the Population File to be used for the assessment.

#### *Generate Genetic Effects?*

If No is selected, genetic effects tables will be suppressed in the Synopsis (.SYN) Output Report.

#### *Create Dose and Risk Factor File?*

Select Yes to generate a Dose and Risk Factor Output Report file (.FAC) when this assessment is used to execute CAP88-PC. 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 CAP88-PC. 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. 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.

#### *Create Concentration Table File?*

Select Yes to generate a Concentration Table Output Report file (.CON) when this assessment is used to execute CAP88-PC. The Concentration Table may be quite large if many radionuclides are selected. 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 are calculated by the model. Estimates of the radionuclide concentrations in food, leafy vegetables, milk and meat consumed by humans are made by coupling the output of the atmospheric transport models with the US Nuclear Regulatory Commission Regulatory Guide 1.109 terrestrial food chain models.

#### *Create Chi/Q Table File?*

Select Yes to generate a Chi/Q analysis (.CHI) of the scenario provided for execution of CAP88-PC. Chi/Q values are used to convert radionuclide release values to concentrations.

#### *Midpoint Distances*

Midpoint distances are required for an Individual Assessment. These distances are the distances at which the doses and risks are calculated, in meters. The distances must be integers between 1 and 80000 meters (inclusive). A message will be displayed if you enter a distance outside this

range. At least one distance must be entered for the dataset to execute. If no distances are entered, the AIRDOS program will abort. The distances entered in the cells must be contiguous and ascending, that is, no cells can be skipped and the midpoint distances must increase from left to right in each row. Cells (at the end) may be left blank after the midpoint distances have been entered.

#### *Population File List*

Select the down arrow to see the descriptive information and Population File names in the Popfiles subdirectory.

#### *Locate Button*

Select this button to get a form to browse the drives and directories for a particular Population File.

### 9.3 Meteorological Data

The Meteorological Data Tab Form is used to supply site meteorological data for the dispersion modeling.

#### *Wind File Directory*

A Wind File is required for CAP88 execution. The Wind File Library in the Run Menu can be used to obtain a Wind File in the proper format. These Wind Files were created from the National Weather Service data which is available for many weather station sites. If the user has on-site meteorological data, select the Stability Array Distribution program in the Run Menu to process and convert on-site data to a properly formatted Wind File. Wind Files can be located and maintained in the Wndfiles subdirectory, or can be located by choosing the Custom Wind File option.

#### *Custom Wind File*

If the Wind File resides anywhere except in the Wndfiles subdirectory, choose this option and select the Locate button to locate and select the Wind File for the assessment. To get a Custom Wind File into the Wind File Directory, use the File Maintenance option to Restore a Wind File, then use the List Maintenance option to record the location and dates for which the meteorological data was collected.

#### *Wind File Location*

Enter the drive, directory, and filename of the desired Wind File or select the Locate button to browse the drives and directory to locate the Wind File to be used for the assessment.

#### *Annual Precipitation*

The average annual precipitation (in centimeters) at or near the site.



### *Annual Ambient Temperature*

Average annual ambient temperature (in degrees Celsius) at or near the site. Temperatures above 200 degrees are assumed to be in degrees Kelvin and will be converted and shown as degrees Celsius when the dataset is re-opened.

### *Height of Lid*

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

### *Locate Button*

Select this button to get a form to browse the drives and directories for a particular Wind File.

### *Wind File List*

Select the down arrow to see the descriptive information and Wind File names in the Wndfiles subdirectory.

## 9.4 Source Data

The Source Data Tab Form is used to identify the type of emitting source and the dimensions of each emitting source being assessed. Stack and Area Sources cannot be mixed in a single assessment. While up to six stack or area sources can be modeled, all the sources are modeled as if located at the same point. The same plume rise mechanism (Buoyant, Momentum, Fixed, or Zero) is used for each source. Also, area sources are treated as uniform. Variation in radionuclide concentrations due to complex terrain cannot be modeled. 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.

### *Source Type*

The emitting sources must be identified as stacks (point) or area sources. While up to six stack or area sources can be modeled, all the sources are modeled as if located at the same point. The same plume rise mechanism (Buoyant, Momentum, Fixed, or Zero) is used for each source. Also, area sources are treated as uniform.

### *Number of Sources*

Up to six (6) emitting sources (stacks or areas) may be modeled. The fields for Height, Diameter/Area, and Plume Rise Type (if Momentum or Buoyant) change as the number of emitting sources change, so select the number of sources before entering any associated data.

### *Area Dimensions*

Height (in meters) and Area (in square meters) of the Area Source.

### *Plume Rise Type*

Select the Plume Rise Type for the dispersion modeling. The choices are Buoyant, Momentum, Fixed, and Zero. The same plume rise mechanism is used for each source.

### *Plume Rise for Pasquill Categories*

Plume Rise for each Pasquill Category for a Fixed Plume Rise Type. Enter the actual plume rise (in meters) for each of the seven Pasquill Categories (A through G) if a Fixed Plume Rise Type is selected. If a Zero Plume Rise Type is selected, zero is entered for each of the seven Pasquill Categories (A through G), and no further action is required.

### *Heat Release Rate or Exit Velocity*

Enter the heat release rate (in calories per second) for a Buoyant Plume Rise Type or enter the exit velocity (in meters per second) for a Momentum Plume Rise Type.

### *Stack Dimensions*

Height (in meters) and Diameter (in meters) of each Stack or Point Source.

## 9.5 Agricultural Data

The Agricultural Data Tab Form is used to enter agricultural factors which will be applied to the dispersion data to estimate uptake of emitted radionuclides into the food chain.

### *EPA Food Source Scenarios*

Selection of each EPA Food Source Scenario (Urban, Rural, Local, Regional, and Imported) will result in different fractions appearing in the 9 cells which describe the fraction of Vegetable, Milk, and Meat produced in the area, or imported to the area. The fractions are not editable unless the Entered scenario is selected, in which case fractions must be entered by the user. The Entered fractions must total to 1.0 for each column or the user will be asked to re-enter the fractions or make another scenario selection.

### *EPA Food Source Scenarios - Fractions*

Selection of each EPA Food Source Scenario will result in different fractions appearing in the 9 cells which describe the fraction of Vegetable, Milk, and Meat produced in the area or imported to the area. These fractions are not editable unless the Entered scenario is selected, in which case fractions must be entered by the user. The Entered fractions must total to 1.0 for each column, otherwise, the user will be asked to re-enter the fractions or make another scenario selection.

### *Beef Cattle Density*

Sample distributions of beef cattle density are provided by EPA for the assessment area using average agricultural productivity data for each of the fifty states. Since data was not available for Alaska, Hawaii, and the District of Columbia, the user must supply relevant agricultural data for these areas. Using zero in this field will result in an error when the program is executed.

### *Milk Cattle Density*

Sample distributions of milk cattle density are provided by EPA for the assessment area using average agricultural productivity data for each of the fifty states. Since data was not available for Alaska, Hawaii, and the District of Columbia, the user must supply relevant agricultural data for these areas. Using zero in this field will result in an error when the program is executed.

### *Land Fraction Cultivated for Vegetable Crops*

Sample distributions of crop productivity are provided by EPA for the assessment area using average agricultural productivity data for each of the fifty states. Since data was not available for Alaska, Hawaii, and the District of Columbia, the user must supply relevant agricultural data for these areas. Using zero in this field will result in an error when the program is executed.

## 9.6 Nuclide Data

The Nuclide Data Tab Form is used to select and describe characteristics of the radionuclides emitted by each source. Two complex chains of nuclides may be selected: U-238, Uranium; and Th-232, Thorium. CAP88 accounts for the buildup of decay products in each of the complex chains. There are also ten simple chains which each have one decay element: Cs-137, Cesium ; Ba-140, Barium; Mo-99, Molybdenum; Pb-210, Lead; Pu-241, Plutonium; Sr-90, Strontium; Zr-95, Zirconium; Ru-103, Ruthenium 103; Ru-106, Ruthenium 106; and Ce-144, Cerium. When one or more of these radionuclide chains are selected, a dialogue box will appear with the information that the nuclide is the beginning of a chain, and asking if the chain should be added. If Yes is selected, the entire chain will be added to the list. If No is selected, only the individual nuclide will be added to the list.

### *Nuclide List*

At least one nuclide should be selected, otherwise the dataset will not be saved or executed (the dataset may, however, be closed). Select a Nuclide from the drop down list by clicking on the down arrow in the Nuclide field and entering the first letter of the Nuclide name. The list will jump to nuclides starting with the letter selected. Click on the nuclide name to be added. Nuclide names appear for each emitting source, but a release rate of zero will show that the nuclide is not emitted from a particular source. If the nuclide selected is a member of a chain, a message will appear to request if the nuclide will be treated as an individual or whether the chain members should be entered. The program counts the nuclides entered and will impose a limit of 36 nuclides to remain compatible with CAP88. After each nuclide is selected, the nuclide's size and class information appears in the data grid. The nuclide size and class data applies to the nuclide emitted from every source. Use the drop down lists to choose other valid size and class selections (if applicable) for each nuclide.

### *Nuclide Release Rate*

There will be Source Tabs (from 1 to 6) above the data entry grid for entry of the Release Rate for each nuclide from each source. If a source does not emit a nuclide in the list, the Release Rate will be zero for that source. The release rates can be entered in decimal or exponential notation.

### *Particle Size*

The default particle size will appear for the selected nuclide. Select the down arrow to change the particle size, if necessary. Select one of the allowed Activity Medium Aerodynamic Diameter Micrometers (AMAD) for particulates. Particle size (AMAD) in micrometers for inhaled particles is 0.0, 0.3, 1.0, or 3.0. Some nuclides are restricted in their particle size allowances, and gases get a particle size assignment of 0.

### *Nuclide Class*

Select one of the allowed lung clearance classes for inhaled particles. If a Class field contains 'None', then class is not applicable to that particular radionuclide. After each nuclide has been selected, the default clearance class appears. Some nuclides are restricted in their clearance class allowances. Use the drop down list as a guide to the valid classes for each nuclide.

## CHAPTER 10

### DEFAULT FILE CHANGES

#### 10.1 Purpose of Default Value

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.

##### 10.1.1 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.**

##### 10.1.2 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.

#### 10.2 Changeable Defaults

##### 10.2.1 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.

| <u>VARIABLE</u>                | <u>UNITS</u>        | <u>DEFAULT</u>          | <u>DESCRIPTION</u>  |
|--------------------------------|---------------------|-------------------------|---|
| <u>Meteorological Defaults</u> |                     |                         |   |
| TG                             | °K/m                | .0728<br>.1090<br>.1455 | Vertical temperature gradient for Pasquill categories E, F, and G (three element array) |
| <u>Default Rates</u>           |                     |                         |   |
| BRTHRT                         | cm <sup>3</sup> /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  |
| <u>Water Defaults</u>          |                     |                         |   |
| 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 <sup>-1</sup>  | 2.9E-3  | Removal rate constant for physical loss by weathering                      |
| MSUBB  | kg                | 200.0   | Muscle mass of animal at slaughter   |
| P      | kg/m <sup>2</sup> | 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 <sup>2</sup> | 0.28  | Agricultural productivity by unit area (grass-cow-milk-man pathway)                  |
| YSUBV2 | kg/m <sup>2</sup> | 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                                     |

#### Miscellaneous Input Values

|        |  |       |  |
|--------|--|-------|--|
| 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   |

#### 10.2.2 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 10.2.1 (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.

### 10.2.3 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 10.2.1, the changes will be printed to the screen (Figure 10-1) 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 10.2.2.

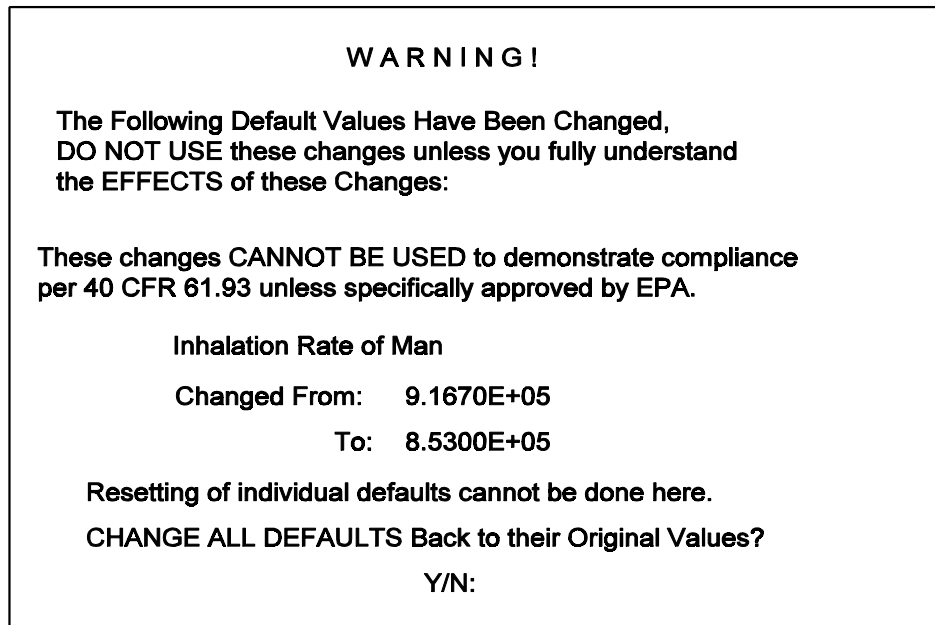


Figure 10-1. Default WARNING Message

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.

### 10.2.4 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.

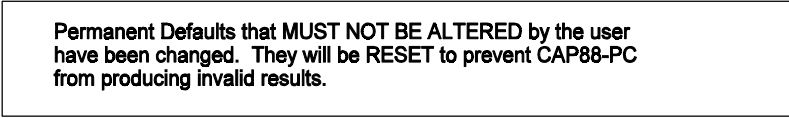
WARNING: CAP88-PC must have a DEFAULT.DAT file available in order for it to run.

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.

### 10.3 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 10-2. 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 10-2). 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 11

### CONVERTING WEATHER DATA WITH THE GETWIND UTILITY

#### 11.1 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.

#### 11.2 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.

#### 11.3 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.

#### 11.4 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:

THIS PROGRAM CONVERTS STAR FORMAT WIND DATA  
TO AIRDOS-EPA FORMAT

FILE WHICH CONTAINS THE WIND DATA TO BE CONVERTED:

<CNTRL> BREAK TO ABORT

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.

## 11.5 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 12

### 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.

#### 12.1 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.

##### 12.1.1 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,  $\Delta h$ , 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:

$$\Delta h = \frac{1.5 v d}{\mu} \quad (\text{Equation 1})$$

where:

$$\begin{aligned} \Delta h &= \text{plume rise [PR]} \\ v &= \text{effluent stack gas velocity (m/sec) [VEL]} \\ d &= \text{inside stack diameter (m) [DIA]} \\ \mu &= \text{wind velocity (m/sec) [U]} \end{aligned}$$

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

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

where:

$$\begin{aligned} \Delta h &= \text{plume rise [PR]} \\ F &= 3.7 \times 10^{-5} Q_H \end{aligned}$$

$Q_H$  = heat emission from stack gases (cal/sec) [QH]  
 $x$  = downwind distance (m)  
 $\mu$  = 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:

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

Equation (2) is also used to a distance of  $X = 2.4 \mu S^{-1/2}$  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:

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

in which:

$$S = (g/T_a)(\partial T_a/\partial z + \Gamma) \quad \text{(Equation 5)}$$

$g$  = gravitational acceleration (m/sec<sup>2</sup>)  
 $T_a$  = air temperature (°K) [TEMPERATURE]  
 $\partial T_a/\partial z$  = vertical temperature gradient (°K/m) [TG]  
 $z$  = vertical distance above stack (m)  
 $\Gamma$  = 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 °K/m for Pasquill category E  
 1.090E-01 °K/m for Pasquill category F  
 1.455E-01 °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.



### 12.1.2 Plume Dispersion

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

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

(Equation 6)

where:

|            |   |  |
|------------|---|--|
| $\chi$     | = | concentration in air (chi) at x meters downwind, y meters crosswind, and z meters above ground (Ci/m <sup>3</sup> ) [ACON] |
| Q          | = | Release rate from stack (Ci/sec) [REL]   |
| $\mu$      | = | wind speed (m/sec) [U]   |
| $\sigma_y$ | = | horizontal dispersion coefficient (m)  |
| $\sigma_z$ | = | 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  $\sigma_y$  and  $\sigma_z$ , which are functions of x as well as the Pasquill atmospheric stability category applicable during emission from the stack. CAP88-PC converts  $\chi$  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:

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

(Equation 7)

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

$$\chi_{ave} = f\chi$$

(Equation 8)

where f is the integral of the exponential expression:

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

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:

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

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

$$\sigma_y (\pi/2)^{1/2} \quad \text{(Equation 10)}$$

Since  $y_s = x \tan (11.25^\circ)$ ,

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

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

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

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:

$$\chi_{ave} = \frac{\int_0^{\infty} \chi dz}{L} \quad \text{(Equation 13)}$$

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

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

$$\chi_{ave} = \frac{\int_0^{\infty} \frac{Q}{\pi \sigma_y \sigma_z \mu} \exp(-z^2/2\sigma_z^2) \exp(-y^2/2\sigma_y^2) dz}{L} \quad \text{(Equation 14)}$$

The result is:

$$\chi_{ave} = \frac{Q}{2.5066 \sigma_y L \mu} \exp(-y^2/2\sigma_y^2) \quad \text{(Equation 15)}$$

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

$$\chi_{ave} = \frac{Q}{0.397825 \times L \mu} \quad \text{(Equation 16)}$$

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  $2x \tan(11.25^\circ)$ .

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.

### 12.1.3 Dry Deposition

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

$$R_d = V_d \chi$$

where:

$$R_d = \text{surface deposition rate (pCi/cm}^2\text{-sec)}$$

$$\begin{aligned}
 V_d &= \text{deposition velocity (cm/sec) [VD]} \\
 \chi &= \text{ground-level concentration (chi) in air (pCi/cm}^3\text{) [ACON]}
 \end{aligned}$$

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.

#### 12.1.4 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:

$$R_s = \Phi \chi_{ave} L$$

where:

$$\begin{aligned}
 R_s &= \text{surface deposition rate (pCi/cm}^2\text{-sec)} \\
 \Phi &= \text{scavenging coefficient (sec}^{-1}\text{) [SC]} \\
 \chi_{ave} &= \text{average concentration in plume up to lid height (pCi/cm}^3\text{) [ACON]} \\
 L &= \text{lid height (tropospheric mixing layer) (cm) [LID]}
 \end{aligned}$$

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

#### 12.1.5 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  $x$  (SI68). 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:

$$\Phi = \text{scavenging coefficient (sec}^{-1}\text{) [SC]}$$

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):

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

where:

$V_d$  = deposition velocity (m/sec) [VD]  
 $\mu$  = wind speed (m/sec) [U]  
 $\sigma_z$  = 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  $\sigma_z$  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  $\mu = 1$  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  $\mu = 1$  m/sec. The value is then converted to the appropriate value for the actual deposition velocity and wind speed by use of the equation:

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

in which subscript 2 refers to the desired value and subscript 1 refers to the value for  $V_d = 0.01$  m/sec and  $\mu = 1$  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):

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

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

The depletion fraction for radioactive decay is:

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

where:

$$\begin{aligned} \lambda_r &= \text{effective decay constant in plume [ANLAM]} \\ t &= \text{time required for plume travel} \end{aligned}$$

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:

$$\mu_a = \text{Arithmetic-average wind speed [UDAV]}$$

$\mu_r$  = 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:

$\lambda_r$  = effective decay constant in plume ( $\text{sec}^{-1}$ ) [ANLAM]

$\mu_a$  = 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  $\Phi$  is the scavenging coefficient ( $\text{sec}^{-1}$ ).

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

### 12.1.6 Dispersion Coefficients

Horizontal and vertical dispersion coefficients ( $\sigma_y$  and  $\sigma_z$ ) 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:

| <u>Pasquill category</u> | <u><math>\sigma_y</math> (m)</u> | <u><math>\sigma_z</math> (m)</u> |
|--------------------------|----------------------------------|----------------------------------|
| A                        | $0.22 x (1+0.0001x)^{-1/2}$      | $0.20 x$                         |

|   |  |                             |
|---|--|-----------------------------|
| B | $0.16 x (1+0.0001x)^{-1/2}$  | $0.12 x$                    |
| C | $0.11 x (1+0.0001x)^{-1/2}$  | $0.08 x (1+0.0002x)^{-1/2}$ |
| D | $0.08 x (1+0.0001x)^{-1/2}$  | $0.06 x (1+0.0015x)^{-1/2}$ |
| E | $0.06 x (1+0.0001x)^{-1/2}$  | $0.03 x (1+0.0003x)^{-1}$   |
| F | $0.04 x (1+0.0001x)^{-1/2}$  | $0.016 x (1+0.0003x)^{-1}$  |
| 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

$$\begin{aligned}\sigma_y &= x^A / C \\ \sigma_z &= x^D / F\end{aligned}$$

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.

### 12.1.7 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.



### 12.1.8 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 g/m<sup>3</sup>. 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.

### 12.1.9 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:

| <u>Distance</u><br><u>(meters)</u> | <u>Equilibrium</u><br><u>Fraction</u> |
|------------------------------------|---------------------------------------|
| 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                                  |

### 12.1.10 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.

## 12.2 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  $1.3 \times 10^5$  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.

### 12.2.1 Air Immersion

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

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

where:

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

### 12.2.2 Surface Exposure

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

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

where:

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

### 12.2.3 Ingestion and Inhalation

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

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

where:

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

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

#### 12.2.4 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.

#### 12.2.5 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 13

### SAMPLE ASSESSMENT

#### 13.1 CAP88-PC Version 2.0 Sample Input Screens

The following screens contain the data used to generate a sample assessment as an example for the user, using the CAP88-PC Windows version and the outputs are the outputs generated by executing this assessment from CAP88-PC Windows version.

Figure 13-1: FACILITY INFORMATION

The screenshot shows the 'Dataset Name: Reactive Metals' window in the CAP88-PC Version 2.0 application. The window has a menu bar with 'File', 'Run', and 'Help'. A vertical toolbar is on the left. The main area contains a form with the following fields:

- Facility Name:** Reactive Metals
- Address:** Address
- City:** Ashtabula
- State:** Ohio
- Zip Code:** (empty)
- Emission Year:** 1986
- Source Category:** DOE Facilities
- Comments:** Reactive Metals -- Population Run

Figure 13-2: SOURCE DATA

CAP88-PC Version 2.0

File Run Help

Dataset Name : Reactive Metals

Facility Data Run Options Met. Data **Source Data** Agri. Data Nuclide Data

Source Type:  Area  Stack

Number of Sources: 6

Enter dimensions of source:

|              | 1     | 2     | 3     | 4     | 5    |
|--------------|-------|-------|-------|-------|------|
| Height (m)   | 15.24 | 15.24 | 15.24 | 15.24 | 7.62 |
| Diameter (m) | 0.41  | 0.46  | 0.58  | 0.36  | 0.25 |

Plume Rise:  Buoyant  Momentum  Fixed  Zero

Enter the exit velocity (meters/sec) for each source

|  | 1    | 2    | 3     | 4    | 5    | 6     |
|--|------|------|-------|------|------|-------|
|  | 13.5 | 9.25 | 19.54 | 3.79 | 7.94 | 15.04 |

Figure 13-3: NUCLIDE DATA

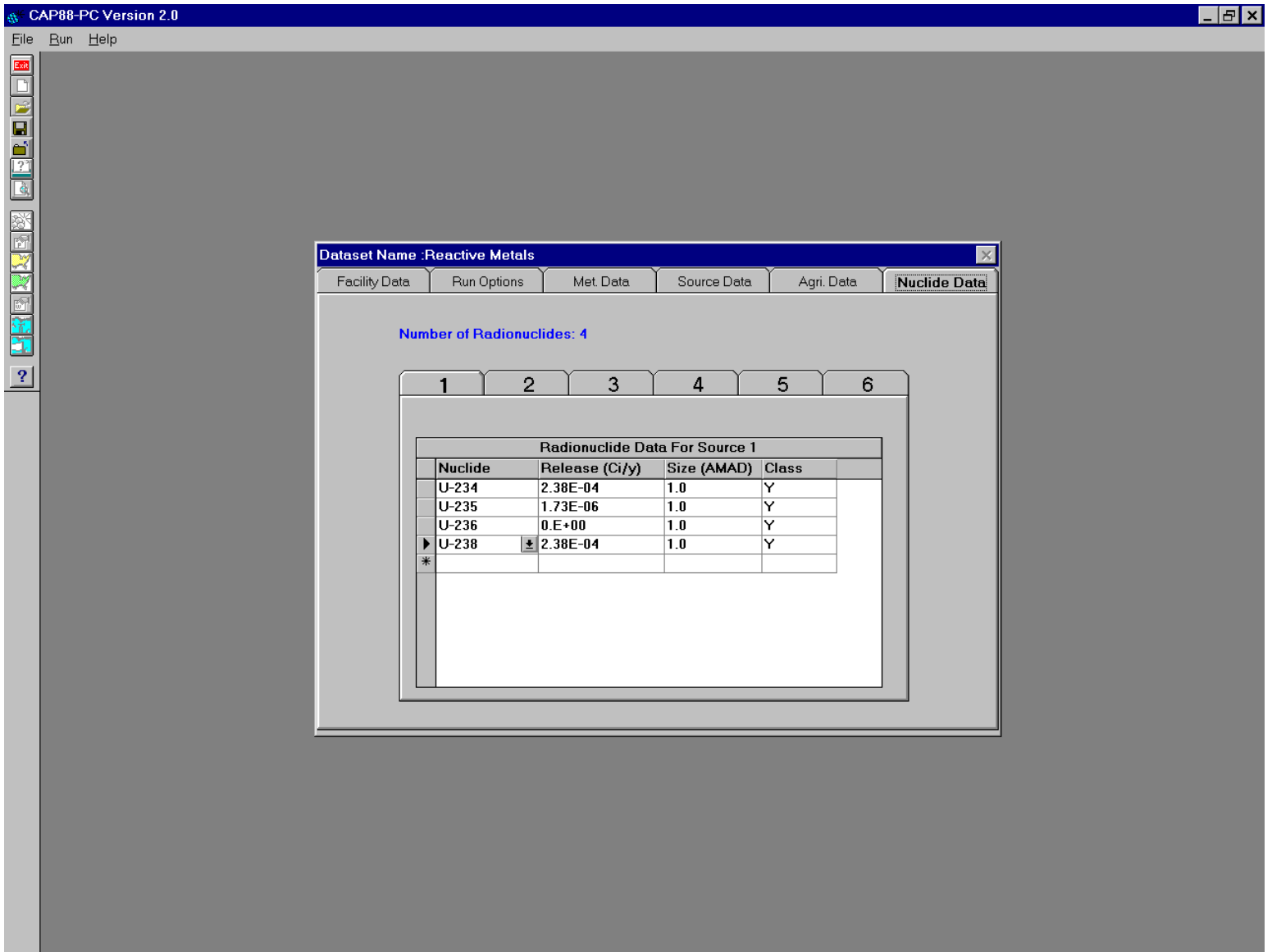


Figure 13-4: METEOROLOGICAL DATA

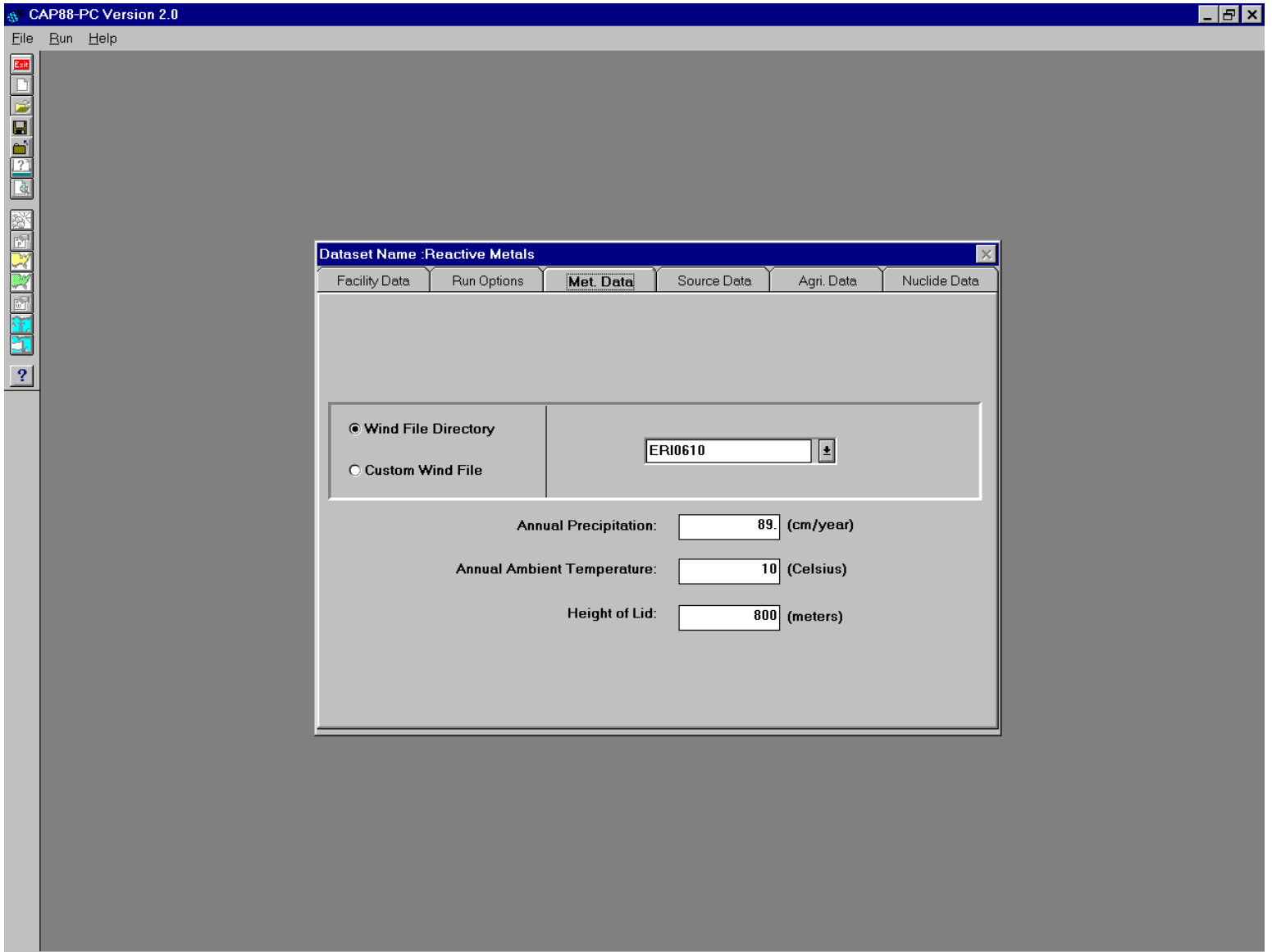


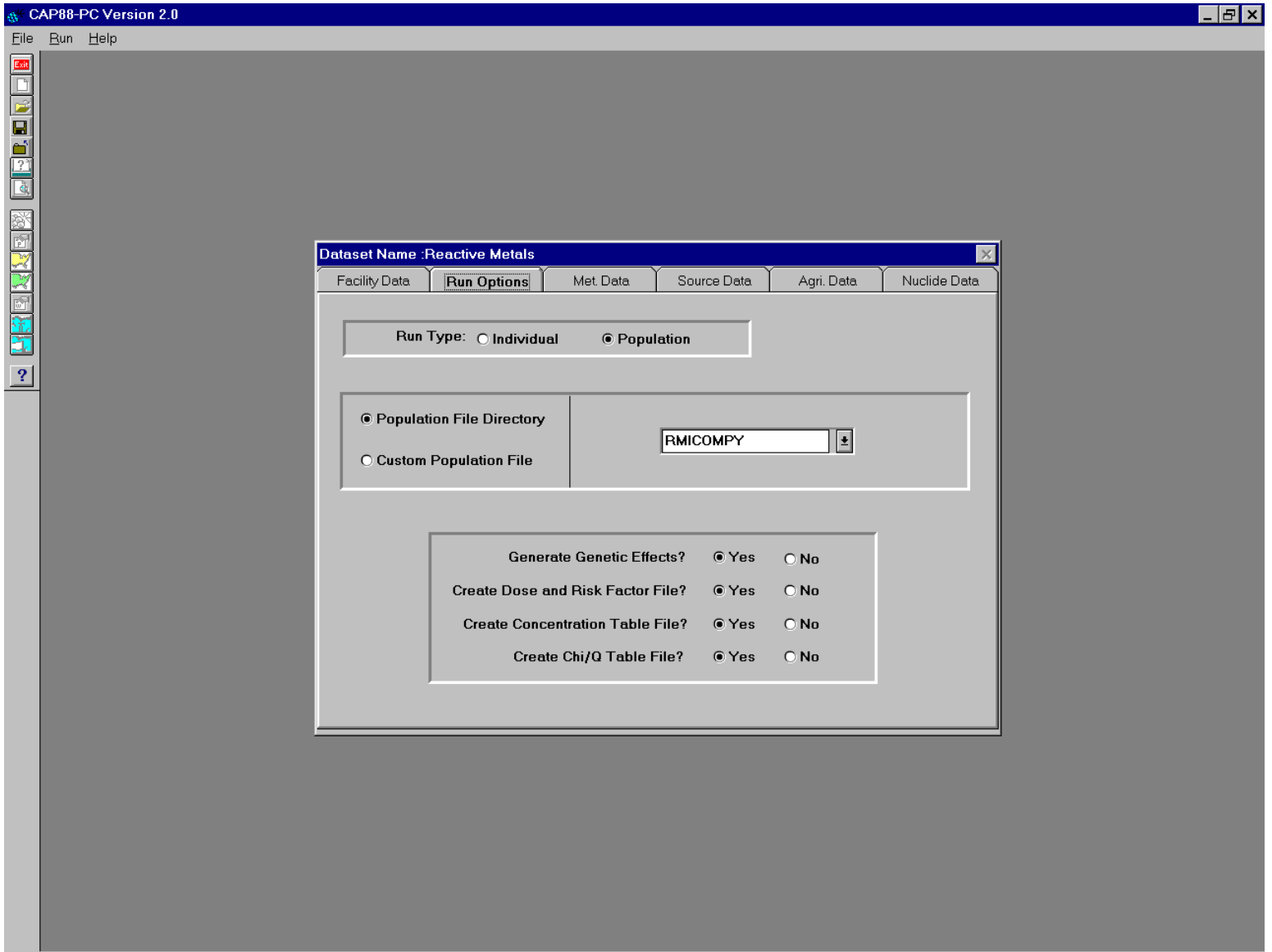


Figure 13-5: AGRICULTURAL DATA

The screenshot shows the 'Dataset Name :Reactive Metals' dialog box in the CAP88-PC Version 2.0 software. The 'Agri. Data' tab is selected, and the 'EPA Food Source Scenarios (Choose one)' section is active. The 'Urban' scenario is selected. The input fields are as follows:

|   | Vegetable         | Milk | Meat |
|---|-------------------|------|------|
| Fraction home produced:                       | .076              | 0    | .008 |
| Fraction from assessment area:                | .924              | 1    | .992 |
| Fraction imported:                            | 0                 | 0    | 0    |
| Beef cattle density:                          | 2.030e-01 (#/km2) |      |      |
| Milk cattle density:                          | 4.560e-02 (#/km2) |      |      |
| Land fraction cultivated for vegetable crops: | 1.700e-02         |      |      |

Figure 13-6: RUN OPTIONS



## 13.2 CAP88-PC Windows version 2.0 Sample Output

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

**Synopsis Report:** 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 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 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.

**Dose and 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.

**Chi/Q Table:** A table of  $\chi^2/Q$  values for each radionuclide in the assessment.

### 13.2.1 Synopsis Report

C A P 8 8 - P C  
Version 2.00

Clean Air Act Assessment Package - 1988

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

Non-Radon Population Assessment  
March 19, 2000 05:10 pm

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

Effective Dose Equivalent  
(mrem/year)

---

7.48E-01

---

At This Location: 310 Meters East Northeast  
Dataset Name: Reactive Metals  
Dataset Date: Mar 19, 2000 05:10 pm  
Wind File: C:\CAP88PC2\WINDFILES\ERIEPA.WND  
Population File: C:\CAP88PC2\POPFILES\RMIA SHTA.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         | # of People | # 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 | Size | Source  | Source  | Source  | Source  | Source  | Source  | TOTAL   |
|---------|-------|------|---------|---------|---------|---------|---------|---------|---------|
|         |       |      | #1      | #2      | #3      | #4      | #5      | #6      |         |
|         |       |      | Ci/y    | Ci/y    | Ci/y    | Ci/y    | Ci/y    | Ci/y    | 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 | 8.0E-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. | 15. | 15. | 15. | 8. | 10. |
| Diameter (m):                      | 0.  | 0.  | 1.  | 0.  | 0. | 0.  |
| Plume Rise                         |     |     |     |     |    |     |
| Momentum (m/s):<br>(Exit Velocity) | 14. | 9.  | 20. | 4.  | 8. | 15. |

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<br>for Vegetable Crops: | 1.70E-02  |       |       |

POPULATION DATA

| Direction | Distance (m) |     |      |      |      |      |      |
|-----------|--------------|-----|------|------|------|------|------|
|           | 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    |

| Direction | Distance (m) |       |       |       |       |        |
|-----------|--------------|-------|-------|-------|-------|--------|
|           | 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      |



## 13.2.2 General Data

C A P 8 8 - P C

Version 2.00

Clean Air Act Assessment Package - 1988

G E N E R A L   D A T A

Non-Radon Population Assessment

Mar 19, 2000 05:10 pm

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 19, 2000 05:10 pm

Wind File: C:\CAP88PC2\WINDFILES\ERIEPA.WND

Population File: C:\CAP88PC2\POPFILES\RMIAASHTA.POP

## VALUES FOR RADIONUCLIDE-DEPENDENT PARAMETERS

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| Nuclide | Clearance<br>Class | Particle<br>Size<br>(microns) | Scavenging<br>Coefficient<br>(per second) | Dry<br>Deposition<br>Velocity<br>(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                               |

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VALUES FOR RADIONUCLIDE-DEPENDENT PARAMETERS

| Nuclide | DECAY CONSTANT (PER DAY) |          |          | TRANSFER COEFFICIENT |          |
|---------|--------------------------|----------|----------|----------------------|----------|
|         | Radio-<br>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)

## VALUES FOR RADIONUCLIDE-DEPENDENT PARAMETERS

| Nuclide | CONCENTRATION<br>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

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| Direction | Distance (meters) |     |      |      |      |      |      |
|-----------|-------------------|-----|------|------|------|------|------|
|           | 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  |

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| Direction | Distance (meters) |       |       |       |       |       |
|-----------|-------------------|-------|-------|-------|-------|-------|
|           | 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 |

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NUMBER OF MILK CATTLE

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Distance (meters)

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| 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   |

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Distance (meters)

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| 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  |

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AREA OF VEGETABLE CROP PRODUCTION (M\*\*2)

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Distance (meters)

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| 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 |

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Distance (meters)

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| 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 |

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## VALUES FOR RADIONUCLIDE-INDEPENDENT PARAMETERS

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|   |  |          |
|---|--|----------|
| HUMAN INHALATION RATE   |  |          |
| Cubic centimeters/hr  |  | 9.17E+05 |
| SOIL PARAMETERS   |  |          |
| Effective surface density (kg/sq m, dry weight)<br>(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<br>when animal grazes on pasture |  | 4.30E-01 |

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## VALUES FOR RADIONUCLIDE-INDEPENDENT PARAMETERS

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|  |          |
|--|----------|
| 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 |

### 13.2.3 Weather Data

C A P 8 8 - P C

Version 2.00

Clean Air Act Assessment Package - 1988

W E A T H E R   D A T A

Non-Radon Population Assessment

Mar 19, 2000 05:10 pm

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 19, 2000 05:10 pm

Wind File: C:\CAP88PC2\WINDFILES\ERIEPA.WND

Population File: C:\CAP88PC2\POPFILES\RMIAASHTA.POP

HARMONIC AVERAGE WIND SPEEDS (WIND TOWARDS)

| Pasquill Stability Class |       |       |       |       |       |       |       |           |
|--------------------------|-------|-------|-------|-------|-------|-------|-------|-----------|
| Dir                      | A     | B     | C     | D     | E     | F     | G     | Wind Freq |
| 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 |
| TOTAL                    | 0.0005 | 0.0298 | 0.0944 | 0.6871 | 0.1003 | 0.0878 | 0.0000 |

ADDITIONAL WEATHER INFORMATION

Average Air Temperature: 10.0 degrees C  
 283.16 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

### 13.2.4 Dose and Risk Conversion Factors

C A P 8 8 - P C

Version 2.00

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 19, 2000 05:10 pm

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 19, 2000 05:10 pm  
Wind File: C:\CAP88PC2\WINDFILES\ERIEPA.WND  
Population File: C:\CAP88PC2\POPFILES\RMIAASHTA.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 cm/microCurie-year  |
| Surface    | millirem-square cm/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 cm/100,000 picoCurie-years  |
| Surface    | lifetime risk-square cm/100,000 picoCurie-years |

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\* NUCLIDE U-234 \*  
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DOSE RATE CONVERSION FACTORS

| Organ   | Ingestion | Inhalation | Air<br>Immersion | Ground<br>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

|         |           |           |           |           |
|---------|-----------|-----------|-----------|-----------|
| 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<br>Immersion | Ground<br>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

|         |           |           |           |           |
|---------|-----------|-----------|-----------|-----------|
| AVERAGE | 3.657E-11 | 7.892E-12 | 4.358E+00 | 3.198E-03 |
|---------|-----------|-----------|-----------|-----------|

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\* NUCLIDE U-235 \*  
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DOSE RATE CONVERSION FACTORS

| Organ   | Ingestion | Inhalation | Air<br>Immersion | Ground<br>Surface |
|---------|-----------|------------|------------------|-------------------|
| GONADS  | 3.811E-05 | 1.177E-05  | 8.732E+08        | 1.939E+05         |
| BREAST  | 3.779E-05 | 2.002E-05  | 9.546E+08        | 2.198E+05         |
| R MAR   | 1.013E-03 | 2.656E-04  | 6.068E+08        | 1.336E+05         |
| LUNGS   | 3.767E-05 | 1.017E+00  | 6.327E+08        | 1.391E+05         |
| THYROID | 3.754E-05 | 1.549E-05  | 8.510E+08        | 1.876E+05         |
| ENDOST  | 1.572E-02 | 3.938E-03  | 9.361E+08        | 2.068E+05         |
| RMNDR   | 1.299E-03 | 4.131E-04  | 6.231E+08        | 1.372E+05         |
| EFFEC   | 1.004E-03 | 1.223E-01  | 7.508E+08        | 1.672E+05         |

GENETIC EFFECT DOSE RATE CONVERSION FACTORS

|         |           |           |           |           |
|---------|-----------|-----------|-----------|-----------|
| TESTES  | 1.021E-03 | 2.227E-04 | 2.620E+10 | 5.816E+06 |
| OVARIES | 1.041E-03 | 2.773E-04 | 1.510E+10 | 3.330E+06 |
| AVERAGE | 1.031E-03 | 2.500E-04 | 2.065E+10 | 4.573E+06 |

RISK CONVERSION FACTORS

| Cancer   | Ingestion | Inhalation | Air<br>Immersion | Ground<br>Surface |
|----------|-----------|------------|------------------|-------------------|
| LEUKEMIA | 1.074E-04 | 2.827E-05  | 1.920E+02        | 4.231E-02         |
| BONE     | 8.775E-05 | 2.024E-05  | 1.656E+01        | 3.661E-03         |
| THYROID  | 6.655E-07 | 3.760E-07  | 3.869E+01        | 8.533E-03         |
| BREAST   | 5.647E-06 | 4.338E-06  | 3.730E+02        | 8.609E-02         |
| LUNG     | 7.138E-06 | 1.635E-01  | 3.129E+02        | 6.897E-02         |
| STOMACH  | 5.160E-06 | 7.298E-06  | 1.852E+02        | 4.090E-02         |
| BOWEL    | 9.027E-06 | 2.076E-05  | 9.162E+01        | 2.018E-02         |
| LIVER    | 4.107E-06 | 5.644E-06  | 2.022E+02        | 4.462E-02         |
| PANCREAS | 3.535E-06 | 4.078E-06  | 1.185E+02        | 2.625E-02         |
| URINARY  | 2.829E-04 | 6.281E-05  | 7.427E+01        | 1.639E-02         |
| OTHER    | 4.323E-06 | 4.988E-06  | 1.450E+02        | 3.210E-02         |

GENETIC EFFECT RISK CONVERSION FACTORS

|         |           |           |           |           |
|---------|-----------|-----------|-----------|-----------|
| AVERAGE | 4.125E-11 | 1.616E-11 | 5.369E+03 | 1.189E+00 |
|---------|-----------|-----------|-----------|-----------|



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\* NUCLIDE U-236 \*  
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DOSE RATE CONVERSION FACTORS

| Organ   | Ingestion | Inhalation | Air<br>Immersion | Ground<br>Surface |
|---------|-----------|------------|------------------|-------------------|
| GONADS  | 3.641E-05 | 9.317E-06  | 6.290E+05        | 6.290E+02         |
| BREAST  | 3.641E-05 | 9.438E-06  | 1.772E+06        | 3.356E+03         |
| R MAR   | 9.731E-04 | 2.433E-04  | 1.720E+05        | 6.512E+01         |
| LUNGS   | 3.641E-05 | 1.040E+00  | 2.990E+05        | 1.399E+02         |
| THYROID | 3.641E-05 | 9.314E-06  | 4.477E+05        | 1.813E+02         |
| ENDOST  | 1.536E-02 | 3.837E-03  | 5.402E+05        | 2.409E+02         |
| RMNDR   | 1.324E-03 | 3.570E-04  | 2.688E+05        | 9.627E+01         |
| EFFEC   | 9.948E-04 | 1.250E-01  | 5.899E+05        | 7.268E+02         |

GENETIC EFFECT DOSE RATE CONVERSION FACTORS

|         |           |           |           |           |
|---------|-----------|-----------|-----------|-----------|
| TESTES  | 1.000E-03 | 2.154E-04 | 1.887E+07 | 1.887E+04 |
| OVARIES | 1.001E-03 | 2.156E-04 | 6.460E+06 | 2.642E+03 |
| AVERAGE | 1.000E-03 | 2.155E-04 | 1.267E+07 | 1.076E+04 |

RISK CONVERSION FACTORS

| Cancer   | Ingestion | Inhalation | Air<br>Immersion | Ground<br>Surface |
|----------|-----------|------------|------------------|-------------------|
| LEUKEMIA | 9.466E-05 | 2.191E-05  | 5.449E-02        | 2.063E-05         |
| BONE     | 8.035E-05 | 1.838E-05  | 9.561E-03        | 4.263E-06         |
| THYROID  | 6.300E-07 | 1.458E-07  | 2.036E-02        | 8.246E-06         |
| BREAST   | 5.300E-06 | 1.203E-06  | 6.942E-01        | 1.314E-03         |
| LUNG     | 6.739E-06 | 1.667E-01  | 1.482E-01        | 6.934E-05         |
| STOMACH  | 4.896E-06 | 1.269E-06  | 7.759E-02        | 2.731E-05         |
| BOWEL    | 7.145E-06 | 4.056E-06  | 3.574E-02        | 1.148E-05         |
| LIVER    | 4.743E-06 | 1.060E-06  | 8.691E-02        | 2.335E-05         |
| PANCREAS | 3.310E-06 | 7.303E-07  | 4.389E-02        | 2.136E-05         |
| URINARY  | 2.888E-04 | 6.355E-05  | 3.277E-02        | 8.588E-06         |
| OTHER    | 4.048E-06 | 8.931E-07  | 5.369E-02        | 2.612E-05         |

GENETIC EFFECT RISK CONVERSION FACTORS

|         |           |           |           |           |
|---------|-----------|-----------|-----------|-----------|
| AVERAGE | 3.457E-11 | 7.460E-12 | 3.294E+00 | 2.798E-03 |
|---------|-----------|-----------|-----------|-----------|

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\* NUCLIDE U-238 \*  
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DOSE RATE CONVERSION FACTORS

| Organ   | Ingestion | Inhalation | Air<br>Immersion | Ground<br>Surface |
|---------|-----------|------------|------------------|-------------------|
| GONADS  | 3.464E-05 | 9.642E-06  | 5.365E+05        | 5.550E+02         |
| BREAST  | 3.467E-05 | 1.122E-05  | 1.550E+06        | 2.967E+03         |
| R MAR   | 1.087E-03 | 2.875E-04  | 1.413E+05        | 5.550E+01         |
| LUNGS   | 3.464E-05 | 9.773E-01  | 2.505E+05        | 1.214E+02         |
| THYROID | 3.461E-05 | 1.045E-05  | 3.774E+05        | 1.572E+02         |
| ENDOST  | 1.408E-02 | 3.540E-03  | 4.514E+05        | 2.094E+02         |
| RMNDR   | 1.248E-03 | 3.947E-04  | 2.247E+05        | 8.303E+01         |
| EFFEC   | 9.465E-04 | 1.175E-01  | 5.060E+05        | 6.410E+02         |

GENETIC EFFECT DOSE RATE CONVERSION FACTORS

|         |           |           |           |           |
|---------|-----------|-----------|-----------|-----------|
| TESTES  | 9.502E-04 | 2.139E-04 | 1.609E+07 | 1.665E+04 |
| OVARIES | 9.509E-04 | 2.196E-04 | 5.395E+06 | 2.287E+03 |
| AVERAGE | 9.506E-04 | 2.169E-04 | 1.074E+07 | 9.468E+03 |

RISK CONVERSION FACTORS

| Cancer   | Ingestion | Inhalation | Air<br>Immersion | Ground<br>Surface |
|----------|-----------|------------|------------------|-------------------|
| LEUKEMIA | 1.364E-04 | 3.538E-05  | 4.477E-02        | 1.758E-05         |
| BONE     | 7.601E-05 | 1.771E-05  | 7.989E-03        | 3.706E-06         |
| THYROID  | 6.076E-07 | 1.892E-07  | 1.717E-02        | 7.153E-06         |
| BREAST   | 5.123E-06 | 1.657E-06  | 6.072E-01        | 1.162E-03         |
| LUNG     | 6.509E-06 | 1.577E-01  | 1.242E-01        | 6.017E-05         |
| STOMACH  | 4.656E-06 | 3.089E-06  | 6.460E-02        | 2.346E-05         |
| BOWEL    | 7.207E-06 | 2.055E-05  | 2.964E-02        | 9.812E-06         |
| LIVER    | 3.860E-06 | 1.884E-06  | 7.238E-02        | 1.985E-05         |
| PANCREAS | 3.197E-06 | 1.139E-06  | 3.638E-02        | 1.846E-05         |
| URINARY  | 2.760E-04 | 6.084E-05  | 2.748E-02        | 7.335E-06         |
| OTHER    | 3.909E-06 | 1.393E-06  | 4.450E-02        | 2.258E-05         |

GENETIC EFFECT RISK CONVERSION FACTORS

|         |           |           |           |           |
|---------|-----------|-----------|-----------|-----------|
| AVERAGE | 3.504E-11 | 1.052E-11 | 2.792E+00 | 2.462E-03 |
|---------|-----------|-----------|-----------|-----------|

### 13.2.5 Dose and Risk Equivalent Summaries

C A P 8 8 - P C

Version 2.00

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 19, 2000 05:10 pm

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 19, 2000 05:10 pm  
Wind File: C:\CAP88PC2\WNDFILES\ERIEPA.WND  
Population File: C:\CAP88PC2\POPFILES\RMIAASHTA.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<br>Individual<br>(mrem/y) | Collective<br>Population<br>(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<br>Total Lifetime<br>Fatal Cancer Risk | Total Collective<br>Population Fatal<br>Cancer Risk<br>(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<br>Total Lifetime<br>Fatal Cancer Risk | Total Collective<br>Population Fatal<br>Cancer Risk<br>(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<br>(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<br>Total Lifetime<br>Fatal Cancer Risk | Total Collective<br>Population Fatal<br>Cancer Risk<br>(Deaths/y) |
|---------|--|---|
| U-234   | 7.36E-07   | 2.44E-05  |
| U-235   | 8.58E-08   | 2.00E-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)

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Distance (m)

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| 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 |

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Distance (m)

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| 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 |

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

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| 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 |

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| 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 |

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

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| 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 |

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| 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)

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| 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 |

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| 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 |

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

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| 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 |

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| 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 |

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### 13.2.6 Concentration Tables

C A P 8 8 - P C

Version 2.00

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 19, 2000 05:10 pm

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 19, 2000 05:10 pm

Wind File: C:\CAP88PC2\WINDFILES\ERIEPA.WND

Population File: C:\CAP88PC2\POPFILES\RMIAASHTA.POP

ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind Toward | Distance (meters) | Nuclide | Air Concentration (pCi/m <sup>3</sup> ) | Dry Deposition Rate (pCi/cm <sup>2</sup> /s) | Wet Deposition Rate (pCi/cm <sup>2</sup> /s) | Ground Deposition Rate (pCi/cm <sup>2</sup> /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   |

ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind<br>Toward | Distance<br>(meters) | Nuclide | Deposition                       |  |  |   |
|----------------|----------------------|---------|----------------------------------|--|--|---|
|                |                      |         | Air<br>Concentration<br>(pCi/m3) | Dry<br>Deposition<br>Rate<br>(pCi/cm2/s) | Wet<br>Deposition<br>Rate<br>(pCi/cm2/s) | Ground<br>Deposition<br>Rate<br>(pCi/cm2/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                                     |
| NNW            | 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                                     |



ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind Toward | Distance (meters) | Nuclide | Air Concentration (pCi/m3) | Dry Deposition Rate (pCi/cm2/s) | Wet Deposition Rate (pCi/cm2/s) | Ground Deposition Rate (pCi/cm2/s) |
|-------------|-------------------|---------|----------------------------|---------------------------------|---------------------------------|------------------------------------|
| NNW         | 45000             | U-236   | 1.9E-10                    | 3.3E-17                         | 3.1E-17                         | 6.4E-17                            |
| NNW         | 45000             | U-238   | 5.5E-07                    | 9.8E-14                         | 9.1E-14                         | 1.9E-13                            |
| NNW         | 55000             | U-234   | 4.1E-08                    | 7.4E-15                         | 7.6E-15                         | 1.5E-14                            |
| NNW         | 55000             | U-235   | 3.2E-09                    | 5.8E-16                         | 5.9E-16                         | 1.2E-15                            |
| NNW         | 55000             | U-236   | 1.3E-10                    | 2.3E-17                         | 2.4E-17                         | 4.7E-17                            |
| NNW         | 55000             | U-238   | 3.8E-07                    | 6.9E-14                         | 7.1E-14                         | 1.4E-13                            |
| NNW         | 70000             | U-234   | 2.3E-08                    | 4.2E-15                         | 5.4E-15                         | 9.6E-15                            |
| NNW         | 70000             | U-235   | 1.8E-09                    | 3.3E-16                         | 4.2E-16                         | 7.5E-16                            |
| NNW         | 70000             | U-236   | 7.4E-11                    | 1.3E-17                         | 1.7E-17                         | 3.0E-17                            |
| NNW         | 70000             | U-238   | 2.2E-07                    | 3.9E-14                         | 5.0E-14                         | 8.9E-14                            |
| NW          | 310               | U-234   | 1.8E-05                    | 3.2E-12                         | 1.1E-12                         | 4.3E-12                            |
| NW          | 310               | U-235   | 2.3E-06                    | 4.2E-13                         | 8.4E-14                         | 5.1E-13                            |
| NW          | 310               | U-236   | 9.2E-08                    | 1.7E-14                         | 3.4E-15                         | 2.0E-14                            |
| NW          | 310               | U-238   | 2.7E-04                    | 4.9E-11                         | 1.0E-11                         | 5.9E-11                            |
| NW          | 810               | U-234   | 8.8E-06                    | 1.6E-12                         | 4.1E-13                         | 2.0E-12                            |
| NW          | 810               | U-235   | 9.9E-07                    | 1.8E-13                         | 3.2E-14                         | 2.1E-13                            |
| NW          | 810               | U-236   | 4.0E-08                    | 7.2E-15                         | 1.3E-15                         | 8.5E-15                            |
| NW          | 810               | U-238   | 1.1E-04                    | 2.1E-11                         | 3.8E-12                         | 2.4E-11                            |
| NW          | 1500              | U-234   | 4.7E-06                    | 8.4E-13                         | 2.2E-13                         | 1.1E-12                            |
| NW          | 1500              | U-235   | 4.4E-07                    | 7.9E-14                         | 1.7E-14                         | 9.6E-14                            |
| NW          | 1500              | U-236   | 1.8E-08                    | 3.2E-15                         | 6.8E-16                         | 3.9E-15                            |
| NW          | 1500              | U-238   | 5.1E-05                    | 9.2E-12                         | 2.0E-12                         | 1.1E-11                            |
| NW          | 2500              | U-234   | 2.4E-06                    | 4.2E-13                         | 1.3E-13                         | 5.5E-13                            |
| NW          | 2500              | U-235   | 2.0E-07                    | 3.6E-14                         | 9.9E-15                         | 4.6E-14                            |
| NW          | 2500              | U-236   | 8.2E-09                    | 1.5E-15                         | 4.0E-16                         | 1.9E-15                            |
| NW          | 2500              | U-238   | 2.4E-05                    | 4.3E-12                         | 1.2E-12                         | 5.5E-12                            |
| NW          | 3500              | U-234   | 1.5E-06                    | 2.6E-13                         | 8.9E-14                         | 3.5E-13                            |
| NW          | 3500              | U-235   | 1.2E-07                    | 2.2E-14                         | 7.0E-15                         | 2.9E-14                            |
| NW          | 3500              | U-236   | 4.9E-09                    | 8.9E-16                         | 2.8E-16                         | 1.2E-15                            |
| NW          | 3500              | U-238   | 1.4E-05                    | 2.6E-12                         | 8.3E-13                         | 3.4E-12                            |
| NW          | 4500              | U-234   | 1.0E-06                    | 1.8E-13                         | 6.8E-14                         | 2.5E-13                            |
| NW          | 4500              | U-235   | 8.4E-08                    | 1.5E-14                         | 5.3E-15                         | 2.0E-14                            |
| NW          | 4500              | U-236   | 3.4E-09                    | 6.1E-16                         | 2.1E-16                         | 8.3E-16                            |
| NW          | 4500              | U-238   | 9.9E-06                    | 1.8E-12                         | 6.3E-13                         | 2.4E-12                            |
| NW          | 7500              | U-234   | 4.8E-07                    | 8.7E-14                         | 3.9E-14                         | 1.3E-13                            |
| NW          | 7500              | U-235   | 3.9E-08                    | 7.0E-15                         | 3.0E-15                         | 1.0E-14                            |
| NW          | 7500              | U-236   | 1.6E-09                    | 2.8E-16                         | 1.2E-16                         | 4.1E-16                            |
| NW          | 7500              | U-238   | 4.6E-06                    | 8.3E-13                         | 3.6E-13                         | 1.2E-12                            |
| NW          | 15000             | U-234   | 1.8E-07                    | 3.2E-14                         | 1.8E-14                         | 5.0E-14                            |
| NW          | 15000             | U-235   | 1.4E-08                    | 2.6E-15                         | 1.4E-15                         | 4.0E-15                            |
| NW          | 15000             | U-236   | 5.8E-10                    | 1.0E-16                         | 5.7E-17                         | 1.6E-16                            |
| NW          | 15000             | U-238   | 1.7E-06                    | 3.0E-13                         | 1.7E-13                         | 4.7E-13                            |
| NW          | 25000             | U-234   | 7.8E-08                    | 1.4E-14                         | 9.4E-15                         | 2.3E-14                            |
| NW          | 25000             | U-235   | 6.1E-09                    | 1.1E-15                         | 7.3E-16                         | 1.8E-15                            |
| NW          | 25000             | U-236   | 2.5E-10                    | 4.4E-17                         | 3.0E-17                         | 7.4E-17                            |
| NW          | 25000             | U-238   | 7.2E-07                    | 1.3E-13                         | 8.7E-14                         | 2.2E-13                            |
| NW          | 35000             | U-234   | 4.8E-08                    | 8.7E-15                         | 6.4E-15                         | 1.5E-14                            |

ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind<br>Toward | Distance<br>(meters) | Nuclide | Air<br>Concentration<br>(pCi/m3) | Dry<br>Deposition<br>Rate<br>(pCi/cm2/s) | Wet<br>Deposition<br>Rate<br>(pCi/cm2/s) | Ground<br>Deposition<br>Rate<br>(pCi/cm2/s) |
|----------------|----------------------|---------|----------------------------------|--|--|---|
| NW             | 35000                | U-235   | 3.8E-09                          | 6.8E-16                                  | 5.0E-16                                  | 1.2E-15                                     |
| NW             | 35000                | U-236   | 1.5E-10                          | 2.7E-17                                  | 2.0E-17                                  | 4.7E-17                                     |
| NW             | 35000                | U-238   | 4.5E-07                          | 8.0E-14                                  | 5.9E-14                                  | 1.4E-13                                     |
| NW             | 45000                | U-234   | 3.3E-08                          | 5.9E-15                                  | 4.7E-15                                  | 1.1E-14                                     |
| NW             | 45000                | U-235   | 2.5E-09                          | 4.6E-16                                  | 3.6E-16                                  | 8.2E-16                                     |
| NW             | 45000                | U-236   | 1.0E-10                          | 1.8E-17                                  | 1.5E-17                                  | 3.3E-17                                     |
| NW             | 45000                | U-238   | 3.0E-07                          | 5.4E-14                                  | 4.3E-14                                  | 9.8E-14                                     |
| NW             | 55000                | U-234   | 2.2E-08                          | 4.0E-15                                  | 3.5E-15                                  | 7.6E-15                                     |
| NW             | 55000                | U-235   | 1.7E-09                          | 3.1E-16                                  | 2.8E-16                                  | 5.9E-16                                     |
| NW             | 55000                | U-236   | 7.0E-11                          | 1.3E-17                                  | 1.1E-17                                  | 2.4E-17                                     |
| NW             | 55000                | U-238   | 2.1E-07                          | 3.7E-14                                  | 3.3E-14                                  | 7.0E-14                                     |
| NW             | 70000                | U-234   | 1.2E-08                          | 2.1E-15                                  | 2.4E-15                                  | 4.5E-15                                     |
| NW             | 70000                | U-235   | 9.2E-10                          | 1.7E-16                                  | 1.9E-16                                  | 3.5E-16                                     |
| NW             | 70000                | U-236   | 3.7E-11                          | 6.7E-18                                  | 7.5E-18                                  | 1.4E-17                                     |
| NW             | 70000                | U-238   | 1.1E-07                          | 2.0E-14                                  | 2.2E-14                                  | 4.2E-14                                     |
| WNW            | 310                  | U-234   | 1.4E-05                          | 2.5E-12                                  | 1.0E-12                                  | 3.6E-12                                     |
| WNW            | 310                  | U-235   | 2.0E-06                          | 3.6E-13                                  | 8.1E-14                                  | 4.4E-13                                     |
| WNW            | 310                  | U-236   | 7.7E-08                          | 1.4E-14                                  | 3.3E-15                                  | 1.7E-14                                     |
| WNW            | 310                  | U-238   | 2.3E-04                          | 4.2E-11                                  | 9.6E-12                                  | 5.1E-11                                     |
| WNW            | 810                  | U-234   | 8.3E-06                          | 1.5E-12                                  | 3.9E-13                                  | 1.9E-12                                     |
| WNW            | 810                  | U-235   | 9.7E-07                          | 1.8E-13                                  | 3.0E-14                                  | 2.1E-13                                     |
| WNW            | 810                  | U-236   | 3.9E-08                          | 7.1E-15                                  | 1.2E-15                                  | 8.3E-15                                     |
| WNW            | 810                  | U-238   | 1.1E-04                          | 2.0E-11                                  | 3.6E-12                                  | 2.4E-11                                     |
| WNW            | 1500                 | U-234   | 4.6E-06                          | 8.3E-13                                  | 2.1E-13                                  | 1.0E-12                                     |
| WNW            | 1500                 | U-235   | 4.4E-07                          | 8.0E-14                                  | 1.6E-14                                  | 9.6E-14                                     |
| WNW            | 1500                 | U-236   | 1.8E-08                          | 3.2E-15                                  | 6.5E-16                                  | 3.9E-15                                     |
| WNW            | 1500                 | U-238   | 5.1E-05                          | 9.3E-12                                  | 1.9E-12                                  | 1.1E-11                                     |
| WNW            | 2500                 | U-234   | 2.4E-06                          | 4.3E-13                                  | 1.2E-13                                  | 5.5E-13                                     |
| WNW            | 2500                 | U-235   | 2.1E-07                          | 3.7E-14                                  | 9.4E-15                                  | 4.7E-14                                     |
| WNW            | 2500                 | U-236   | 8.4E-09                          | 1.5E-15                                  | 3.8E-16                                  | 1.9E-15                                     |
| WNW            | 2500                 | U-238   | 2.4E-05                          | 4.4E-12                                  | 1.1E-12                                  | 5.5E-12                                     |
| WNW            | 3500                 | U-234   | 1.5E-06                          | 2.7E-13                                  | 8.4E-14                                  | 3.5E-13                                     |
| WNW            | 3500                 | U-235   | 1.2E-07                          | 2.2E-14                                  | 6.6E-15                                  | 2.9E-14                                     |
| WNW            | 3500                 | U-236   | 5.1E-09                          | 9.1E-16                                  | 2.6E-16                                  | 1.2E-15                                     |
| WNW            | 3500                 | U-238   | 1.5E-05                          | 2.6E-12                                  | 7.8E-13                                  | 3.4E-12                                     |
| WNW            | 4500                 | U-234   | 1.0E-06                          | 1.9E-13                                  | 6.4E-14                                  | 2.5E-13                                     |
| WNW            | 4500                 | U-235   | 8.6E-08                          | 1.6E-14                                  | 5.0E-15                                  | 2.0E-14                                     |
| WNW            | 4500                 | U-236   | 3.5E-09                          | 6.3E-16                                  | 2.0E-16                                  | 8.3E-16                                     |
| WNW            | 4500                 | U-238   | 1.0E-05                          | 1.8E-12                                  | 5.9E-13                                  | 2.4E-12                                     |
| WNW            | 7500                 | U-234   | 4.9E-07                          | 8.9E-14                                  | 3.6E-14                                  | 1.3E-13                                     |
| WNW            | 7500                 | U-235   | 4.0E-08                          | 7.1E-15                                  | 2.8E-15                                  | 1.0E-14                                     |
| WNW            | 7500                 | U-236   | 1.6E-09                          | 2.9E-16                                  | 1.1E-16                                  | 4.0E-16                                     |
| WNW            | 7500                 | U-238   | 4.7E-06                          | 8.5E-13                                  | 3.4E-13                                  | 1.2E-12                                     |
| WNW            | 15000                | U-234   | 1.8E-07                          | 3.3E-14                                  | 1.7E-14                                  | 5.0E-14                                     |
| WNW            | 15000                | U-235   | 1.5E-08                          | 2.6E-15                                  | 1.3E-15                                  | 3.9E-15                                     |
| WNW            | 15000                | U-236   | 5.9E-10                          | 1.1E-16                                  | 5.2E-17                                  | 1.6E-16                                     |
| WNW            | 15000                | U-238   | 1.7E-06                          | 3.1E-13                                  | 1.5E-13                                  | 4.6E-13                                     |

ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind<br>Toward | Distance<br>(meters) | Nuclide | Air<br>Concentration<br>(pCi/m3) | Dry<br>Deposition<br>Rate<br>(pCi/cm2/s) | Wet<br>Deposition<br>Rate<br>(pCi/cm2/s) | Ground<br>Deposition<br>Rate<br>(pCi/cm2/s) |
|----------------|----------------------|---------|----------------------------------|--|--|---|
| WNW            | 25000                | U-234   | 7.9E-08                          | 1.4E-14                                  | 8.4E-15                                  | 2.3E-14                                     |
| WNW            | 25000                | U-235   | 6.1E-09                          | 1.1E-15                                  | 6.5E-16                                  | 1.8E-15                                     |
| WNW            | 25000                | U-236   | 2.5E-10                          | 4.5E-17                                  | 2.6E-17                                  | 7.1E-17                                     |
| WNW            | 25000                | U-238   | 7.3E-07                          | 1.3E-13                                  | 7.7E-14                                  | 2.1E-13                                     |
| WNW            | 35000                | U-234   | 4.9E-08                          | 8.8E-15                                  | 5.6E-15                                  | 1.4E-14                                     |
| WNW            | 35000                | U-235   | 3.8E-09                          | 6.9E-16                                  | 4.3E-16                                  | 1.1E-15                                     |
| WNW            | 35000                | U-236   | 1.5E-10                          | 2.8E-17                                  | 1.8E-17                                  | 4.5E-17                                     |
| WNW            | 35000                | U-238   | 4.5E-07                          | 8.1E-14                                  | 5.2E-14                                  | 1.3E-13                                     |
| WNW            | 45000                | U-234   | 3.3E-08                          | 5.9E-15                                  | 4.1E-15                                  | 1.0E-14                                     |
| WNW            | 45000                | U-235   | 2.6E-09                          | 4.6E-16                                  | 3.1E-16                                  | 7.8E-16                                     |
| WNW            | 45000                | U-236   | 1.0E-10                          | 1.9E-17                                  | 1.3E-17                                  | 3.1E-17                                     |
| WNW            | 45000                | U-238   | 3.0E-07                          | 5.5E-14                                  | 3.7E-14                                  | 9.2E-14                                     |
| WNW            | 55000                | U-234   | 2.2E-08                          | 4.0E-15                                  | 3.0E-15                                  | 7.0E-15                                     |
| WNW            | 55000                | U-235   | 1.7E-09                          | 3.1E-16                                  | 2.3E-16                                  | 5.5E-16                                     |
| WNW            | 55000                | U-236   | 7.0E-11                          | 1.3E-17                                  | 9.4E-18                                  | 2.2E-17                                     |
| WNW            | 55000                | U-238   | 2.1E-07                          | 3.7E-14                                  | 2.8E-14                                  | 6.5E-14                                     |
| WNW            | 70000                | U-234   | 1.2E-08                          | 2.1E-15                                  | 1.9E-15                                  | 4.0E-15                                     |
| WNW            | 70000                | U-235   | 8.9E-10                          | 1.6E-16                                  | 1.5E-16                                  | 3.1E-16                                     |
| WNW            | 70000                | U-236   | 3.6E-11                          | 6.4E-18                                  | 6.1E-18                                  | 1.3E-17                                     |
| WNW            | 70000                | U-238   | 1.1E-07                          | 1.9E-14                                  | 1.8E-14                                  | 3.7E-14                                     |
| W              | 310                  | U-234   | 2.3E-05                          | 4.1E-12                                  | 1.4E-12                                  | 5.5E-12                                     |
| W              | 310                  | U-235   | 3.1E-06                          | 5.6E-13                                  | 1.1E-13                                  | 6.7E-13                                     |
| W              | 310                  | U-236   | 1.2E-07                          | 2.2E-14                                  | 4.5E-15                                  | 2.7E-14                                     |
| W              | 310                  | U-238   | 3.6E-04                          | 6.5E-11                                  | 1.3E-11                                  | 7.8E-11                                     |
| W              | 810                  | U-234   | 1.2E-05                          | 2.2E-12                                  | 5.3E-13                                  | 2.7E-12                                     |
| W              | 810                  | U-235   | 1.3E-06                          | 2.4E-13                                  | 4.2E-14                                  | 2.8E-13                                     |
| W              | 810                  | U-236   | 5.4E-08                          | 9.7E-15                                  | 1.7E-15                                  | 1.1E-14                                     |
| W              | 810                  | U-238   | 1.5E-04                          | 2.8E-11                                  | 5.0E-12                                  | 3.3E-11                                     |
| W              | 1500                 | U-234   | 6.3E-06                          | 1.1E-12                                  | 2.8E-13                                  | 1.4E-12                                     |
| W              | 1500                 | U-235   | 5.8E-07                          | 1.0E-13                                  | 2.2E-14                                  | 1.3E-13                                     |
| W              | 1500                 | U-236   | 2.4E-08                          | 4.3E-15                                  | 9.0E-16                                  | 5.2E-15                                     |
| W              | 1500                 | U-238   | 6.8E-05                          | 1.2E-11                                  | 2.6E-12                                  | 1.5E-11                                     |
| W              | 2500                 | U-234   | 3.1E-06                          | 5.7E-13                                  | 1.7E-13                                  | 7.3E-13                                     |
| W              | 2500                 | U-235   | 2.7E-07                          | 4.9E-14                                  | 1.3E-14                                  | 6.2E-14                                     |
| W              | 2500                 | U-236   | 1.1E-08                          | 2.0E-15                                  | 5.3E-16                                  | 2.5E-15                                     |
| W              | 2500                 | U-238   | 3.2E-05                          | 5.7E-12                                  | 1.6E-12                                  | 7.3E-12                                     |
| W              | 3500                 | U-234   | 1.9E-06                          | 3.5E-13                                  | 1.2E-13                                  | 4.7E-13                                     |
| W              | 3500                 | U-235   | 1.6E-07                          | 2.9E-14                                  | 9.1E-15                                  | 3.8E-14                                     |
| W              | 3500                 | U-236   | 6.6E-09                          | 1.2E-15                                  | 3.7E-16                                  | 1.6E-15                                     |
| W              | 3500                 | U-238   | 1.9E-05                          | 3.4E-12                                  | 1.1E-12                                  | 4.5E-12                                     |
| W              | 4500                 | U-234   | 1.4E-06                          | 2.5E-13                                  | 8.9E-14                                  | 3.3E-13                                     |
| W              | 4500                 | U-235   | 1.1E-07                          | 2.0E-14                                  | 7.0E-15                                  | 2.7E-14                                     |
| W              | 4500                 | U-236   | 4.5E-09                          | 8.2E-16                                  | 2.8E-16                                  | 1.1E-15                                     |
| W              | 4500                 | U-238   | 1.3E-05                          | 2.4E-12                                  | 8.3E-13                                  | 3.2E-12                                     |
| W              | 7500                 | U-234   | 6.5E-07                          | 1.2E-13                                  | 5.1E-14                                  | 1.7E-13                                     |
| W              | 7500                 | U-235   | 5.2E-08                          | 9.4E-15                                  | 4.0E-15                                  | 1.3E-14                                     |
| W              | 7500                 | U-236   | 2.1E-09                          | 3.8E-16                                  | 1.6E-16                                  | 5.4E-16                                     |

ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind<br>Toward | Distance<br>(meters) | Nuclide | Air<br>Concentration<br>(pCi/m3) | Dry<br>Deposition<br>Rate<br>(pCi/cm2/s) | Wet<br>Deposition<br>Rate<br>(pCi/cm2/s) | Ground<br>Deposition<br>Rate<br>(pCi/cm2/s) |
|----------------|----------------------|---------|----------------------------------|--|--|---|
| W              | 7500                 | U-238   | 6.1E-06                          | 1.1E-12                                  | 4.7E-13                                  | 1.6E-12                                     |
| W              | 15000                | U-234   | 2.4E-07                          | 4.4E-14                                  | 2.4E-14                                  | 6.7E-14                                     |
| W              | 15000                | U-235   | 1.9E-08                          | 3.5E-15                                  | 1.8E-15                                  | 5.3E-15                                     |
| W              | 15000                | U-236   | 7.8E-10                          | 1.4E-16                                  | 7.4E-17                                  | 2.1E-16                                     |
| W              | 15000                | U-238   | 2.3E-06                          | 4.1E-13                                  | 2.2E-13                                  | 6.3E-13                                     |
| W              | 25000                | U-234   | 1.1E-07                          | 1.9E-14                                  | 1.2E-14                                  | 3.2E-14                                     |
| W              | 25000                | U-235   | 8.3E-09                          | 1.5E-15                                  | 9.6E-16                                  | 2.5E-15                                     |
| W              | 25000                | U-236   | 3.4E-10                          | 6.1E-17                                  | 3.9E-17                                  | 1.0E-16                                     |
| W              | 25000                | U-238   | 9.9E-07                          | 1.8E-13                                  | 1.1E-13                                  | 2.9E-13                                     |
| W              | 35000                | U-234   | 6.6E-08                          | 1.2E-14                                  | 8.4E-15                                  | 2.0E-14                                     |
| W              | 35000                | U-235   | 5.2E-09                          | 9.3E-16                                  | 6.5E-16                                  | 1.6E-15                                     |
| W              | 35000                | U-236   | 2.1E-10                          | 3.8E-17                                  | 2.6E-17                                  | 6.4E-17                                     |
| W              | 35000                | U-238   | 6.2E-07                          | 1.1E-13                                  | 7.7E-14                                  | 1.9E-13                                     |
| W              | 45000                | U-234   | 4.5E-08                          | 8.1E-15                                  | 6.1E-15                                  | 1.4E-14                                     |
| W              | 45000                | U-235   | 3.5E-09                          | 6.4E-16                                  | 4.8E-16                                  | 1.1E-15                                     |
| W              | 45000                | U-236   | 1.4E-10                          | 2.6E-17                                  | 1.9E-17                                  | 4.5E-17                                     |
| W              | 45000                | U-238   | 4.2E-07                          | 7.5E-14                                  | 5.7E-14                                  | 1.3E-13                                     |
| W              | 55000                | U-234   | 3.1E-08                          | 5.6E-15                                  | 4.6E-15                                  | 1.0E-14                                     |
| W              | 55000                | U-235   | 2.4E-09                          | 4.4E-16                                  | 3.6E-16                                  | 8.0E-16                                     |
| W              | 55000                | U-236   | 9.9E-11                          | 1.8E-17                                  | 1.4E-17                                  | 3.2E-17                                     |
| W              | 55000                | U-238   | 2.9E-07                          | 5.2E-14                                  | 4.3E-14                                  | 9.5E-14                                     |
| W              | 70000                | U-234   | 1.7E-08                          | 3.0E-15                                  | 3.1E-15                                  | 6.1E-15                                     |
| W              | 70000                | U-235   | 1.3E-09                          | 2.4E-16                                  | 2.4E-16                                  | 4.7E-16                                     |
| W              | 70000                | U-236   | 5.3E-11                          | 9.5E-18                                  | 9.6E-18                                  | 1.9E-17                                     |
| W              | 70000                | U-238   | 1.6E-07                          | 2.8E-14                                  | 2.8E-14                                  | 5.6E-14                                     |
| WSW            | 310                  | U-234   | 3.2E-05                          | 5.8E-12                                  | 1.4E-12                                  | 7.2E-12                                     |
| WSW            | 310                  | U-235   | 4.1E-06                          | 7.3E-13                                  | 1.1E-13                                  | 8.5E-13                                     |
| WSW            | 310                  | U-236   | 1.6E-07                          | 3.0E-14                                  | 4.5E-15                                  | 3.4E-14                                     |
| WSW            | 310                  | U-238   | 4.7E-04                          | 8.5E-11                                  | 1.3E-11                                  | 9.8E-11                                     |
| WSW            | 810                  | U-234   | 1.3E-05                          | 2.3E-12                                  | 5.4E-13                                  | 2.9E-12                                     |
| WSW            | 810                  | U-235   | 1.3E-06                          | 2.3E-13                                  | 4.2E-14                                  | 2.7E-13                                     |
| WSW            | 810                  | U-236   | 5.1E-08                          | 9.3E-15                                  | 1.7E-15                                  | 1.1E-14                                     |
| WSW            | 810                  | U-238   | 1.5E-04                          | 2.7E-11                                  | 5.0E-12                                  | 3.2E-11                                     |
| WSW            | 1500                 | U-234   | 5.8E-06                          | 1.0E-12                                  | 2.9E-13                                  | 1.3E-12                                     |
| WSW            | 1500                 | U-235   | 5.1E-07                          | 9.2E-14                                  | 2.3E-14                                  | 1.1E-13                                     |
| WSW            | 1500                 | U-236   | 2.1E-08                          | 3.7E-15                                  | 9.1E-16                                  | 4.6E-15                                     |
| WSW            | 1500                 | U-238   | 6.0E-05                          | 1.1E-11                                  | 2.7E-12                                  | 1.3E-11                                     |
| WSW            | 2500                 | U-234   | 2.7E-06                          | 4.9E-13                                  | 1.7E-13                                  | 6.6E-13                                     |
| WSW            | 2500                 | U-235   | 2.3E-07                          | 4.1E-14                                  | 1.3E-14                                  | 5.4E-14                                     |
| WSW            | 2500                 | U-236   | 9.3E-09                          | 1.7E-15                                  | 5.4E-16                                  | 2.2E-15                                     |
| WSW            | 2500                 | U-238   | 2.7E-05                          | 4.8E-12                                  | 1.6E-12                                  | 6.4E-12                                     |
| WSW            | 3500                 | U-234   | 1.7E-06                          | 3.0E-13                                  | 1.2E-13                                  | 4.2E-13                                     |
| WSW            | 3500                 | U-235   | 1.4E-07                          | 2.4E-14                                  | 9.4E-15                                  | 3.4E-14                                     |
| WSW            | 3500                 | U-236   | 5.5E-09                          | 9.9E-16                                  | 3.8E-16                                  | 1.4E-15                                     |
| WSW            | 3500                 | U-238   | 1.6E-05                          | 2.9E-12                                  | 1.1E-12                                  | 4.0E-12                                     |
| WSW            | 4500                 | U-234   | 1.2E-06                          | 2.1E-13                                  | 9.2E-14                                  | 3.0E-13                                     |
| WSW            | 4500                 | U-235   | 9.4E-08                          | 1.7E-14                                  | 7.3E-15                                  | 2.4E-14                                     |

ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind<br>Toward | Distance<br>(meters) | Nuclide | Air                       | Dry                               | Wet                               | Ground                            |
|----------------|----------------------|---------|---------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|                |                      |         | Concentration<br>(pCi/m3) | Deposition<br>Rate<br>(pCi/cm2/s) | Deposition<br>Rate<br>(pCi/cm2/s) | Deposition<br>Rate<br>(pCi/cm2/s) |
| WSW            | 4500                 | U-236   | 3.8E-09                   | 6.8E-16                           | 2.9E-16                           | 9.8E-16                           |
| WSW            | 4500                 | U-238   | 1.1E-05                   | 2.0E-12                           | 8.6E-13                           | 2.9E-12                           |
| WSW            | 7500                 | U-234   | 5.4E-07                   | 9.8E-14                           | 5.4E-14                           | 1.5E-13                           |
| WSW            | 7500                 | U-235   | 4.3E-08                   | 7.8E-15                           | 4.2E-15                           | 1.2E-14                           |
| WSW            | 7500                 | U-236   | 1.8E-09                   | 3.2E-16                           | 1.7E-16                           | 4.9E-16                           |
| WSW            | 7500                 | U-238   | 5.1E-06                   | 9.3E-13                           | 5.0E-13                           | 1.4E-12                           |
| WSW            | 15000                | U-234   | 2.0E-07                   | 3.6E-14                           | 2.6E-14                           | 6.2E-14                           |
| WSW            | 15000                | U-235   | 1.6E-08                   | 2.9E-15                           | 2.0E-15                           | 4.9E-15                           |
| WSW            | 15000                | U-236   | 6.4E-10                   | 1.2E-16                           | 8.2E-17                           | 2.0E-16                           |
| WSW            | 15000                | U-238   | 1.9E-06                   | 3.4E-13                           | 2.4E-13                           | 5.8E-13                           |
| WSW            | 25000                | U-234   | 9.1E-08                   | 1.6E-14                           | 1.4E-14                           | 3.1E-14                           |
| WSW            | 25000                | U-235   | 7.2E-09                   | 1.3E-15                           | 1.1E-15                           | 2.4E-15                           |
| WSW            | 25000                | U-236   | 2.9E-10                   | 5.3E-17                           | 4.5E-17                           | 9.8E-17                           |
| WSW            | 25000                | U-238   | 8.6E-07                   | 1.5E-13                           | 1.3E-13                           | 2.9E-13                           |
| WSW            | 35000                | U-234   | 5.7E-08                   | 1.0E-14                           | 9.8E-15                           | 2.0E-14                           |
| WSW            | 35000                | U-235   | 4.5E-09                   | 8.1E-16                           | 7.7E-16                           | 1.6E-15                           |
| WSW            | 35000                | U-236   | 1.8E-10                   | 3.3E-17                           | 3.1E-17                           | 6.4E-17                           |
| WSW            | 35000                | U-238   | 5.3E-07                   | 9.6E-14                           | 9.1E-14                           | 1.9E-13                           |
| WSW            | 45000                | U-234   | 3.9E-08                   | 7.0E-15                           | 7.3E-15                           | 1.4E-14                           |
| WSW            | 45000                | U-235   | 3.1E-09                   | 5.5E-16                           | 5.7E-16                           | 1.1E-15                           |
| WSW            | 45000                | U-236   | 1.2E-10                   | 2.2E-17                           | 2.3E-17                           | 4.6E-17                           |
| WSW            | 45000                | U-238   | 3.6E-07                   | 6.6E-14                           | 6.8E-14                           | 1.3E-13                           |
| WSW            | 55000                | U-234   | 2.8E-08                   | 5.0E-15                           | 5.7E-15                           | 1.1E-14                           |
| WSW            | 55000                | U-235   | 2.2E-09                   | 3.9E-16                           | 4.5E-16                           | 8.4E-16                           |
| WSW            | 55000                | U-236   | 8.8E-11                   | 1.6E-17                           | 1.8E-17                           | 3.4E-17                           |
| WSW            | 55000                | U-238   | 2.6E-07                   | 4.7E-14                           | 5.3E-14                           | 1.0E-13                           |
| WSW            | 70000                | U-234   | 1.7E-08                   | 3.0E-15                           | 4.1E-15                           | 7.1E-15                           |
| WSW            | 70000                | U-235   | 1.3E-09                   | 2.4E-16                           | 3.2E-16                           | 5.5E-16                           |
| WSW            | 70000                | U-236   | 5.3E-11                   | 9.5E-18                           | 1.3E-17                           | 2.2E-17                           |
| WSW            | 70000                | U-238   | 1.6E-07                   | 2.8E-14                           | 3.8E-14                           | 6.6E-14                           |
| SW             | 310                  | U-234   | 3.9E-05                   | 7.0E-12                           | 1.5E-12                           | 8.5E-12                           |
| SW             | 310                  | U-235   | 4.6E-06                   | 8.4E-13                           | 1.2E-13                           | 9.5E-13                           |
| SW             | 310                  | U-236   | 1.9E-07                   | 3.4E-14                           | 4.7E-15                           | 3.9E-14                           |
| SW             | 310                  | U-238   | 5.4E-04                   | 9.7E-11                           | 1.4E-11                           | 1.1E-10                           |
| SW             | 810                  | U-234   | 1.3E-05                   | 2.4E-12                           | 5.6E-13                           | 3.0E-12                           |
| SW             | 810                  | U-235   | 1.2E-06                   | 2.2E-13                           | 4.4E-14                           | 2.7E-13                           |
| SW             | 810                  | U-236   | 5.0E-08                   | 9.1E-15                           | 1.8E-15                           | 1.1E-14                           |
| SW             | 810                  | U-238   | 1.5E-04                   | 2.6E-11                           | 5.3E-12                           | 3.1E-11                           |
| SW             | 1500                 | U-234   | 5.5E-06                   | 1.0E-12                           | 3.0E-13                           | 1.3E-12                           |
| SW             | 1500                 | U-235   | 4.7E-07                   | 8.5E-14                           | 2.4E-14                           | 1.1E-13                           |
| SW             | 1500                 | U-236   | 1.9E-08                   | 3.5E-15                           | 9.6E-16                           | 4.4E-15                           |
| SW             | 1500                 | U-238   | 5.6E-05                   | 1.0E-11                           | 2.8E-12                           | 1.3E-11                           |
| SW             | 2500                 | U-234   | 2.5E-06                   | 4.6E-13                           | 1.8E-13                           | 6.3E-13                           |
| SW             | 2500                 | U-235   | 2.1E-07                   | 3.7E-14                           | 1.4E-14                           | 5.2E-14                           |
| SW             | 2500                 | U-236   | 8.4E-09                   | 1.5E-15                           | 5.7E-16                           | 2.1E-15                           |
| SW             | 2500                 | U-238   | 2.5E-05                   | 4.4E-12                           | 1.7E-12                           | 6.1E-12                           |
| SW             | 3500                 | U-234   | 1.5E-06                   | 2.7E-13                           | 1.3E-13                           | 4.0E-13                           |

ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind<br>Toward | Distance<br>(meters) | Nuclide | Air<br>Concentration<br>(pCi/m3) | Dry<br>Deposition<br>Rate<br>(pCi/cm2/s) | Wet<br>Deposition<br>Rate<br>(pCi/cm2/s) | Ground<br>Deposition<br>Rate<br>(pCi/cm2/s) |
|----------------|----------------------|---------|----------------------------------|--|--|---|
| SW             | 3500                 | U-235   | 1.2E-07                          | 2.2E-14                                  | 1.0E-14                                  | 3.2E-14                                     |
| SW             | 3500                 | U-236   | 5.0E-09                          | 8.9E-16                                  | 4.0E-16                                  | 1.3E-15                                     |
| SW             | 3500                 | U-238   | 1.5E-05                          | 2.6E-12                                  | 1.2E-12                                  | 3.8E-12                                     |
| SW             | 4500                 | U-234   | 1.0E-06                          | 1.9E-13                                  | 9.8E-14                                  | 2.9E-13                                     |
| SW             | 4500                 | U-235   | 8.4E-08                          | 1.5E-14                                  | 7.7E-15                                  | 2.3E-14                                     |
| SW             | 4500                 | U-236   | 3.4E-09                          | 6.1E-16                                  | 3.1E-16                                  | 9.2E-16                                     |
| SW             | 4500                 | U-238   | 1.0E-05                          | 1.8E-12                                  | 9.1E-13                                  | 2.7E-12                                     |
| SW             | 7500                 | U-234   | 4.8E-07                          | 8.7E-14                                  | 5.7E-14                                  | 1.4E-13                                     |
| SW             | 7500                 | U-235   | 3.9E-08                          | 7.0E-15                                  | 4.5E-15                                  | 1.1E-14                                     |
| SW             | 7500                 | U-236   | 1.6E-09                          | 2.8E-16                                  | 1.8E-16                                  | 4.6E-16                                     |
| SW             | 7500                 | U-238   | 4.6E-06                          | 8.3E-13                                  | 5.4E-13                                  | 1.4E-12                                     |
| SW             | 15000                | U-234   | 1.8E-07                          | 3.2E-14                                  | 2.8E-14                                  | 5.9E-14                                     |
| SW             | 15000                | U-235   | 1.4E-08                          | 2.5E-15                                  | 2.2E-15                                  | 4.7E-15                                     |
| SW             | 15000                | U-236   | 5.6E-10                          | 1.0E-16                                  | 8.8E-17                                  | 1.9E-16                                     |
| SW             | 15000                | U-238   | 1.7E-06                          | 3.0E-13                                  | 2.6E-13                                  | 5.6E-13                                     |
| SW             | 25000                | U-234   | 8.1E-08                          | 1.5E-14                                  | 1.6E-14                                  | 3.0E-14                                     |
| SW             | 25000                | U-235   | 6.4E-09                          | 1.1E-15                                  | 1.2E-15                                  | 2.4E-15                                     |
| SW             | 25000                | U-236   | 2.6E-10                          | 4.6E-17                                  | 5.0E-17                                  | 9.6E-17                                     |
| SW             | 25000                | U-238   | 7.6E-07                          | 1.4E-13                                  | 1.5E-13                                  | 2.8E-13                                     |
| SW             | 35000                | U-234   | 5.0E-08                          | 9.0E-15                                  | 1.1E-14                                  | 2.0E-14                                     |
| SW             | 35000                | U-235   | 3.9E-09                          | 7.1E-16                                  | 8.5E-16                                  | 1.6E-15                                     |
| SW             | 35000                | U-236   | 1.6E-10                          | 2.9E-17                                  | 3.4E-17                                  | 6.3E-17                                     |
| SW             | 35000                | U-238   | 4.7E-07                          | 8.4E-14                                  | 1.0E-13                                  | 1.9E-13                                     |
| SW             | 45000                | U-234   | 3.4E-08                          | 6.1E-15                                  | 8.1E-15                                  | 1.4E-14                                     |
| SW             | 45000                | U-235   | 2.7E-09                          | 4.8E-16                                  | 6.4E-16                                  | 1.1E-15                                     |
| SW             | 45000                | U-236   | 1.1E-10                          | 2.0E-17                                  | 2.6E-17                                  | 4.5E-17                                     |
| SW             | 45000                | U-238   | 3.2E-07                          | 5.8E-14                                  | 7.6E-14                                  | 1.3E-13                                     |
| SW             | 55000                | U-234   | 2.5E-08                          | 4.4E-15                                  | 6.4E-15                                  | 1.1E-14                                     |
| SW             | 55000                | U-235   | 1.9E-09                          | 3.5E-16                                  | 5.0E-16                                  | 8.5E-16                                     |
| SW             | 55000                | U-236   | 7.8E-11                          | 1.4E-17                                  | 2.0E-17                                  | 3.4E-17                                     |
| SW             | 55000                | U-238   | 2.3E-07                          | 4.1E-14                                  | 6.0E-14                                  | 1.0E-13                                     |
| SW             | 70000                | U-234   | 1.6E-08                          | 2.8E-15                                  | 4.7E-15                                  | 7.5E-15                                     |
| SW             | 70000                | U-235   | 1.2E-09                          | 2.2E-16                                  | 3.7E-16                                  | 5.9E-16                                     |
| SW             | 70000                | U-236   | 4.9E-11                          | 8.9E-18                                  | 1.5E-17                                  | 2.4E-17                                     |
| SW             | 70000                | U-238   | 1.4E-07                          | 2.6E-14                                  | 4.4E-14                                  | 7.0E-14                                     |
| SSW            | 310                  | U-234   | 2.5E-05                          | 4.5E-12                                  | 9.7E-13                                  | 5.5E-12                                     |
| SSW            | 310                  | U-235   | 2.9E-06                          | 5.3E-13                                  | 7.7E-14                                  | 6.0E-13                                     |
| SSW            | 310                  | U-236   | 1.2E-07                          | 2.1E-14                                  | 3.1E-15                                  | 2.4E-14                                     |
| SSW            | 310                  | U-238   | 3.4E-04                          | 6.1E-11                                  | 9.1E-12                                  | 7.0E-11                                     |
| SSW            | 810                  | U-234   | 8.4E-06                          | 1.5E-12                                  | 3.7E-13                                  | 1.9E-12                                     |
| SSW            | 810                  | U-235   | 7.9E-07                          | 1.4E-13                                  | 2.9E-14                                  | 1.7E-13                                     |
| SSW            | 810                  | U-236   | 3.2E-08                          | 5.7E-15                                  | 1.2E-15                                  | 6.9E-15                                     |
| SSW            | 810                  | U-238   | 9.2E-05                          | 1.7E-11                                  | 3.5E-12                                  | 2.0E-11                                     |
| SSW            | 1500                 | U-234   | 3.5E-06                          | 6.3E-13                                  | 2.0E-13                                  | 8.3E-13                                     |
| SSW            | 1500                 | U-235   | 3.0E-07                          | 5.4E-14                                  | 1.6E-14                                  | 7.0E-14                                     |
| SSW            | 1500                 | U-236   | 1.2E-08                          | 2.2E-15                                  | 6.3E-16                                  | 2.8E-15                                     |
| SSW            | 1500                 | U-238   | 3.6E-05                          | 6.4E-12                                  | 1.9E-12                                  | 8.3E-12                                     |

ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind<br>Toward | Distance<br>(meters) | Nuclide | Air<br>Concentration<br>(pCi/m3) | Dry<br>Deposition<br>Rate<br>(pCi/cm2/s) | Wet<br>Deposition<br>Rate<br>(pCi/cm2/s) | Ground<br>Deposition<br>Rate<br>(pCi/cm2/s) |
|----------------|----------------------|---------|----------------------------------|--|--|---|
| SSW            | 2500                 | U-234   | 1.6E-06                          | 2.9E-13                                  | 1.2E-13                                  | 4.1E-13                                     |
| SSW            | 2500                 | U-235   | 1.3E-07                          | 2.4E-14                                  | 9.3E-15                                  | 3.3E-14                                     |
| SSW            | 2500                 | U-236   | 5.4E-09                          | 9.7E-16                                  | 3.7E-16                                  | 1.3E-15                                     |
| SSW            | 2500                 | U-238   | 1.6E-05                          | 2.8E-12                                  | 1.1E-12                                  | 3.9E-12                                     |
| SSW            | 3500                 | U-234   | 9.6E-07                          | 1.7E-13                                  | 8.3E-14                                  | 2.6E-13                                     |
| SSW            | 3500                 | U-235   | 7.8E-08                          | 1.4E-14                                  | 6.6E-15                                  | 2.1E-14                                     |
| SSW            | 3500                 | U-236   | 3.2E-09                          | 5.7E-16                                  | 2.6E-16                                  | 8.4E-16                                     |
| SSW            | 3500                 | U-238   | 9.3E-06                          | 1.7E-12                                  | 7.8E-13                                  | 2.4E-12                                     |
| SSW            | 4500                 | U-234   | 6.6E-07                          | 1.2E-13                                  | 6.4E-14                                  | 1.8E-13                                     |
| SSW            | 4500                 | U-235   | 5.4E-08                          | 9.7E-15                                  | 5.1E-15                                  | 1.5E-14                                     |
| SSW            | 4500                 | U-236   | 2.2E-09                          | 3.9E-16                                  | 2.0E-16                                  | 6.0E-16                                     |
| SSW            | 4500                 | U-238   | 6.4E-06                          | 1.1E-12                                  | 6.0E-13                                  | 1.7E-12                                     |
| SSW            | 7500                 | U-234   | 3.1E-07                          | 5.6E-14                                  | 3.8E-14                                  | 9.3E-14                                     |
| SSW            | 7500                 | U-235   | 2.5E-08                          | 4.4E-15                                  | 3.0E-15                                  | 7.4E-15                                     |
| SSW            | 7500                 | U-236   | 1.0E-09                          | 1.8E-16                                  | 1.2E-16                                  | 3.0E-16                                     |
| SSW            | 7500                 | U-238   | 2.9E-06                          | 5.3E-13                                  | 3.5E-13                                  | 8.8E-13                                     |
| SSW            | 15000                | U-234   | 1.1E-07                          | 2.0E-14                                  | 1.8E-14                                  | 3.8E-14                                     |
| SSW            | 15000                | U-235   | 8.8E-09                          | 1.6E-15                                  | 1.4E-15                                  | 3.0E-15                                     |
| SSW            | 15000                | U-236   | 3.6E-10                          | 6.4E-17                                  | 5.8E-17                                  | 1.2E-16                                     |
| SSW            | 15000                | U-238   | 1.0E-06                          | 1.9E-13                                  | 1.7E-13                                  | 3.6E-13                                     |
| SSW            | 25000                | U-234   | 5.1E-08                          | 9.1E-15                                  | 1.0E-14                                  | 1.9E-14                                     |
| SSW            | 25000                | U-235   | 4.0E-09                          | 7.2E-16                                  | 8.1E-16                                  | 1.5E-15                                     |
| SSW            | 25000                | U-236   | 1.6E-10                          | 2.9E-17                                  | 3.3E-17                                  | 6.2E-17                                     |
| SSW            | 25000                | U-238   | 4.7E-07                          | 8.5E-14                                  | 9.6E-14                                  | 1.8E-13                                     |
| SSW            | 35000                | U-234   | 3.1E-08                          | 5.6E-15                                  | 7.1E-15                                  | 1.3E-14                                     |
| SSW            | 35000                | U-235   | 2.5E-09                          | 4.4E-16                                  | 5.6E-16                                  | 1.0E-15                                     |
| SSW            | 35000                | U-236   | 9.9E-11                          | 1.8E-17                                  | 2.3E-17                                  | 4.0E-17                                     |
| SSW            | 35000                | U-238   | 2.9E-07                          | 5.3E-14                                  | 6.6E-14                                  | 1.2E-13                                     |
| SSW            | 45000                | U-234   | 2.1E-08                          | 3.8E-15                                  | 5.3E-15                                  | 9.2E-15                                     |
| SSW            | 45000                | U-235   | 1.7E-09                          | 3.0E-16                                  | 4.2E-16                                  | 7.2E-16                                     |
| SSW            | 45000                | U-236   | 6.8E-11                          | 1.2E-17                                  | 1.7E-17                                  | 2.9E-17                                     |
| SSW            | 45000                | U-238   | 2.0E-07                          | 3.6E-14                                  | 5.0E-14                                  | 8.6E-14                                     |
| SSW            | 55000                | U-234   | 1.5E-08                          | 2.7E-15                                  | 4.2E-15                                  | 6.9E-15                                     |
| SSW            | 55000                | U-235   | 1.2E-09                          | 2.2E-16                                  | 3.3E-16                                  | 5.5E-16                                     |
| SSW            | 55000                | U-236   | 4.9E-11                          | 8.7E-18                                  | 1.3E-17                                  | 2.2E-17                                     |
| SSW            | 55000                | U-238   | 1.4E-07                          | 2.6E-14                                  | 3.9E-14                                  | 6.5E-14                                     |
| SSW            | 70000                | U-234   | 9.5E-09                          | 1.7E-15                                  | 3.1E-15                                  | 4.8E-15                                     |
| SSW            | 70000                | U-235   | 7.5E-10                          | 1.3E-16                                  | 2.4E-16                                  | 3.8E-16                                     |
| SSW            | 70000                | U-236   | 3.0E-11                          | 5.4E-18                                  | 9.8E-18                                  | 1.5E-17                                     |
| SSW            | 70000                | U-238   | 8.9E-08                          | 1.6E-14                                  | 2.9E-14                                  | 4.5E-14                                     |
| S              | 310                  | U-234   | 4.6E-05                          | 8.3E-12                                  | 1.8E-12                                  | 1.0E-11                                     |
| S              | 310                  | U-235   | 5.1E-06                          | 9.2E-13                                  | 1.4E-13                                  | 1.1E-12                                     |
| S              | 310                  | U-236   | 2.1E-07                          | 3.8E-14                                  | 5.7E-15                                  | 4.3E-14                                     |
| S              | 310                  | U-238   | 6.0E-04                          | 1.1E-10                                  | 1.7E-11                                  | 1.2E-10                                     |
| S              | 810                  | U-234   | 1.4E-05                          | 2.6E-12                                  | 6.8E-13                                  | 3.2E-12                                     |
| S              | 810                  | U-235   | 1.3E-06                          | 2.4E-13                                  | 5.4E-14                                  | 2.9E-13                                     |
| S              | 810                  | U-236   | 5.3E-08                          | 9.6E-15                                  | 2.2E-15                                  | 1.2E-14                                     |

ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind<br>Toward | Distance<br>(meters) | Nuclide | Air                       | Dry                               | Wet                               | Ground                            |
|----------------|----------------------|---------|---------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|                |                      |         | Concentration<br>(pCi/m3) | Deposition<br>Rate<br>(pCi/cm2/s) | Deposition<br>Rate<br>(pCi/cm2/s) | Deposition<br>Rate<br>(pCi/cm2/s) |
| S              | 810                  | U-238   | 1.5E-04                   | 2.8E-11                           | 6.4E-12                           | 3.4E-11                           |
| S              | 1500                 | U-234   | 5.8E-06                   | 1.0E-12                           | 3.6E-13                           | 1.4E-12                           |
| S              | 1500                 | U-235   | 5.0E-07                   | 8.9E-14                           | 2.9E-14                           | 1.2E-13                           |
| S              | 1500                 | U-236   | 2.0E-08                   | 3.6E-15                           | 1.2E-15                           | 4.8E-15                           |
| S              | 1500                 | U-238   | 5.8E-05                   | 1.1E-11                           | 3.4E-12                           | 1.4E-11                           |
| S              | 2500                 | U-234   | 2.6E-06                   | 4.7E-13                           | 2.2E-13                           | 6.9E-13                           |
| S              | 2500                 | U-235   | 2.2E-07                   | 3.9E-14                           | 1.7E-14                           | 5.6E-14                           |
| S              | 2500                 | U-236   | 8.8E-09                   | 1.6E-15                           | 6.9E-16                           | 2.3E-15                           |
| S              | 2500                 | U-238   | 2.6E-05                   | 4.6E-12                           | 2.0E-12                           | 6.6E-12                           |
| S              | 3500                 | U-234   | 1.6E-06                   | 2.8E-13                           | 1.5E-13                           | 4.3E-13                           |
| S              | 3500                 | U-235   | 1.3E-07                   | 2.3E-14                           | 1.2E-14                           | 3.5E-14                           |
| S              | 3500                 | U-236   | 5.1E-09                   | 9.2E-16                           | 4.9E-16                           | 1.4E-15                           |
| S              | 3500                 | U-238   | 1.5E-05                   | 2.7E-12                           | 1.4E-12                           | 4.1E-12                           |
| S              | 4500                 | U-234   | 1.1E-06                   | 1.9E-13                           | 1.2E-13                           | 3.1E-13                           |
| S              | 4500                 | U-235   | 8.6E-08                   | 1.6E-14                           | 9.3E-15                           | 2.5E-14                           |
| S              | 4500                 | U-236   | 3.5E-09                   | 6.3E-16                           | 3.8E-16                           | 1.0E-15                           |
| S              | 4500                 | U-238   | 1.0E-05                   | 1.8E-12                           | 1.1E-12                           | 2.9E-12                           |
| S              | 7500                 | U-234   | 4.9E-07                   | 8.9E-14                           | 7.0E-14                           | 1.6E-13                           |
| S              | 7500                 | U-235   | 3.9E-08                   | 7.1E-15                           | 5.5E-15                           | 1.3E-14                           |
| S              | 7500                 | U-236   | 1.6E-09                   | 2.9E-16                           | 2.2E-16                           | 5.1E-16                           |
| S              | 7500                 | U-238   | 4.7E-06                   | 8.4E-13                           | 6.5E-13                           | 1.5E-12                           |
| S              | 15000                | U-234   | 1.8E-07                   | 3.2E-14                           | 3.4E-14                           | 6.5E-14                           |
| S              | 15000                | U-235   | 1.4E-08                   | 2.5E-15                           | 2.6E-15                           | 5.2E-15                           |
| S              | 15000                | U-236   | 5.7E-10                   | 1.0E-16                           | 1.1E-16                           | 2.1E-16                           |
| S              | 15000                | U-238   | 1.7E-06                   | 3.0E-13                           | 3.1E-13                           | 6.1E-13                           |
| S              | 25000                | U-234   | 8.1E-08                   | 1.5E-14                           | 1.9E-14                           | 3.3E-14                           |
| S              | 25000                | U-235   | 6.4E-09                   | 1.1E-15                           | 1.5E-15                           | 2.6E-15                           |
| S              | 25000                | U-236   | 2.6E-10                   | 4.6E-17                           | 6.0E-17                           | 1.1E-16                           |
| S              | 25000                | U-238   | 7.6E-07                   | 1.4E-13                           | 1.8E-13                           | 3.1E-13                           |
| S              | 35000                | U-234   | 5.0E-08                   | 8.9E-15                           | 1.3E-14                           | 2.2E-14                           |
| S              | 35000                | U-235   | 3.9E-09                   | 7.0E-16                           | 1.0E-15                           | 1.7E-15                           |
| S              | 35000                | U-236   | 1.6E-10                   | 2.8E-17                           | 4.2E-17                           | 7.0E-17                           |
| S              | 35000                | U-238   | 4.6E-07                   | 8.4E-14                           | 1.2E-13                           | 2.1E-13                           |
| S              | 45000                | U-234   | 3.4E-08                   | 6.1E-15                           | 9.8E-15                           | 1.6E-14                           |
| S              | 45000                | U-235   | 2.7E-09                   | 4.8E-16                           | 7.8E-16                           | 1.3E-15                           |
| S              | 45000                | U-236   | 1.1E-10                   | 1.9E-17                           | 3.1E-17                           | 5.1E-17                           |
| S              | 45000                | U-238   | 3.2E-07                   | 5.7E-14                           | 9.2E-14                           | 1.5E-13                           |
| S              | 55000                | U-234   | 2.4E-08                   | 4.4E-15                           | 7.7E-15                           | 1.2E-14                           |
| S              | 55000                | U-235   | 1.9E-09                   | 3.5E-16                           | 6.1E-16                           | 9.5E-16                           |
| S              | 55000                | U-236   | 7.8E-11                   | 1.4E-17                           | 2.5E-17                           | 3.9E-17                           |
| S              | 55000                | U-238   | 2.3E-07                   | 4.1E-14                           | 7.2E-14                           | 1.1E-13                           |
| S              | 70000                | U-234   | 1.5E-08                   | 2.8E-15                           | 5.7E-15                           | 8.4E-15                           |
| S              | 70000                | U-235   | 1.2E-09                   | 2.2E-16                           | 4.5E-16                           | 6.7E-16                           |
| S              | 70000                | U-236   | 4.9E-11                   | 8.8E-18                           | 1.8E-17                           | 2.7E-17                           |
| S              | 70000                | U-238   | 1.4E-07                   | 2.6E-14                           | 5.3E-14                           | 7.9E-14                           |
| SSE            | 310                  | U-234   | 3.6E-05                   | 6.4E-12                           | 1.4E-12                           | 7.8E-12                           |
| SSE            | 310                  | U-235   | 3.9E-06                   | 7.1E-13                           | 1.1E-13                           | 8.2E-13                           |



ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind<br>Toward | Distance<br>(meters) | Nuclide | Air<br>Concentration<br>(pCi/m3) | Dry<br>Deposition<br>Rate<br>(pCi/cm2/s) | Wet<br>Deposition<br>Rate<br>(pCi/cm2/s) | Ground<br>Deposition<br>Rate<br>(pCi/cm2/s) |
|----------------|----------------------|---------|----------------------------------|--|--|---|
| SSE            | 310                  | U-236   | 1.6E-07                          | 2.9E-14                                  | 4.4E-15                                  | 3.3E-14                                     |
| SSE            | 310                  | U-238   | 4.6E-04                          | 8.2E-11                                  | 1.3E-11                                  | 9.5E-11                                     |
| SSE            | 810                  | U-234   | 1.1E-05                          | 2.0E-12                                  | 5.2E-13                                  | 2.5E-12                                     |
| SSE            | 810                  | U-235   | 9.9E-07                          | 1.8E-13                                  | 4.1E-14                                  | 2.2E-13                                     |
| SSE            | 810                  | U-236   | 4.0E-08                          | 7.2E-15                                  | 1.7E-15                                  | 8.9E-15                                     |
| SSE            | 810                  | U-238   | 1.2E-04                          | 2.1E-11                                  | 4.9E-12                                  | 2.6E-11                                     |
| SSE            | 1500                 | U-234   | 4.4E-06                          | 7.8E-13                                  | 2.8E-13                                  | 1.1E-12                                     |
| SSE            | 1500                 | U-235   | 3.7E-07                          | 6.7E-14                                  | 2.2E-14                                  | 8.9E-14                                     |
| SSE            | 1500                 | U-236   | 1.5E-08                          | 2.7E-15                                  | 8.9E-16                                  | 3.6E-15                                     |
| SSE            | 1500                 | U-238   | 4.4E-05                          | 7.9E-12                                  | 2.6E-12                                  | 1.0E-11                                     |
| SSE            | 2500                 | U-234   | 2.0E-06                          | 3.5E-13                                  | 1.7E-13                                  | 5.2E-13                                     |
| SSE            | 2500                 | U-235   | 1.6E-07                          | 2.9E-14                                  | 1.3E-14                                  | 4.2E-14                                     |
| SSE            | 2500                 | U-236   | 6.5E-09                          | 1.2E-15                                  | 5.3E-16                                  | 1.7E-15                                     |
| SSE            | 2500                 | U-238   | 1.9E-05                          | 3.4E-12                                  | 1.6E-12                                  | 5.0E-12                                     |
| SSE            | 3500                 | U-234   | 1.2E-06                          | 2.1E-13                                  | 1.2E-13                                  | 3.3E-13                                     |
| SSE            | 3500                 | U-235   | 9.4E-08                          | 1.7E-14                                  | 9.3E-15                                  | 2.6E-14                                     |
| SSE            | 3500                 | U-236   | 3.8E-09                          | 6.9E-16                                  | 3.8E-16                                  | 1.1E-15                                     |
| SSE            | 3500                 | U-238   | 1.1E-05                          | 2.0E-12                                  | 1.1E-12                                  | 3.1E-12                                     |
| SSE            | 4500                 | U-234   | 8.0E-07                          | 1.4E-13                                  | 9.1E-14                                  | 2.3E-13                                     |
| SSE            | 4500                 | U-235   | 6.4E-08                          | 1.2E-14                                  | 7.2E-15                                  | 1.9E-14                                     |
| SSE            | 4500                 | U-236   | 2.6E-09                          | 4.7E-16                                  | 2.9E-16                                  | 7.6E-16                                     |
| SSE            | 4500                 | U-238   | 7.6E-06                          | 1.4E-12                                  | 8.6E-13                                  | 2.2E-12                                     |
| SSE            | 7500                 | U-234   | 3.7E-07                          | 6.6E-14                                  | 5.4E-14                                  | 1.2E-13                                     |
| SSE            | 7500                 | U-235   | 2.9E-08                          | 5.3E-15                                  | 4.2E-15                                  | 9.5E-15                                     |
| SSE            | 7500                 | U-236   | 1.2E-09                          | 2.1E-16                                  | 1.7E-16                                  | 3.9E-16                                     |
| SSE            | 7500                 | U-238   | 3.5E-06                          | 6.3E-13                                  | 5.0E-13                                  | 1.1E-12                                     |
| SSE            | 15000                | U-234   | 1.3E-07                          | 2.4E-14                                  | 2.6E-14                                  | 5.0E-14                                     |
| SSE            | 15000                | U-235   | 1.1E-08                          | 1.9E-15                                  | 2.0E-15                                  | 4.0E-15                                     |
| SSE            | 15000                | U-236   | 4.3E-10                          | 7.7E-17                                  | 8.3E-17                                  | 1.6E-16                                     |
| SSE            | 15000                | U-238   | 1.3E-06                          | 2.3E-13                                  | 2.4E-13                                  | 4.7E-13                                     |
| SSE            | 25000                | U-234   | 6.2E-08                          | 1.1E-14                                  | 1.5E-14                                  | 2.6E-14                                     |
| SSE            | 25000                | U-235   | 4.9E-09                          | 8.8E-16                                  | 1.2E-15                                  | 2.0E-15                                     |
| SSE            | 25000                | U-236   | 2.0E-10                          | 3.5E-17                                  | 4.7E-17                                  | 8.2E-17                                     |
| SSE            | 25000                | U-238   | 5.8E-07                          | 1.0E-13                                  | 1.4E-13                                  | 2.4E-13                                     |
| SSE            | 35000                | U-234   | 3.8E-08                          | 6.9E-15                                  | 1.0E-14                                  | 1.7E-14                                     |
| SSE            | 35000                | U-235   | 3.0E-09                          | 5.4E-16                                  | 8.0E-16                                  | 1.3E-15                                     |
| SSE            | 35000                | U-236   | 1.2E-10                          | 2.2E-17                                  | 3.2E-17                                  | 5.4E-17                                     |
| SSE            | 35000                | U-238   | 3.6E-07                          | 6.4E-14                                  | 9.6E-14                                  | 1.6E-13                                     |
| SSE            | 45000                | U-234   | 2.6E-08                          | 4.7E-15                                  | 7.7E-15                                  | 1.2E-14                                     |
| SSE            | 45000                | U-235   | 2.1E-09                          | 3.7E-16                                  | 6.0E-16                                  | 9.8E-16                                     |
| SSE            | 45000                | U-236   | 8.4E-11                          | 1.5E-17                                  | 2.4E-17                                  | 3.9E-17                                     |
| SSE            | 45000                | U-238   | 2.5E-07                          | 4.4E-14                                  | 7.2E-14                                  | 1.2E-13                                     |
| SSE            | 55000                | U-234   | 1.9E-08                          | 3.4E-15                                  | 6.0E-15                                  | 9.4E-15                                     |
| SSE            | 55000                | U-235   | 1.5E-09                          | 2.7E-16                                  | 4.8E-16                                  | 7.4E-16                                     |
| SSE            | 55000                | U-236   | 6.0E-11                          | 1.1E-17                                  | 1.9E-17                                  | 3.0E-17                                     |
| SSE            | 55000                | U-238   | 1.8E-07                          | 3.2E-14                                  | 5.6E-14                                  | 8.8E-14                                     |
| SSE            | 70000                | U-234   | 1.2E-08                          | 2.2E-15                                  | 4.4E-15                                  | 6.6E-15                                     |

ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind<br>Toward | Distance<br>(meters) | Nuclide | Air                                    | Dry  | Wet  | Ground   |
|----------------|----------------------|---------|--|--|--|--|
|                |                      |         | Concentration<br>(pCi/m <sup>3</sup> ) | Deposition<br>Rate<br>(pCi/cm <sup>2</sup> /s) | Deposition<br>Rate<br>(pCi/cm <sup>2</sup> /s) | Deposition<br>Rate<br>(pCi/cm <sup>2</sup> /s) |
| SSE            | 70000                | U-235   | 9.5E-10                                | 1.7E-16  | 3.5E-16  | 5.2E-16  |
| SSE            | 70000                | U-236   | 3.8E-11                                | 6.9E-18  | 1.4E-17  | 2.1E-17  |
| SSE            | 70000                | U-238   | 1.1E-07                                | 2.0E-14  | 4.2E-14  | 6.2E-14  |
| SE             | 310                  | U-234   | 3.7E-05                                | 6.6E-12  | 1.4E-12  | 8.0E-12  |
| SE             | 310                  | U-235   | 4.1E-06                                | 7.4E-13  | 1.1E-13  | 8.5E-13  |
| SE             | 310                  | U-236   | 1.7E-07                                | 3.0E-14  | 4.4E-15  | 3.4E-14  |
| SE             | 310                  | U-238   | 4.7E-04                                | 8.5E-11  | 1.3E-11  | 9.8E-11  |
| SE             | 810                  | U-234   | 1.1E-05                                | 2.0E-12  | 5.3E-13  | 2.5E-12  |
| SE             | 810                  | U-235   | 1.0E-06                                | 1.8E-13  | 4.2E-14  | 2.2E-13  |
| SE             | 810                  | U-236   | 4.1E-08                                | 7.4E-15  | 1.7E-15  | 9.0E-15  |
| SE             | 810                  | U-238   | 1.2E-04                                | 2.1E-11  | 5.0E-12  | 2.6E-11  |
| SE             | 1500                 | U-234   | 4.5E-06                                | 8.0E-13  | 2.8E-13  | 1.1E-12  |
| SE             | 1500                 | U-235   | 3.8E-07                                | 6.8E-14  | 2.2E-14  | 9.0E-14  |
| SE             | 1500                 | U-236   | 1.5E-08                                | 2.8E-15  | 9.0E-16  | 3.7E-15  |
| SE             | 1500                 | U-238   | 4.4E-05                                | 8.0E-12  | 2.7E-12  | 1.1E-11  |
| SE             | 2500                 | U-234   | 2.0E-06                                | 3.6E-13  | 1.7E-13  | 5.3E-13  |
| SE             | 2500                 | U-235   | 1.6E-07                                | 2.9E-14  | 1.3E-14  | 4.3E-14  |
| SE             | 2500                 | U-236   | 6.6E-09                                | 1.2E-15  | 5.4E-16  | 1.7E-15  |
| SE             | 2500                 | U-238   | 1.9E-05                                | 3.5E-12  | 1.6E-12  | 5.1E-12  |
| SE             | 3500                 | U-234   | 1.2E-06                                | 2.1E-13  | 1.2E-13  | 3.3E-13  |
| SE             | 3500                 | U-235   | 9.6E-08                                | 1.7E-14  | 9.4E-15  | 2.7E-14  |
| SE             | 3500                 | U-236   | 3.9E-09                                | 7.0E-16  | 3.8E-16  | 1.1E-15  |
| SE             | 3500                 | U-238   | 1.1E-05                                | 2.0E-12  | 1.1E-12  | 3.2E-12  |
| SE             | 4500                 | U-234   | 8.1E-07                                | 1.5E-13  | 9.2E-14  | 2.4E-13  |
| SE             | 4500                 | U-235   | 6.5E-08                                | 1.2E-14  | 7.3E-15  | 1.9E-14  |
| SE             | 4500                 | U-236   | 2.6E-09                                | 4.7E-16  | 2.9E-16  | 7.7E-16  |
| SE             | 4500                 | U-238   | 7.7E-06                                | 1.4E-12  | 8.7E-13  | 2.3E-12  |
| SE             | 7500                 | U-234   | 3.7E-07                                | 6.7E-14  | 5.4E-14  | 1.2E-13  |
| SE             | 7500                 | U-235   | 3.0E-08                                | 5.3E-15  | 4.3E-15  | 9.6E-15  |
| SE             | 7500                 | U-236   | 1.2E-09                                | 2.2E-16  | 1.7E-16  | 3.9E-16  |
| SE             | 7500                 | U-238   | 3.5E-06                                | 6.3E-13  | 5.1E-13  | 1.1E-12  |
| SE             | 15000                | U-234   | 1.3E-07                                | 2.4E-14  | 2.6E-14  | 5.0E-14  |
| SE             | 15000                | U-235   | 1.1E-08                                | 1.9E-15  | 2.1E-15  | 4.0E-15  |
| SE             | 15000                | U-236   | 4.3E-10                                | 7.7E-17  | 8.4E-17  | 1.6E-16  |
| SE             | 15000                | U-238   | 1.2E-06                                | 2.2E-13  | 2.5E-13  | 4.7E-13  |
| SE             | 25000                | U-234   | 6.1E-08                                | 1.1E-14  | 1.5E-14  | 2.6E-14  |
| SE             | 25000                | U-235   | 4.8E-09                                | 8.6E-16  | 1.2E-15  | 2.0E-15  |
| SE             | 25000                | U-236   | 1.9E-10                                | 3.5E-17  | 4.8E-17  | 8.3E-17  |
| SE             | 25000                | U-238   | 5.7E-07                                | 1.0E-13  | 1.4E-13  | 2.4E-13  |
| SE             | 35000                | U-234   | 3.7E-08                                | 6.7E-15  | 1.0E-14  | 1.7E-14  |
| SE             | 35000                | U-235   | 2.9E-09                                | 5.3E-16  | 8.2E-16  | 1.3E-15  |
| SE             | 35000                | U-236   | 1.2E-10                                | 2.1E-17  | 3.3E-17  | 5.4E-17  |
| SE             | 35000                | U-238   | 3.5E-07                                | 6.3E-14  | 9.7E-14  | 1.6E-13  |
| SE             | 45000                | U-234   | 2.6E-08                                | 4.6E-15  | 7.8E-15  | 1.2E-14  |
| SE             | 45000                | U-235   | 2.0E-09                                | 3.6E-16  | 6.2E-16  | 9.8E-16  |
| SE             | 45000                | U-236   | 8.1E-11                                | 1.5E-17  | 2.5E-17  | 3.9E-17  |
| SE             | 45000                | U-238   | 2.4E-07                                | 4.3E-14  | 7.3E-14  | 1.2E-13  |

ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind<br>Toward | Distance<br>(meters) | Nuclide | Air<br>Concentration<br>(pCi/m3) | Dry<br>Deposition<br>Rate<br>(pCi/cm2/s) | Wet<br>Deposition<br>Rate<br>(pCi/cm2/s) | Ground<br>Deposition<br>Rate<br>(pCi/cm2/s) |
|----------------|----------------------|---------|----------------------------------|--|--|---|
| SE             | 55000                | U-234   | 1.8E-08                          | 3.3E-15                                  | 6.1E-15                                  | 9.5E-15                                     |
| SE             | 55000                | U-235   | 1.4E-09                          | 2.6E-16                                  | 4.8E-16                                  | 7.5E-16                                     |
| SE             | 55000                | U-236   | 5.9E-11                          | 1.1E-17                                  | 2.0E-17                                  | 3.0E-17                                     |
| SE             | 55000                | U-238   | 1.7E-07                          | 3.1E-14                                  | 5.8E-14                                  | 8.9E-14                                     |
| SE             | 70000                | U-234   | 1.2E-08                          | 2.1E-15                                  | 4.6E-15                                  | 6.7E-15                                     |
| SE             | 70000                | U-235   | 9.3E-10                          | 1.7E-16                                  | 3.6E-16                                  | 5.3E-16                                     |
| SE             | 70000                | U-236   | 3.7E-11                          | 6.7E-18                                  | 1.5E-17                                  | 2.1E-17                                     |
| SE             | 70000                | U-238   | 1.1E-07                          | 2.0E-14                                  | 4.3E-14                                  | 6.2E-14                                     |
| ESE            | 310                  | U-234   | 5.1E-05                          | 9.2E-12                                  | 1.8E-12                                  | 1.1E-11                                     |
| ESE            | 310                  | U-235   | 5.7E-06                          | 1.0E-12                                  | 1.5E-13                                  | 1.2E-12                                     |
| ESE            | 310                  | U-236   | 2.3E-07                          | 4.1E-14                                  | 5.9E-15                                  | 4.7E-14                                     |
| ESE            | 310                  | U-238   | 6.6E-04                          | 1.2E-10                                  | 1.7E-11                                  | 1.4E-10                                     |
| ESE            | 810                  | U-234   | 1.5E-05                          | 2.8E-12                                  | 7.0E-13                                  | 3.5E-12                                     |
| ESE            | 810                  | U-235   | 1.4E-06                          | 2.5E-13                                  | 5.5E-14                                  | 3.1E-13                                     |
| ESE            | 810                  | U-236   | 5.7E-08                          | 1.0E-14                                  | 2.2E-15                                  | 1.2E-14                                     |
| ESE            | 810                  | U-238   | 1.6E-04                          | 3.0E-11                                  | 6.6E-12                                  | 3.6E-11                                     |
| ESE            | 1500                 | U-234   | 6.2E-06                          | 1.1E-12                                  | 3.8E-13                                  | 1.5E-12                                     |
| ESE            | 1500                 | U-235   | 5.2E-07                          | 9.4E-14                                  | 3.0E-14                                  | 1.2E-13                                     |
| ESE            | 1500                 | U-236   | 2.1E-08                          | 3.8E-15                                  | 1.2E-15                                  | 5.0E-15                                     |
| ESE            | 1500                 | U-238   | 6.2E-05                          | 1.1E-11                                  | 3.5E-12                                  | 1.5E-11                                     |
| ESE            | 2500                 | U-234   | 2.8E-06                          | 5.0E-13                                  | 2.2E-13                                  | 7.2E-13                                     |
| ESE            | 2500                 | U-235   | 2.3E-07                          | 4.1E-14                                  | 1.8E-14                                  | 5.9E-14                                     |
| ESE            | 2500                 | U-236   | 9.2E-09                          | 1.7E-15                                  | 7.1E-16                                  | 2.4E-15                                     |
| ESE            | 2500                 | U-238   | 2.7E-05                          | 4.9E-12                                  | 2.1E-12                                  | 6.9E-12                                     |
| ESE            | 3500                 | U-234   | 1.6E-06                          | 3.0E-13                                  | 1.6E-13                                  | 4.6E-13                                     |
| ESE            | 3500                 | U-235   | 1.3E-07                          | 2.4E-14                                  | 1.3E-14                                  | 3.7E-14                                     |
| ESE            | 3500                 | U-236   | 5.4E-09                          | 9.7E-16                                  | 5.1E-16                                  | 1.5E-15                                     |
| ESE            | 3500                 | U-238   | 1.6E-05                          | 2.8E-12                                  | 1.5E-12                                  | 4.3E-12                                     |
| ESE            | 4500                 | U-234   | 1.1E-06                          | 2.0E-13                                  | 1.2E-13                                  | 3.3E-13                                     |
| ESE            | 4500                 | U-235   | 9.1E-08                          | 1.6E-14                                  | 9.7E-15                                  | 2.6E-14                                     |
| ESE            | 4500                 | U-236   | 3.7E-09                          | 6.6E-16                                  | 3.9E-16                                  | 1.1E-15                                     |
| ESE            | 4500                 | U-238   | 1.1E-05                          | 1.9E-12                                  | 1.1E-12                                  | 3.1E-12                                     |
| ESE            | 7500                 | U-234   | 5.2E-07                          | 9.4E-14                                  | 7.2E-14                                  | 1.7E-13                                     |
| ESE            | 7500                 | U-235   | 4.2E-08                          | 7.5E-15                                  | 5.7E-15                                  | 1.3E-14                                     |
| ESE            | 7500                 | U-236   | 1.7E-09                          | 3.0E-16                                  | 2.3E-16                                  | 5.3E-16                                     |
| ESE            | 7500                 | U-238   | 4.9E-06                          | 8.9E-13                                  | 6.8E-13                                  | 1.6E-12                                     |
| ESE            | 15000                | U-234   | 1.8E-07                          | 3.3E-14                                  | 3.5E-14                                  | 6.8E-14                                     |
| ESE            | 15000                | U-235   | 1.5E-08                          | 2.6E-15                                  | 2.8E-15                                  | 5.4E-15                                     |
| ESE            | 15000                | U-236   | 5.9E-10                          | 1.1E-16                                  | 1.1E-16                                  | 2.2E-16                                     |
| ESE            | 15000                | U-238   | 1.7E-06                          | 3.1E-13                                  | 3.3E-13                                  | 6.4E-13                                     |
| ESE            | 25000                | U-234   | 8.4E-08                          | 1.5E-14                                  | 2.0E-14                                  | 3.5E-14                                     |
| ESE            | 25000                | U-235   | 6.6E-09                          | 1.2E-15                                  | 1.6E-15                                  | 2.8E-15                                     |
| ESE            | 25000                | U-236   | 2.7E-10                          | 4.8E-17                                  | 6.4E-17                                  | 1.1E-16                                     |
| ESE            | 25000                | U-238   | 7.9E-07                          | 1.4E-13                                  | 1.9E-13                                  | 3.3E-13                                     |
| ESE            | 35000                | U-234   | 5.1E-08                          | 9.2E-15                                  | 1.4E-14                                  | 2.3E-14                                     |
| ESE            | 35000                | U-235   | 4.0E-09                          | 7.3E-16                                  | 1.1E-15                                  | 1.8E-15                                     |
| ESE            | 35000                | U-236   | 1.6E-10                          | 2.9E-17                                  | 4.5E-17                                  | 7.4E-17                                     |

ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind<br>Toward | Distance<br>(meters) | Nuclide | Air<br>Concentration<br>(pCi/m3) | Dry<br>Deposition<br>Rate<br>(pCi/cm2/s) | Wet<br>Deposition<br>Rate<br>(pCi/cm2/s) | Ground<br>Deposition<br>Rate<br>(pCi/cm2/s) |
|----------------|----------------------|---------|----------------------------------|--|--|---|
| ESE            | 35000                | U-238   | 4.8E-07                          | 8.6E-14                                  | 1.3E-13                                  | 2.2E-13                                     |
| ESE            | 45000                | U-234   | 3.5E-08                          | 6.3E-15                                  | 1.1E-14                                  | 1.7E-14                                     |
| ESE            | 45000                | U-235   | 2.8E-09                          | 5.0E-16                                  | 8.3E-16                                  | 1.3E-15                                     |
| ESE            | 45000                | U-236   | 1.1E-10                          | 2.0E-17                                  | 3.4E-17                                  | 5.4E-17                                     |
| ESE            | 45000                | U-238   | 3.3E-07                          | 5.9E-14                                  | 9.9E-14                                  | 1.6E-13                                     |
| ESE            | 55000                | U-234   | 2.5E-08                          | 4.5E-15                                  | 8.4E-15                                  | 1.3E-14                                     |
| ESE            | 55000                | U-235   | 2.0E-09                          | 3.6E-16                                  | 6.6E-16                                  | 1.0E-15                                     |
| ESE            | 55000                | U-236   | 8.0E-11                          | 1.4E-17                                  | 2.7E-17                                  | 4.1E-17                                     |
| ESE            | 55000                | U-238   | 2.4E-07                          | 4.2E-14                                  | 7.8E-14                                  | 1.2E-13                                     |
| ESE            | 70000                | U-234   | 1.6E-08                          | 2.9E-15                                  | 6.2E-15                                  | 9.1E-15                                     |
| ESE            | 70000                | U-235   | 1.3E-09                          | 2.3E-16                                  | 4.9E-16                                  | 7.2E-16                                     |
| ESE            | 70000                | U-236   | 5.1E-11                          | 9.2E-18                                  | 2.0E-17                                  | 2.9E-17                                     |
| ESE            | 70000                | U-238   | 1.5E-07                          | 2.7E-14                                  | 5.9E-14                                  | 8.6E-14                                     |
| E              | 310                  | U-234   | 7.4E-05                          | 1.3E-11                                  | 2.6E-12                                  | 1.6E-11                                     |
| E              | 310                  | U-235   | 8.5E-06                          | 1.5E-12                                  | 2.0E-13                                  | 1.7E-12                                     |
| E              | 310                  | U-236   | 3.5E-07                          | 6.2E-14                                  | 8.2E-15                                  | 7.1E-14                                     |
| E              | 310                  | U-238   | 9.8E-04                          | 1.8E-10                                  | 2.4E-11                                  | 2.0E-10                                     |
| E              | 810                  | U-234   | 2.3E-05                          | 4.2E-12                                  | 9.8E-13                                  | 5.2E-12                                     |
| E              | 810                  | U-235   | 2.1E-06                          | 3.7E-13                                  | 7.8E-14                                  | 4.5E-13                                     |
| E              | 810                  | U-236   | 8.4E-08                          | 1.5E-14                                  | 3.1E-15                                  | 1.8E-14                                     |
| E              | 810                  | U-238   | 2.4E-04                          | 4.4E-11                                  | 9.2E-12                                  | 5.3E-11                                     |
| E              | 1500                 | U-234   | 9.2E-06                          | 1.6E-12                                  | 5.3E-13                                  | 2.2E-12                                     |
| E              | 1500                 | U-235   | 7.6E-07                          | 1.4E-13                                  | 4.2E-14                                  | 1.8E-13                                     |
| E              | 1500                 | U-236   | 3.1E-08                          | 5.6E-15                                  | 1.7E-15                                  | 7.3E-15                                     |
| E              | 1500                 | U-238   | 9.0E-05                          | 1.6E-11                                  | 4.9E-12                                  | 2.1E-11                                     |
| E              | 2500                 | U-234   | 4.1E-06                          | 7.3E-13                                  | 3.1E-13                                  | 1.0E-12                                     |
| E              | 2500                 | U-235   | 3.3E-07                          | 6.0E-14                                  | 2.5E-14                                  | 8.5E-14                                     |
| E              | 2500                 | U-236   | 1.3E-08                          | 2.4E-15                                  | 1.0E-15                                  | 3.4E-15                                     |
| E              | 2500                 | U-238   | 3.9E-05                          | 7.1E-12                                  | 2.9E-12                                  | 1.0E-11                                     |
| E              | 3500                 | U-234   | 2.4E-06                          | 4.3E-13                                  | 2.2E-13                                  | 6.6E-13                                     |
| E              | 3500                 | U-235   | 1.9E-07                          | 3.5E-14                                  | 1.8E-14                                  | 5.3E-14                                     |
| E              | 3500                 | U-236   | 7.9E-09                          | 1.4E-15                                  | 7.1E-16                                  | 2.1E-15                                     |
| E              | 3500                 | U-238   | 2.3E-05                          | 4.1E-12                                  | 2.1E-12                                  | 6.2E-12                                     |
| E              | 4500                 | U-234   | 1.7E-06                          | 3.0E-13                                  | 1.7E-13                                  | 4.7E-13                                     |
| E              | 4500                 | U-235   | 1.3E-07                          | 2.4E-14                                  | 1.4E-14                                  | 3.8E-14                                     |
| E              | 4500                 | U-236   | 5.4E-09                          | 9.7E-16                                  | 5.5E-16                                  | 1.5E-15                                     |
| E              | 4500                 | U-238   | 1.6E-05                          | 2.8E-12                                  | 1.6E-12                                  | 4.4E-12                                     |
| E              | 7500                 | U-234   | 7.6E-07                          | 1.4E-13                                  | 1.0E-13                                  | 2.4E-13                                     |
| E              | 7500                 | U-235   | 6.1E-08                          | 1.1E-14                                  | 8.0E-15                                  | 1.9E-14                                     |
| E              | 7500                 | U-236   | 2.5E-09                          | 4.4E-16                                  | 3.2E-16                                  | 7.7E-16                                     |
| E              | 7500                 | U-238   | 7.2E-06                          | 1.3E-12                                  | 9.5E-13                                  | 2.3E-12                                     |
| E              | 15000                | U-234   | 2.7E-07                          | 4.9E-14                                  | 5.0E-14                                  | 9.8E-14                                     |
| E              | 15000                | U-235   | 2.1E-08                          | 3.9E-15                                  | 3.9E-15                                  | 7.8E-15                                     |
| E              | 15000                | U-236   | 8.7E-10                          | 1.6E-16                                  | 1.6E-16                                  | 3.1E-16                                     |
| E              | 15000                | U-238   | 2.5E-06                          | 4.6E-13                                  | 4.6E-13                                  | 9.2E-13                                     |
| E              | 25000                | U-234   | 1.2E-07                          | 2.2E-14                                  | 2.9E-14                                  | 5.1E-14                                     |
| E              | 25000                | U-235   | 9.8E-09                          | 1.8E-15                                  | 2.3E-15                                  | 4.0E-15                                     |

ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind<br>Toward | Distance<br>(meters) | Nuclide | Air<br>Concentration<br>(pCi/m3) | Dry<br>Deposition<br>Rate<br>(pCi/cm2/s) | Wet<br>Deposition<br>Rate<br>(pCi/cm2/s) | Ground<br>Deposition<br>Rate<br>(pCi/cm2/s) |
|----------------|----------------------|---------|----------------------------------|--|--|---|
| E              | 25000                | U-236   | 4.0E-10                          | 7.2E-17                                  | 9.1E-17                                  | 1.6E-16                                     |
| E              | 25000                | U-238   | 1.2E-06                          | 2.1E-13                                  | 2.7E-13                                  | 4.8E-13                                     |
| E              | 35000                | U-234   | 7.6E-08                          | 1.4E-14                                  | 2.0E-14                                  | 3.4E-14                                     |
| E              | 35000                | U-235   | 6.0E-09                          | 1.1E-15                                  | 1.6E-15                                  | 2.7E-15                                     |
| E              | 35000                | U-236   | 2.4E-10                          | 4.4E-17                                  | 6.4E-17                                  | 1.1E-16                                     |
| E              | 35000                | U-238   | 7.1E-07                          | 1.3E-13                                  | 1.9E-13                                  | 3.2E-13                                     |
| E              | 45000                | U-234   | 5.2E-08                          | 9.3E-15                                  | 1.5E-14                                  | 2.4E-14                                     |
| E              | 45000                | U-235   | 4.1E-09                          | 7.4E-16                                  | 1.2E-15                                  | 1.9E-15                                     |
| E              | 45000                | U-236   | 1.7E-10                          | 3.0E-17                                  | 4.8E-17                                  | 7.8E-17                                     |
| E              | 45000                | U-238   | 4.9E-07                          | 8.7E-14                                  | 1.4E-13                                  | 2.3E-13                                     |
| E              | 55000                | U-234   | 3.8E-08                          | 6.8E-15                                  | 1.2E-14                                  | 1.9E-14                                     |
| E              | 55000                | U-235   | 3.0E-09                          | 5.3E-16                                  | 9.5E-16                                  | 1.5E-15                                     |
| E              | 55000                | U-236   | 1.2E-10                          | 2.2E-17                                  | 3.8E-17                                  | 6.0E-17                                     |
| E              | 55000                | U-238   | 3.5E-07                          | 6.3E-14                                  | 1.1E-13                                  | 1.8E-13                                     |
| E              | 70000                | U-234   | 2.5E-08                          | 4.4E-15                                  | 9.0E-15                                  | 1.3E-14                                     |
| E              | 70000                | U-235   | 1.9E-09                          | 3.5E-16                                  | 7.1E-16                                  | 1.1E-15                                     |
| E              | 70000                | U-236   | 7.8E-11                          | 1.4E-17                                  | 2.9E-17                                  | 4.3E-17                                     |
| E              | 70000                | U-238   | 2.3E-07                          | 4.1E-14                                  | 8.5E-14                                  | 1.3E-13                                     |
| ENE            | 310                  | U-234   | 5.2E-05                          | 9.3E-12                                  | 2.0E-12                                  | 1.1E-11                                     |
| ENE            | 310                  | U-235   | 6.3E-06                          | 1.1E-12                                  | 1.6E-13                                  | 1.3E-12                                     |
| ENE            | 310                  | U-236   | 2.5E-07                          | 4.6E-14                                  | 6.5E-15                                  | 5.2E-14                                     |
| ENE            | 310                  | U-238   | 7.2E-04                          | 1.3E-10                                  | 1.9E-11                                  | 1.5E-10                                     |
| ENE            | 810                  | U-234   | 1.9E-05                          | 3.4E-12                                  | 7.7E-13                                  | 4.1E-12                                     |
| ENE            | 810                  | U-235   | 1.8E-06                          | 3.2E-13                                  | 6.1E-14                                  | 3.8E-13                                     |
| ENE            | 810                  | U-236   | 7.1E-08                          | 1.3E-14                                  | 2.5E-15                                  | 1.5E-14                                     |
| ENE            | 810                  | U-238   | 2.1E-04                          | 3.7E-11                                  | 7.2E-12                                  | 4.4E-11                                     |
| ENE            | 1500                 | U-234   | 7.9E-06                          | 1.4E-12                                  | 4.1E-13                                  | 1.8E-12                                     |
| ENE            | 1500                 | U-235   | 6.9E-07                          | 1.2E-13                                  | 3.2E-14                                  | 1.6E-13                                     |
| ENE            | 1500                 | U-236   | 2.8E-08                          | 5.0E-15                                  | 1.3E-15                                  | 6.3E-15                                     |
| ENE            | 1500                 | U-238   | 8.1E-05                          | 1.5E-11                                  | 3.9E-12                                  | 1.8E-11                                     |
| ENE            | 2500                 | U-234   | 3.7E-06                          | 6.6E-13                                  | 2.4E-13                                  | 9.1E-13                                     |
| ENE            | 2500                 | U-235   | 3.0E-07                          | 5.5E-14                                  | 1.9E-14                                  | 7.4E-14                                     |
| ENE            | 2500                 | U-236   | 1.2E-08                          | 2.2E-15                                  | 7.8E-16                                  | 3.0E-15                                     |
| ENE            | 2500                 | U-238   | 3.6E-05                          | 6.5E-12                                  | 2.3E-12                                  | 8.8E-12                                     |
| ENE            | 3500                 | U-234   | 2.2E-06                          | 4.0E-13                                  | 1.7E-13                                  | 5.7E-13                                     |
| ENE            | 3500                 | U-235   | 1.8E-07                          | 3.3E-14                                  | 1.4E-14                                  | 4.6E-14                                     |
| ENE            | 3500                 | U-236   | 7.3E-09                          | 1.3E-15                                  | 5.5E-16                                  | 1.9E-15                                     |
| ENE            | 3500                 | U-238   | 2.1E-05                          | 3.8E-12                                  | 1.6E-12                                  | 5.5E-12                                     |
| ENE            | 4500                 | U-234   | 1.5E-06                          | 2.8E-13                                  | 1.3E-13                                  | 4.1E-13                                     |
| ENE            | 4500                 | U-235   | 1.2E-07                          | 2.2E-14                                  | 1.1E-14                                  | 3.3E-14                                     |
| ENE            | 4500                 | U-236   | 5.0E-09                          | 9.0E-16                                  | 4.3E-16                                  | 1.3E-15                                     |
| ENE            | 4500                 | U-238   | 1.5E-05                          | 2.6E-12                                  | 1.3E-12                                  | 3.9E-12                                     |
| ENE            | 7500                 | U-234   | 7.2E-07                          | 1.3E-13                                  | 7.8E-14                                  | 2.1E-13                                     |
| ENE            | 7500                 | U-235   | 5.7E-08                          | 1.0E-14                                  | 6.2E-15                                  | 1.7E-14                                     |
| ENE            | 7500                 | U-236   | 2.3E-09                          | 4.2E-16                                  | 2.5E-16                                  | 6.7E-16                                     |
| ENE            | 7500                 | U-238   | 6.8E-06                          | 1.2E-12                                  | 7.3E-13                                  | 2.0E-12                                     |
| ENE            | 15000                | U-234   | 2.6E-07                          | 4.7E-14                                  | 3.8E-14                                  | 8.5E-14                                     |

ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind<br>Toward | Distance<br>(meters) | Nuclide | Air<br>Concentration<br>(pCi/m3) | Dry<br>Deposition<br>Rate<br>(pCi/cm2/s) | Wet<br>Deposition<br>Rate<br>(pCi/cm2/s) | Ground<br>Deposition<br>Rate<br>(pCi/cm2/s) |
|----------------|----------------------|---------|----------------------------------|--|--|---|
| ENE            | 15000                | U-235   | 2.1E-08                          | 3.7E-15                                  | 3.0E-15                                  | 6.7E-15                                     |
| ENE            | 15000                | U-236   | 8.4E-10                          | 1.5E-16                                  | 1.2E-16                                  | 2.7E-16                                     |
| ENE            | 15000                | U-238   | 2.5E-06                          | 4.4E-13                                  | 3.5E-13                                  | 8.0E-13                                     |
| ENE            | 25000                | U-234   | 1.2E-07                          | 2.1E-14                                  | 2.1E-14                                  | 4.3E-14                                     |
| ENE            | 25000                | U-235   | 9.4E-09                          | 1.7E-15                                  | 1.7E-15                                  | 3.4E-15                                     |
| ENE            | 25000                | U-236   | 3.8E-10                          | 6.8E-17                                  | 6.8E-17                                  | 1.4E-16                                     |
| ENE            | 25000                | U-238   | 1.1E-06                          | 2.0E-13                                  | 2.0E-13                                  | 4.0E-13                                     |
| ENE            | 35000                | U-234   | 7.3E-08                          | 1.3E-14                                  | 1.5E-14                                  | 2.8E-14                                     |
| ENE            | 35000                | U-235   | 5.8E-09                          | 1.0E-15                                  | 1.2E-15                                  | 2.2E-15                                     |
| ENE            | 35000                | U-236   | 2.3E-10                          | 4.2E-17                                  | 4.7E-17                                  | 8.9E-17                                     |
| ENE            | 35000                | U-238   | 6.9E-07                          | 1.2E-13                                  | 1.4E-13                                  | 2.6E-13                                     |
| ENE            | 45000                | U-234   | 5.0E-08                          | 9.0E-15                                  | 1.1E-14                                  | 2.0E-14                                     |
| ENE            | 45000                | U-235   | 4.0E-09                          | 7.1E-16                                  | 8.8E-16                                  | 1.6E-15                                     |
| ENE            | 45000                | U-236   | 1.6E-10                          | 2.9E-17                                  | 3.6E-17                                  | 6.4E-17                                     |
| ENE            | 45000                | U-238   | 4.7E-07                          | 8.5E-14                                  | 1.0E-13                                  | 1.9E-13                                     |
| ENE            | 55000                | U-234   | 3.6E-08                          | 6.5E-15                                  | 8.8E-15                                  | 1.5E-14                                     |
| ENE            | 55000                | U-235   | 2.8E-09                          | 5.1E-16                                  | 6.9E-16                                  | 1.2E-15                                     |
| ENE            | 55000                | U-236   | 1.1E-10                          | 2.1E-17                                  | 2.8E-17                                  | 4.9E-17                                     |
| ENE            | 55000                | U-238   | 3.4E-07                          | 6.0E-14                                  | 8.2E-14                                  | 1.4E-13                                     |
| ENE            | 70000                | U-234   | 2.2E-08                          | 4.0E-15                                  | 6.5E-15                                  | 1.0E-14                                     |
| ENE            | 70000                | U-235   | 1.7E-09                          | 3.1E-16                                  | 5.1E-16                                  | 8.2E-16                                     |
| ENE            | 70000                | U-236   | 7.0E-11                          | 1.3E-17                                  | 2.1E-17                                  | 3.3E-17                                     |
| ENE            | 70000                | U-238   | 2.1E-07                          | 3.7E-14                                  | 6.0E-14                                  | 9.8E-14                                     |
| NE             | 310                  | U-234   | 5.1E-05                          | 9.2E-12                                  | 2.1E-12                                  | 1.1E-11                                     |
| NE             | 310                  | U-235   | 6.3E-06                          | 1.1E-12                                  | 1.6E-13                                  | 1.3E-12                                     |
| NE             | 310                  | U-236   | 2.5E-07                          | 4.6E-14                                  | 6.6E-15                                  | 5.2E-14                                     |
| NE             | 310                  | U-238   | 7.3E-04                          | 1.3E-10                                  | 1.9E-11                                  | 1.5E-10                                     |
| NE             | 810                  | U-234   | 1.9E-05                          | 3.5E-12                                  | 7.8E-13                                  | 4.2E-12                                     |
| NE             | 810                  | U-235   | 1.8E-06                          | 3.3E-13                                  | 6.2E-14                                  | 3.9E-13                                     |
| NE             | 810                  | U-236   | 7.4E-08                          | 1.3E-14                                  | 2.5E-15                                  | 1.6E-14                                     |
| NE             | 810                  | U-238   | 2.1E-04                          | 3.9E-11                                  | 7.4E-12                                  | 4.6E-11                                     |
| NE             | 1500                 | U-234   | 8.3E-06                          | 1.5E-12                                  | 4.2E-13                                  | 1.9E-12                                     |
| NE             | 1500                 | U-235   | 7.2E-07                          | 1.3E-13                                  | 3.3E-14                                  | 1.6E-13                                     |
| NE             | 1500                 | U-236   | 2.9E-08                          | 5.3E-15                                  | 1.3E-15                                  | 6.6E-15                                     |
| NE             | 1500                 | U-238   | 8.5E-05                          | 1.5E-11                                  | 3.9E-12                                  | 1.9E-11                                     |
| NE             | 2500                 | U-234   | 3.9E-06                          | 7.0E-13                                  | 2.5E-13                                  | 9.5E-13                                     |
| NE             | 2500                 | U-235   | 3.2E-07                          | 5.8E-14                                  | 2.0E-14                                  | 7.8E-14                                     |
| NE             | 2500                 | U-236   | 1.3E-08                          | 2.3E-15                                  | 7.9E-16                                  | 3.1E-15                                     |
| NE             | 2500                 | U-238   | 3.8E-05                          | 6.8E-12                                  | 2.3E-12                                  | 9.2E-12                                     |
| NE             | 3500                 | U-234   | 2.3E-06                          | 4.2E-13                                  | 1.8E-13                                  | 6.0E-13                                     |
| NE             | 3500                 | U-235   | 1.9E-07                          | 3.4E-14                                  | 1.4E-14                                  | 4.8E-14                                     |
| NE             | 3500                 | U-236   | 7.7E-09                          | 1.4E-15                                  | 5.6E-16                                  | 2.0E-15                                     |
| NE             | 3500                 | U-238   | 2.3E-05                          | 4.1E-12                                  | 1.6E-12                                  | 5.7E-12                                     |
| NE             | 4500                 | U-234   | 1.6E-06                          | 2.9E-13                                  | 1.4E-13                                  | 4.3E-13                                     |
| NE             | 4500                 | U-235   | 1.3E-07                          | 2.4E-14                                  | 1.1E-14                                  | 3.4E-14                                     |
| NE             | 4500                 | U-236   | 5.3E-09                          | 9.6E-16                                  | 4.3E-16                                  | 1.4E-15                                     |
| NE             | 4500                 | U-238   | 1.6E-05                          | 2.8E-12                                  | 1.3E-12                                  | 4.1E-12                                     |

ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind<br>Toward | Distance<br>(meters) | Nuclide | Air<br>Concentration<br>(pCi/m3) | Dry<br>Deposition<br>Rate<br>(pCi/cm2/s) | Wet<br>Deposition<br>Rate<br>(pCi/cm2/s) | Ground<br>Deposition<br>Rate<br>(pCi/cm2/s) |
|----------------|----------------------|---------|----------------------------------|--|--|---|
| NE             | 7500                 | U-234   | 7.6E-07                          | 1.4E-13                                  | 8.0E-14                                  | 2.2E-13                                     |
| NE             | 7500                 | U-235   | 6.1E-08                          | 1.1E-14                                  | 6.3E-15                                  | 1.7E-14                                     |
| NE             | 7500                 | U-236   | 2.5E-09                          | 4.4E-16                                  | 2.5E-16                                  | 7.0E-16                                     |
| NE             | 7500                 | U-238   | 7.2E-06                          | 1.3E-12                                  | 7.4E-13                                  | 2.0E-12                                     |
| NE             | 15000                | U-234   | 2.8E-07                          | 5.0E-14                                  | 3.8E-14                                  | 8.8E-14                                     |
| NE             | 15000                | U-235   | 2.2E-08                          | 4.0E-15                                  | 3.0E-15                                  | 7.0E-15                                     |
| NE             | 15000                | U-236   | 8.9E-10                          | 1.6E-16                                  | 1.2E-16                                  | 2.8E-16                                     |
| NE             | 15000                | U-238   | 2.6E-06                          | 4.7E-13                                  | 3.6E-13                                  | 8.3E-13                                     |
| NE             | 25000                | U-234   | 1.3E-07                          | 2.3E-14                                  | 2.1E-14                                  | 4.4E-14                                     |
| NE             | 25000                | U-235   | 1.0E-08                          | 1.8E-15                                  | 1.7E-15                                  | 3.5E-15                                     |
| NE             | 25000                | U-236   | 4.0E-10                          | 7.2E-17                                  | 6.8E-17                                  | 1.4E-16                                     |
| NE             | 25000                | U-238   | 1.2E-06                          | 2.1E-13                                  | 2.0E-13                                  | 4.1E-13                                     |
| NE             | 35000                | U-234   | 7.8E-08                          | 1.4E-14                                  | 1.5E-14                                  | 2.9E-14                                     |
| NE             | 35000                | U-235   | 6.1E-09                          | 1.1E-15                                  | 1.2E-15                                  | 2.3E-15                                     |
| NE             | 35000                | U-236   | 2.5E-10                          | 4.5E-17                                  | 4.7E-17                                  | 9.2E-17                                     |
| NE             | 35000                | U-238   | 7.3E-07                          | 1.3E-13                                  | 1.4E-13                                  | 2.7E-13                                     |
| NE             | 45000                | U-234   | 5.3E-08                          | 9.6E-15                                  | 1.1E-14                                  | 2.1E-14                                     |
| NE             | 45000                | U-235   | 4.2E-09                          | 7.6E-16                                  | 8.8E-16                                  | 1.6E-15                                     |
| NE             | 45000                | U-236   | 1.7E-10                          | 3.1E-17                                  | 3.6E-17                                  | 6.6E-17                                     |
| NE             | 45000                | U-238   | 5.0E-07                          | 9.0E-14                                  | 1.0E-13                                  | 1.9E-13                                     |
| NE             | 55000                | U-234   | 3.8E-08                          | 6.8E-15                                  | 8.8E-15                                  | 1.6E-14                                     |
| NE             | 55000                | U-235   | 3.0E-09                          | 5.4E-16                                  | 6.9E-16                                  | 1.2E-15                                     |
| NE             | 55000                | U-236   | 1.2E-10                          | 2.2E-17                                  | 2.8E-17                                  | 5.0E-17                                     |
| NE             | 55000                | U-238   | 3.6E-07                          | 6.4E-14                                  | 8.2E-14                                  | 1.5E-13                                     |
| NE             | 70000                | U-234   | 2.3E-08                          | 4.2E-15                                  | 6.4E-15                                  | 1.1E-14                                     |
| NE             | 70000                | U-235   | 1.8E-09                          | 3.3E-16                                  | 5.0E-16                                  | 8.3E-16                                     |
| NE             | 70000                | U-236   | 7.4E-11                          | 1.3E-17                                  | 2.0E-17                                  | 3.4E-17                                     |
| NE             | 70000                | U-238   | 2.2E-07                          | 3.9E-14                                  | 6.0E-14                                  | 9.9E-14                                     |
| NNE            | 310                  | U-234   | 6.4E-05                          | 1.2E-11                                  | 2.9E-12                                  | 1.4E-11                                     |
| NNE            | 310                  | U-235   | 8.0E-06                          | 1.4E-12                                  | 2.3E-13                                  | 1.7E-12                                     |
| NNE            | 310                  | U-236   | 3.2E-07                          | 5.8E-14                                  | 9.3E-15                                  | 6.7E-14                                     |
| NNE            | 310                  | U-238   | 9.3E-04                          | 1.7E-10                                  | 2.7E-11                                  | 1.9E-10                                     |
| NNE            | 810                  | U-234   | 2.6E-05                          | 4.7E-12                                  | 1.1E-12                                  | 5.8E-12                                     |
| NNE            | 810                  | U-235   | 2.7E-06                          | 4.8E-13                                  | 8.7E-14                                  | 5.7E-13                                     |
| NNE            | 810                  | U-236   | 1.1E-07                          | 2.0E-14                                  | 3.5E-15                                  | 2.3E-14                                     |
| NNE            | 810                  | U-238   | 3.1E-04                          | 5.6E-11                                  | 1.0E-11                                  | 6.6E-11                                     |
| NNE            | 1500                 | U-234   | 1.2E-05                          | 2.2E-12                                  | 5.9E-13                                  | 2.8E-12                                     |
| NNE            | 1500                 | U-235   | 1.1E-06                          | 2.0E-13                                  | 4.7E-14                                  | 2.4E-13                                     |
| NNE            | 1500                 | U-236   | 4.5E-08                          | 8.0E-15                                  | 1.9E-15                                  | 9.9E-15                                     |
| NNE            | 1500                 | U-238   | 1.3E-04                          | 2.3E-11                                  | 5.5E-12                                  | 2.9E-11                                     |
| NNE            | 2500                 | U-234   | 5.9E-06                          | 1.1E-12                                  | 3.5E-13                                  | 1.4E-12                                     |
| NNE            | 2500                 | U-235   | 5.0E-07                          | 9.0E-14                                  | 2.8E-14                                  | 1.2E-13                                     |
| NNE            | 2500                 | U-236   | 2.0E-08                          | 3.6E-15                                  | 1.1E-15                                  | 4.8E-15                                     |
| NNE            | 2500                 | U-238   | 5.9E-05                          | 1.1E-11                                  | 3.3E-12                                  | 1.4E-11                                     |
| NNE            | 3500                 | U-234   | 3.6E-06                          | 6.5E-13                                  | 2.5E-13                                  | 9.0E-13                                     |
| NNE            | 3500                 | U-235   | 3.0E-07                          | 5.4E-14                                  | 1.9E-14                                  | 7.3E-14                                     |
| NNE            | 3500                 | U-236   | 1.2E-08                          | 2.2E-15                                  | 7.9E-16                                  | 3.0E-15                                     |

ESTIMATED RADIONUCLIDE CONCENTRATIONS  
AT VARIOUS LOCATIONS IN THE ENVIRONMENT

| Wind<br>Toward | Distance<br>(meters) | Nuclide | Air<br>Concentration<br>(pCi/m3) | Dry<br>Deposition<br>Rate<br>(pCi/cm2/s) | Wet<br>Deposition<br>Rate<br>(pCi/cm2/s) | Ground<br>Deposition<br>Rate<br>(pCi/cm2/s) |
|----------------|----------------------|---------|----------------------------------|--|--|---|
| NNE            | 3500                 | U-238   | 3.5E-05                          | 6.3E-12                                  | 2.3E-12                                  | 8.6E-12                                     |
| NNE            | 4500                 | U-234   | 2.5E-06                          | 4.5E-13                                  | 1.9E-13                                  | 6.4E-13                                     |
| NNE            | 4500                 | U-235   | 2.1E-07                          | 3.7E-14                                  | 1.5E-14                                  | 5.2E-14                                     |
| NNE            | 4500                 | U-236   | 8.4E-09                          | 1.5E-15                                  | 6.0E-16                                  | 2.1E-15                                     |
| NNE            | 4500                 | U-238   | 2.4E-05                          | 4.4E-12                                  | 1.8E-12                                  | 6.2E-12                                     |
| NNE            | 7500                 | U-234   | 1.2E-06                          | 2.2E-13                                  | 1.1E-13                                  | 3.3E-13                                     |
| NNE            | 7500                 | U-235   | 9.6E-08                          | 1.7E-14                                  | 8.7E-15                                  | 2.6E-14                                     |
| NNE            | 7500                 | U-236   | 3.9E-09                          | 7.0E-16                                  | 3.5E-16                                  | 1.1E-15                                     |
| NNE            | 7500                 | U-238   | 1.1E-05                          | 2.1E-12                                  | 1.0E-12                                  | 3.1E-12                                     |
| NNE            | 15000                | U-234   | 4.5E-07                          | 8.1E-14                                  | 5.3E-14                                  | 1.3E-13                                     |
| NNE            | 15000                | U-235   | 3.6E-08                          | 6.4E-15                                  | 4.2E-15                                  | 1.1E-14                                     |
| NNE            | 15000                | U-236   | 1.4E-09                          | 2.6E-16                                  | 1.7E-16                                  | 4.3E-16                                     |
| NNE            | 15000                | U-238   | 4.2E-06                          | 7.6E-13                                  | 4.9E-13                                  | 1.3E-12                                     |
| NNE            | 25000                | U-234   | 2.0E-07                          | 3.7E-14                                  | 2.9E-14                                  | 6.6E-14                                     |
| NNE            | 25000                | U-235   | 1.6E-08                          | 2.9E-15                                  | 2.3E-15                                  | 5.2E-15                                     |
| NNE            | 25000                | U-236   | 6.5E-10                          | 1.2E-16                                  | 9.3E-17                                  | 2.1E-16                                     |
| NNE            | 25000                | U-238   | 1.9E-06                          | 3.5E-13                                  | 2.7E-13                                  | 6.2E-13                                     |
| NNE            | 35000                | U-234   | 1.3E-07                          | 2.3E-14                                  | 2.0E-14                                  | 4.3E-14                                     |
| NNE            | 35000                | U-235   | 1.0E-08                          | 1.8E-15                                  | 1.6E-15                                  | 3.4E-15                                     |
| NNE            | 35000                | U-236   | 4.1E-10                          | 7.3E-17                                  | 6.4E-17                                  | 1.4E-16                                     |
| NNE            | 35000                | U-238   | 1.2E-06                          | 2.2E-13                                  | 1.9E-13                                  | 4.1E-13                                     |
| NNE            | 45000                | U-234   | 8.8E-08                          | 1.6E-14                                  | 1.5E-14                                  | 3.1E-14                                     |
| NNE            | 45000                | U-235   | 7.0E-09                          | 1.3E-15                                  | 1.2E-15                                  | 2.4E-15                                     |
| NNE            | 45000                | U-236   | 2.8E-10                          | 5.1E-17                                  | 4.8E-17                                  | 9.9E-17                                     |
| NNE            | 45000                | U-238   | 8.3E-07                          | 1.5E-13                                  | 1.4E-13                                  | 2.9E-13                                     |
| NNE            | 55000                | U-234   | 6.3E-08                          | 1.1E-14                                  | 1.2E-14                                  | 2.3E-14                                     |
| NNE            | 55000                | U-235   | 5.0E-09                          | 8.9E-16                                  | 9.3E-16                                  | 1.8E-15                                     |
| NNE            | 55000                | U-236   | 2.0E-10                          | 3.6E-17                                  | 3.8E-17                                  | 7.4E-17                                     |
| NNE            | 55000                | U-238   | 5.9E-07                          | 1.1E-13                                  | 1.1E-13                                  | 2.2E-13                                     |
| NNE            | 70000                | U-234   | 3.7E-08                          | 6.7E-15                                  | 8.5E-15                                  | 1.5E-14                                     |
| NNE            | 70000                | U-235   | 2.9E-09                          | 5.2E-16                                  | 6.7E-16                                  | 1.2E-15                                     |
| NNE            | 70000                | U-236   | 1.2E-10                          | 2.1E-17                                  | 2.7E-17                                  | 4.8E-17                                     |
| NNE            | 70000                | U-238   | 3.5E-07                          | 6.2E-14                                  | 7.9E-14                                  | 1.4E-13                                     |



13.2.7 Chi/Q Tables

C A P 8 8 - P C

Version 2.00

Clean Air Act Assessment Package - 1988

C H I / Q T A B L E S

Non-Radon Population Assessment

Mar 19, 2000 05:10 pm

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 19, 2000 05:10 pm

Wind File: C:\CAP88PC2\WINDFILES\ERIEPA.WND

Population File: C:\CAPBBPC2\POPFILES\RMIA SHTA.POP

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

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| 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) |           |           |           |           |           |           |
|-------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| 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)

| Distance (meters) |           |           |           |           |           |           |           |
|-------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 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 | 7.037E-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               | 2.902E-06 | 9.027E-07 | 3.617E-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-03 |
| NNE               | 5.707E-06 | 1.903E-06 | 7.819E-07 | 3.547E-07 | 2.122E-07 | 1.468E-07 | 6.847E-08 |

| Distance (meters) |           |           |           |           |           |           |
|-------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| 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 |

GROUND-LEVEL CHI/Q VALUES FOR U-236  
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   | 1.269E-05 | 5.274E-06 | 2.288E-06 | 1.055E-06 | 6.338E-07 | 4.396E-07 | 2.050E-07 |
| NNW | 3.648E-06 | 1.309E-06 | 5.527E-07 | 2.521E-07 | 1.507E-07 | 1.041E-07 | 4.817E-08 |
| NW  | 1.621E-06 | 7.053E-07 | 3.132E-07 | 1.449E-07 | 8.691E-08 | 6.003E-08 | 2.766E-08 |
| WNW | 1.360E-06 | 6.943E-07 | 3.173E-07 | 1.481E-07 | 8.900E-08 | 6.154E-08 | 2.832E-08 |
| W   | 2.167E-06 | 9.513E-07 | 4.180E-07 | 1.930E-07 | 1.158E-07 | 8.009E-08 | 3.704E-08 |
| WSW | 2.899E-06 | 9.073E-07 | 3.638E-07 | 1.630E-07 | 9.690E-08 | 6.680E-08 | 3.095E-08 |
| SW  | 3.324E-06 | 8.869E-07 | 3.377E-07 | 1.483E-07 | 8.738E-08 | 5.991E-08 | 2.759E-08 |
| SSW | 2.089E-06 | 5.616E-07 | 2.160E-07 | 9.502E-08 | 5.594E-08 | 3.828E-08 | 1.756E-08 |
| S   | 3.673E-06 | 9.357E-07 | 3.545E-07 | 1.545E-07 | 9.036E-08 | 6.149E-08 | 2.805E-08 |
| SSE | 2.820E-06 | 7.057E-07 | 2.649E-07 | 1.151E-07 | 6.722E-08 | 4.573E-08 | 2.095E-08 |
| SE  | 2.927E-06 | 7.199E-07 | 2.692E-07 | 1.168E-07 | 6.814E-08 | 4.631E-08 | 2.112E-08 |
| ESE | 4.057E-06 | 9.981E-07 | 3.740E-07 | 1.626E-07 | 9.515E-08 | 6.482E-08 | 2.960E-08 |
| E   | 6.108E-06 | 1.478E-06 | 5.457E-07 | 2.366E-07 | 1.386E-07 | 9.461E-08 | 4.337E-08 |
| ENE | 4.468E-06 | 1.259E-06 | 4.906E-07 | 2.176E-07 | 1.288E-07 | 8.852E-08 | 4.089E-08 |
| NE  | 4.490E-06 | 1.309E-06 | 5.152E-07 | 2.294E-07 | 1.360E-07 | 9.358E-08 | 4.327E-08 |
| NNE | 5.674E-06 | 1.912E-06 | 7.868E-07 | 3.563E-07 | 2.129E-07 | 1.472E-07 | 6.860E-08 |

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Distance (meters)

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| Dir | 15000     | 25000     | 35000     | 45000     | 55000     | 70000     |
|-----|-----------|-----------|-----------|-----------|-----------|-----------|
| N   | 7.675E-08 | 3.426E-08 | 2.151E-08 | 1.480E-08 | 1.041E-08 | 5.817E-09 |
| NNW | 1.766E-08 | 7.746E-09 | 4.796E-09 | 3.267E-09 | 2.288E-09 | 1.298E-09 |
| NW  | 1.015E-08 | 4.323E-09 | 2.675E-09 | 1.808E-09 | 1.241E-09 | 6.531E-10 |
| WNW | 1.042E-08 | 4.378E-09 | 2.710E-09 | 1.826E-09 | 1.241E-09 | 6.299E-10 |
| W   | 1.370E-08 | 5.943E-09 | 3.695E-09 | 2.512E-09 | 1.736E-09 | 9.290E-10 |
| WSW | 1.134E-08 | 5.141E-09 | 3.189E-09 | 2.187E-09 | 1.555E-09 | 9.311E-10 |
| SW  | 9.918E-09 | 4.546E-09 | 2.796E-09 | 1.916E-09 | 1.377E-09 | 8.682E-10 |
| SSW | 6.280E-09 | 2.847E-09 | 1.750E-09 | 1.196E-09 | 8.563E-10 | 5.305E-10 |
| S   | 9.985E-09 | 4.527E-09 | 2.785E-09 | 1.906E-09 | 1.367E-09 | 8.575E-10 |
| SSE | 7.528E-09 | 3.462E-09 | 2.140E-09 | 1.473E-09 | 1.064E-09 | 6.762E-10 |
| SE  | 7.492E-09 | 3.411E-09 | 2.093E-09 | 1.433E-09 | 1.031E-09 | 6.580E-10 |
| ESE | 1.043E-08 | 4.715E-09 | 2.875E-09 | 1.961E-09 | 1.410E-09 | 8.992E-10 |
| E   | 1.528E-08 | 7.002E-09 | 4.262E-09 | 2.911E-09 | 2.108E-09 | 1.377E-09 |
| ENE | 1.477E-08 | 6.692E-09 | 4.116E-09 | 2.815E-09 | 2.012E-09 | 1.241E-09 |
| NE  | 1.570E-08 | 7.090E-09 | 4.368E-09 | 2.986E-09 | 2.128E-09 | 1.300E-09 |
| NNE | 2.541E-08 | 1.153E-08 | 7.193E-09 | 4.952E-09 | 3.525E-09 | 2.073E-09 |

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GROUND-LEVEL CHI/Q VALUES FOR U-238  
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   | 1.266E-05 | 5.126E-06 | 2.234E-06 | 1.039E-06 | 6.269E-07 | 4.357E-07 | 2.039E-07 |
| NNW | 3.597E-06 | 1.278E-06 | 5.411E-07 | 2.487E-07 | 1.492E-07 | 1.033E-07 | 4.795E-08 |
| NW  | 1.629E-06 | 6.860E-07 | 3.051E-07 | 1.425E-07 | 8.584E-08 | 5.944E-08 | 2.750E-08 |
| WNW | 1.384E-06 | 6.738E-07 | 3.083E-07 | 1.454E-07 | 8.782E-08 | 6.088E-08 | 2.814E-08 |
| W   | 2.170E-06 | 9.242E-07 | 4.076E-07 | 1.899E-07 | 1.144E-07 | 7.934E-08 | 3.684E-08 |
| WSW | 2.827E-06 | 8.875E-07 | 3.578E-07 | 1.614E-07 | 9.618E-08 | 6.640E-08 | 3.084E-08 |
| SW  | 3.218E-06 | 8.715E-07 | 3.338E-07 | 1.473E-07 | 8.694E-08 | 5.967E-08 | 2.753E-08 |
| SSW | 2.029E-06 | 5.517E-07 | 2.132E-07 | 9.426E-08 | 5.562E-08 | 3.810E-08 | 1.751E-08 |
| S   | 3.572E-06 | 9.207E-07 | 3.502E-07 | 1.533E-07 | 8.985E-08 | 6.121E-08 | 2.798E-08 |
| SSE | 2.742E-06 | 6.947E-07 | 2.619E-07 | 1.142E-07 | 6.687E-08 | 4.554E-08 | 2.090E-08 |
| SE  | 2.842E-06 | 7.093E-07 | 2.663E-07 | 1.160E-07 | 6.780E-08 | 4.613E-08 | 2.107E-08 |
| ESE | 3.935E-06 | 9.836E-07 | 3.701E-07 | 1.616E-07 | 9.471E-08 | 6.458E-08 | 2.954E-08 |
| E   | 5.898E-06 | 1.457E-06 | 5.412E-07 | 2.354E-07 | 1.381E-07 | 9.434E-08 | 4.330E-08 |
| ENE | 4.337E-06 | 1.235E-06 | 4.839E-07 | 2.157E-07 | 1.280E-07 | 8.808E-08 | 4.078E-08 |
| NE  | 4.363E-06 | 1.283E-06 | 5.077E-07 | 2.273E-07 | 1.351E-07 | 9.309E-08 | 4.314E-08 |
| NNE | 5.571E-06 | 1.867E-06 | 7.721E-07 | 3.521E-07 | 2.110E-07 | 1.462E-07 | 6.831E-08 |

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Distance (meters)

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| Dir | 15000     | 25000     | 35000     | 45000     | 55000     | 70000     |
|-----|-----------|-----------|-----------|-----------|-----------|-----------|
| N   | 7.652E-08 | 3.423E-08 | 2.150E-08 | 1.479E-08 | 1.041E-08 | 5.830E-09 |
| NNW | 1.762E-08 | 7.743E-09 | 4.795E-09 | 3.268E-09 | 2.289E-09 | 1.301E-09 |
| NW  | 1.012E-08 | 4.321E-09 | 2.675E-09 | 1.809E-09 | 1.242E-09 | 6.553E-10 |
| WNW | 1.038E-08 | 4.377E-09 | 2.711E-09 | 1.827E-09 | 1.241E-09 | 6.323E-10 |
| W   | 1.366E-08 | 5.939E-09 | 3.695E-09 | 2.512E-09 | 1.737E-09 | 9.317E-10 |
| WSW | 1.132E-08 | 5.138E-09 | 3.188E-09 | 2.187E-09 | 1.555E-09 | 9.324E-10 |
| SW  | 9.905E-09 | 4.544E-09 | 2.795E-09 | 1.915E-09 | 1.377E-09 | 8.689E-10 |
| SSW | 6.271E-09 | 2.846E-09 | 1.749E-09 | 1.196E-09 | 8.563E-10 | 5.311E-10 |
| S   | 9.972E-09 | 4.526E-09 | 2.785E-09 | 1.906E-09 | 1.367E-09 | 8.585E-10 |
| SSE | 7.518E-09 | 3.461E-09 | 2.140E-09 | 1.473E-09 | 1.064E-09 | 6.769E-10 |
| SE  | 7.483E-09 | 3.410E-09 | 2.093E-09 | 1.433E-09 | 1.032E-09 | 6.586E-10 |
| ESE | 1.042E-08 | 4.714E-09 | 2.875E-09 | 1.961E-09 | 1.410E-09 | 9.000E-10 |
| E   | 1.527E-08 | 7.000E-09 | 4.262E-09 | 2.911E-09 | 2.108E-09 | 1.378E-09 |
| ENE | 1.475E-08 | 6.689E-09 | 4.115E-09 | 2.814E-09 | 2.012E-09 | 1.242E-09 |
| NE  | 1.567E-08 | 7.087E-09 | 4.367E-09 | 2.986E-09 | 2.129E-09 | 1.302E-09 |
| NNE | 2.535E-08 | 1.152E-08 | 7.189E-09 | 4.950E-09 | 3.524E-09 | 2.076E-09 |

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## CHAPTER 14

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## 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  |         |         |        |        |        |

## Appendix B

### 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 0.000080.000660.000000.000000.000000.000000
 NNE     A 0.000160.000330.000000.000000.000000.000000
  NE     A 0.000160.000160.000000.000000.000000.000000
 ENE    A 0.000080.000000.000000.000000.000000.000000
  E     A 0.000000.000000.000000.000000.000000.000000
 ESE    A 0.000000.000000.000000.000000.000000.000000
  SE     A 0.000160.000160.000000.000000.000000.000000
 SSE    A 0.000410.000490.000000.000000.000000.000000
  S     A 0.000160.000330.000000.000000.000000.000000
 SSW    A 0.000330.000410.000000.000000.000000.000000
  SW    A 0.000740.000410.000000.000000.000000.000000
 WSW    A 0.000570.000410.000000.000000.000000.000000
  W     A 0.000570.001070.000000.000000.000000.000000
 WNW    A 0.000330.000330.000000.000000.000000.000000
  NW    A 0.000330.000570.000000.000000.000000.000000
 NNW    A 0.000160.000490.000000.000000.000000.000000
  N     B 0.001860.001390.000250.000000.000000.000000
 NNE    B 0.001800.000820.000000.000000.000000.000000
  NE    B 0.002130.000660.000000.000000.000000.000000
 ENE    B 0.000410.000160.000000.000000.000000.000000
  E     B 0.000410.000160.000000.000000.000000.000000
 ESE    B 0.000330.000820.000080.000000.000000.000000
```

SE B 0.000740.001880.000000.000000.000000.000000  
 SSE B 0.001480.002620.000250.000000.000000.000000  
 S B 0.001560.002460.000080.000000.000000.000000  
 SSW B 0.001230.001720.000160.000000.000000.000000  
 SW B 0.001390.001800.000330.000000.000000.000000  
 WSW B 0.002130.002130.000740.000000.000000.000000  
 W B 0.003120.002300.000160.000000.000000.000000  
 WNW B 0.001880.002460.000330.000000.000000.000000  
 NW B 0.001310.003610.000250.000000.000000.000000  
 NNW B 0.002050.003440.000080.000000.000000.000000  
 N C 0.003440.003280.000900.000080.000000.000000  
 NNE C 0.002620.001480.000080.000000.000000.000000  
 NE C 0.003120.000820.000080.000000.000000.000000  
 ENE C 0.001390.001070.000160.000000.000000.000000  
 E C 0.001070.001310.000250.000000.000000.000000  
 ESE C 0.000570.000820.000900.000000.000000.000000  
 SE C 0.001390.002460.002790.000410.000000.000000  
 SSE C 0.001970.005900.004260.000330.000000.000000  
 S C 0.001390.005740.001880.000330.000000.000000  
 SSW C 0.001390.002790.001310.000080.000000.000000  
 SW C 0.001800.004430.003770.000490.000000.000000  
 WSW C 0.002210.004020.004260.000820.000000.000000  
 W C 0.003940.006310.003360.000330.000000.000000  
 WNW C 0.002700.004840.002380.000080.000000.000000  
 NW C 0.003030.005900.003120.000080.000000.000000  
 NNW C 0.003610.006890.001720.000080.000000.000000  
 N D 0.010000.013360.007300.001070.000000.000000  
 NNE D 0.005570.007300.002870.000250.000080.000000  
 NE D 0.004590.003200.000570.000160.000000.000000  
 ENE D 0.002870.003770.001070.000160.000000.000000  
 E D 0.002210.004430.002460.000660.000000.000000  
 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 0.003770.008120.000250.000000.000000.000000  
ENE E 0.003940.007210.000250.000000.000000.000000  
E E 0.004670.012460.000330.000000.000000.000000  
ESE E 0.003770.007050.001880.000000.000000.000000  
SE E 0.002380.011970.008120.000000.000000.000000  
SSE E 0.002620.009590.004510.000000.000000.000000  
S E 0.002380.007130.002460.000000.000000.000000  
SSW E 0.002460.004260.000980.000000.000000.000000  
SW E 0.002620.003940.002300.000000.000000.000000  
WSW E 0.001390.002790.001800.000000.000000.000000  
W E 0.002790.009020.003610.000000.000000.000000  
WNW E 0.003770.010410.002130.000000.000000.000000  
NW E 0.006480.012620.003440.000000.000000.000000  
NNW E 0.010250.018120.003520.000000.000000.000000  
N F 0.000410.001070.000000.000000.000000.000000  
NNE F 0.000570.001970.000000.000000.000000.000000  
NE F 0.000980.000900.000000.000000.000000.000000  
ENE F 0.000330.002210.000000.000000.000000.000000  
E F 0.001230.001800.000000.000000.000000.000000  
ESE F 0.000660.001480.000000.000000.000000.000000  
SE F 0.000330.000820.000000.000000.000000.000000  
SSE F 0.000080.000490.000000.000000.000000.000000  
S F 0.000160.000250.000000.000000.000000.000000  
SSW F 0.000160.000000.000000.000000.000000.000000  
SW F 0.000000.000080.000000.000000.000000.000000  
WSW F 0.000160.000080.000000.000000.000000.000000  
W F 0.000080.000490.000000.000000.000000.000000  
WNW F 0.000740.001230.000000.000000.000000.000000  
NW F 0.000410.001070.000000.000000.000000.000000  
NNW F 0.000250.001720.000000.000000.000000.000000

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.

| <u>State</u>  | <u>Beef</u> | <u>Milk</u> | <u>Vegetable</u> |
|---------------|-------------|-------------|------------------|
| Alabama       | 1.520E-01   | 7.020E-03   | 4.160E-03        |
| Alaska        | 0.000E+0    | 0.000E+0    | 0.000E+0         |
| Arkansas      | 1.270E-01   | 5.900E-03   | 1.460E-03        |
| Arizona       | 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         | 7.190E-02   | 8.560E-03   | 7.150E-02        |
| Illinois      | 3.330E-01   | 2.160E-02   | 2.800E-02        |
| Indiana       | 3.340E-01   | 2.800E-02   | 2.720E-02        |
| Iowa          | 7.400E-01   | 3.140E-02   | 2.430E-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         | 7.650E-03   | 8.070E-03   | 5.970E-02        |
| Maryland      | 1.090E-01   | 6.110E-02   | 1.110E-02        |
| Massachusetts | 2.900E-02   | 3.130E-02   | 4.960E-03        |
| Michigan      | 7.900E-02   | 3.510E-02   | 1.700E-02        |
| Minnesota     | 1.850E+0    | 4.880E-02   | 3.050E-02        |
| Mississippi   | 1.750E-01   | 8.700E-03   | 1.070E-03        |
| Missouri      | 3.430E-01   | 1.890E-02   | 8.140E-03        |
| Montana       | 7.290E-02   | 9.270E-04   | 8.780E-03        |
| Nebraska      | 3.500E-01   | 8.780E-03   | 2.390E-02        |
| Nevada        | 1.840E-02   | 5.650E-04   | 8.920E-03        |
| New Hampshire | 1.400E-02   | 1.580E-02   | 6.690E-02        |
| New Jersey    | 4.250E-02   | 3.290E-02   | 1.820E-02        |
| New Mexico    | 4.130E-02   | 1.140E-03   | 1.380E-03        |

| <u>State</u>  | <u>Beef</u> | <u>Milk</u> | <u>Vegetable</u> |
|---------------|-------------|-------------|------------------|
| New York      | 5.830E-02   | 8.560E-02   | 1.880E-02        |
| North         |             |             |                  |
| Carolina      | 1.020E-01   | 1.260E-02   | 6.320E-03        |
| North Dakota  | 1.180E-01   | 6.250E-03   | 6.290E-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        |
| 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       | 4.710E-02   | 8.880E-02   | 1.080E-03        |
| Virginia      | 1.310E-01   | 1.840E-02   | 8.700E-03        |
| Washington    | 5.620E-02   | 1.500E-02   | 5.200E-02        |
| West Virginia | 6.230E-02   | 6.000E-03   | 1.160E-03        |
| Wisconsin     | 1.810E-01   | 1.430E-01   | 1.789E-02        |
| 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/St. Pl, 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:

| <u>Organ</u> | <u>Weight</u> |
|--------------|---------------|
| 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:

| <u>Class</u> | <u>VD</u><br><u>m/sec</u> |
|--------------|---------------------------|
| 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\POPFILS 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.     | 0.      | 2435.  | 0.    | 1688.  | 3376.  |
| 3448.   | 7591. | 6999. | 23331. | 187240. | 0.     | 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.     | 2002.   | 0.     | 534.  | 8224.  |        |
| 2252.   | 2388. | 5752. | 7858.  | 140074. | 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.     | 974.  | 1388.  |        |
| 2021.   | 3148. | 5123. | 4351.  | 14935.  | 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.     | 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.     |        |

