NUREG/CR-6210, Supp. 1
PNNL-10496

Computer Codes for Evaluation of Control Room Habitability (HABIT V1.1)

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Innovative Emergency Management

Prepared for
U.S. Nuclear Regulatory Commission

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Manuscript Completed: September 1998
Date Published: October 1998

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Prepared for
Division of Reactor Program Management
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
NRC Job Code J2028

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Abstract

Over the years the U.S. Nuclear Regulatory Commission has developed computational tools for use in evaluation of control room habitability in the event of postulated accidents at nuclear reactors. Five of these tools, which were developed individually, were combined in a single Control Room Habitability software package called HABIT. Advances in understanding of the reactor source terms and changes in regulations have expanded the arena in which two of the codes, TACT5 and CONHAB, may be applied. Consequently, these codes and the HABIT user interface were modified to simplify control room habitability assessments in the current regulatory environment. This report describes the changes made to HABIT, TACT5, and CONHAB. It supplements, but does not replace, the original description of HABIT.

The changes include modifications (1) to permit calculation of doses using updated source term insights from NUREG-1465, *Accident Source Terms for Light-Water Nuclear Power Plants*, (2) to permit calculation of total effective dose equivalent (TEDE) and maximum two-hour dose discussed in recent revisions to 10 CFR Parts 50 and 100, and (3) to limit routine output to doses of interest. In addition, new radionuclide data files were prepared to permit dose calculations using dose factors from Federal Guidance Reports 11 and 12.

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1 Overview of the Control Room Habitability Package (HABIT)

The Control Room Habitability Package (HABIT) is an integrated set of computer codes for use in control room habitability assessments. The codes within HABIT were developed for the U.S. Nuclear Regulatory Commission (NRC) over the years. Stage (1996) modified the codes to permit them to exchange data and developed the user interface that integrates the codes in a common package.

Publication of the updated reactor source terms in *Accident Source Terms for Light-Water Nuclear Power Plants* (NUREG-1465, Soffer et al. 1995) and the recent revisions to 10 CFR Part 100 and 10 CFR Part 50 have expanded the arena in which the HABIT codes, TACT5 and CONHAB, may be applied. HABIT Version 1.1 (HABIT V1.1) can perform all of the functions of HABIT Version 1.0 (HABIT V1.0) and, in addition, it simplifies the data manipulations required to calculate the doses discussed in revisions to 10 CFR Parts 50 and 100 using the updated source term insights outlined in NUREG-1465. Specifically, HABIT V1.1 calculates the total effective dose equivalent (TEDE) and the maximum two-hour dose at the exclusion area boundary in addition to the doses calculated in HABIT V1.0. These calculations have been added to TACT5 and CONHAB without altering the basic computational algorithms of those codes.

This supplement to NUREG/CR-6210 describes changes to HABIT, TACT5, CONHAB, and the files used by the codes. It does not replace NUREG/CR-6210. Appendix A describes the revised radionuclide data file used in HABIT V1.1, and Appendices B through E contain the four radionuclide data files distributed with HABIT V1.1. Appendix F contains worksheets that may be useful in organizing input to the revised versions of TACT5 and CONHAB, and Appendix G contains tables that list and describe the files that are part of HABIT V1.1. Appendix H describes a small utility program included with HABIT V1.1 that may be used to convert TACT5 design files from the HABIT V1.0 format to the HABIT V1.1 format.

HABIT V1.1 also includes a revised version of the EXTRAN code. The changes to EXTRAN are limited to those required to correct an error in implementation of the virtual point source algorithm. Appendix I describes changes to the EXTRAN code and contains comments on the use of EXTRAN.

1.1 History of HABIT V1.1

During the 1970's and 1980's, the NRC developed a series of codes called TACT for Transport of ACTivity. The TACT codes model the transport of radionuclides through a series of compartments (nodes) between the reactor vessel and the environment. Organization of compartments, flows among compartments and between compartments and the environment, and filters and other physical processes that decrease the activity released to the environment are specified in the code input. Ultimately, the TACT codes calculate doses at three locations: the exclusion area boundary, the low population zone boundary, and one other location specified by the user. Typically, this location is the control room air intake. Two versions of these codes were documented. TACT III is described in NUREG/CR-3287 (Killough et al. 1983), and TACT5 is described in NUREG/CR-5108 (West and Gilpin 1988).

In the mid to late 1980's and early 1990's another set of codes was developed for the NRC to supplement TACT5 in control room habitability assessments. These codes included CONHAB and CHEM (Gilpin 1990), EXTRAN (Ramsdell 1991), and FPFP_2 (Owczarski et al. 1991). FPFP_2, which is similar to

the control room. EXTRAN models the dispersion of toxic chemicals in the environment. It combines the release model of Wing (1979) with the puff dispersion model from MESOI (Ramsdell and Athey 1983) and MESORAD (Scherpelz et al. 1986; Ramsdell et al. 1988) to estimate maximum short-term concentrations at the control room air intake. The CONHAB and CHEM codes model the reactor control room; CONHAB is used with TACT5 and FPFP_2, and CHEM is used with EXTRAN. Both CONHAB and CHEM have two filtered and two unfiltered paths and a recirculation path with a filter. HABIT was developed to provide a common user interface for TACT5, FPFP_2, CONHAB, EXTRAN, and CHEM. When HABIT was developed, TACT5 and CONHAB were being used with a source term based on TID-14844 (DiNunno et al. 1962) and assumptions in Regulatory Guides 1.3 and 1.4 (USNRC 1974a and 1974b) to calculate whole body and thyroid doses for comparison with dose criteria set forth in 10 CFR parts 50 and 100. With publication of NUREG-1465 (Soffer et al. 1995) and revision of 10 CFR parts 50 and 100, revision of TACT5, CONHAB, and HABIT to provide additional computational capabilities became desirable. The versions of TACT5 and CONHAB included in HABIT V1.1 facilitate the use of the codes with the updated source term insights.

HABIT V1.1 extends the capabilities of the previous codes to calculation of TEDE, use of the NUREG-1465 source term, and determination of the maximum dose in any two-hour period on the exclusion area boundary. These additional capabilities were achieved without alteration of the basic computational algorithms of TACT5 and CONHAB. However, modifications of the data handling within TACT5 and CONHAB and in the structure some of the files used by the programs were necessary. The most extensive modifications were made to the radionuclide data files. These modifications will not concern casual users of HABIT because radionuclide data files are provided for both the TID-14844 and NUREG-1465 source terms. The new radionuclide data file structure is described in detail in Chapter 2 for those who may want to add radionuclides or otherwise modify a file for a specific application.

Revision of HABIT to extend the computational capabilities of the codes provided an opportunity to revise the code output. It is no longer necessary to sort through a lengthy output file to find the two-hour dose at the exclusion area boundary, the 720-hour dose at the low-population zone boundary, or the dose to control room operators. TACT5 and CONHAB have been revised to include several output options. The available options are described in detail in Appendix A. Regardless of the output selections, each code always produces a file that lists the input and the final doses.

1.2 Document Structure

This supplement consists of an introductory chapter, three chapters that describe the changes to the HABIT code, a chapter that contains sample problems, then the references and the appendices. The introductory chapter contains information on the background of HABIT V1.1, describes installation and execution of the programs, and discusses problems that might arise when the programs are run. It also covers code verification and tests.

The second chapter describes the changes to the HABIT main screen. The most significant change is the addition of control buttons that permit selection of a radionuclide data file and choice of output products. Discussion of the functions of these buttons leads to descriptions of the new radionuclide data format and the output products. Examples of the files' contents are provided.

Chapter 3 describes the changes to TACT5. To a large extent these changes are internal to the computer

Chapter 3 describes the changes to TACT5. To a large extent these changes are internal to the computer programs and do not alter the user interface. Chapter 4 describes the changes to CONHAB. Again, the changes are largely transparent to users.

Chapter 5 contains a set of sample problems. The first three problems are taken from the TACT5 User's Guide (West and Gilpin 1988) and HABIT V1.0 documentation (Stage 1996). These problems provide a link to previous versions of the code. They demonstrate that the computational portions of the codes provide the same results as in earlier versions. The remaining problems demonstrate the use of revised reactor source term and calculation of maximum two-hour doses.

There are nine appendices to this supplement labeled A through I. Appendix A describes the revised radionuclide data file structure; Appendices B through E list the primary radionuclide data files included with HABIT V1.1. Two of the radionuclide data files include the radionuclide-specific information that has historically been used by the staff with TACT5. The other two radionuclide data files contain more recent radionuclide-specific information for use in calculations involving the NUREG-1465 source term. Appendix F contains worksheets that may facilitate collection and organization of data to be used in HABIT V1.1. Appendix G lists the various files included with and created by HABIT V1.1. Appendix H describes a utility program that can convert HABIT V1.0 TACT5 design files to design files used in HABIT V1.1. Appendix I describes a correction to EXTRAN and provides notes related to the use of the code.

1.3 Installing HABIT V1.1

HABIT V1.1 is a suite of MS-DOS programs that run under DOS Version 5.1 and higher. It consists of a user interface, five computational programs, and several supporting files and utility programs. This section describes general features the installation of HABIT V1.1. See the READ_ME file included on the distribution disks for details about transferring the distribution files to your computer.

1.3.1 Computer System Requirements

The HABIT V1.1 computational routines are 32-bit programs that are intended for use on computers having 80486 or pentium processors. They will not run on computers with 16-bit processors (80286 and earlier). See Section 1.5.2 if you have a computer with a 80287 coprocessor.

The user interface for HABIT V1.1 has been designed for a color monitor with at least 800 by 600 pixels. Higher resolution displays may be used.

The HABIT V1.1 program files, including the radionuclide data files and the default design and template files, require about 5.0 megabytes of disk space. The files for Sample Problems 1 through 6 require an additional 7.1 megabytes. The amount of disk space required for case-specific data files depends on the complexity of the problem. For example, the files for Sample Problem 1 (simple TACT5 run) require just over 300 kilobytes of disk space, while the files for Sample Problem 6 (complex TACT5 run followed by CONHAB) require more than 1.4 megabytes.

HABIT V1.1 requires 640 kilobytes of conventional memory. At least 500 kilobytes of conventional memory must be available to HABIT V1.1 at run time. Networked computers having CD-ROM drives with sound may not have sufficient free memory to run HABIT V1.1. Use the DOS MEM command to

determine the amount of free memory. In DOS and Windows 3.1 systems, type MEM at the DOS prompt; in Windows95 systems, type C:\WINDOWS\COMMAND\MEM at the DOS prompt.

Conventional memory may not be sufficient to hold the time-dependent data for a complex problem. If expanded memory is available, HABIT V1.1 will use up to 1.2 megabytes for time-dependent data. See the computer's manuals for instructions on enabling expanded memory.

1.3.2 Installation Procedure

HABIT V1.1 is distributed in a set of self-extracting, compressed files. The files on the distribution disks may be copied to the destination folder (directory) and extracted in place, or they may be extracted directly from the distribution disks. The default directory structure for HABIT V1.1 uses C:\habit11 as the primary folder (directory). This folder contains the program files, several data files, and temporary files created by HABIT.

The HABIT11 folder also contains three folders (subdirectories) with additional files. These folders are DSGNFLS, NFLS, and EXAMPLES. The DSGNFLS folder contains the design files you create and the output files from the computational programs. The NFLS folder contains the files with the radionuclide data. These files all start with the letters mlwr. The EXAMPLES folder contains design files and selected output files for the example problems presented in Chapter 5.

HABIT may be installed directly from the disks or by copying the files from the three disks to the directory or folder where the programs are to reside.

The READ_ME file on the distribution disks contains specific directions for installation of HABIT V1.1 for each operating environment. .

1.3.3 Batch and MLWR.DAT Files

If you do not install HABIT V1.1 in the default folders on drive C:, you must edit the following seven batch files using a standard text editor, such as Edit or Notepad, after the HABIT V1.1 files have been extracted:

- Habit.bat
- Cb.bat
- Ch.bat
- Ex.bat
- Fp.bat
- T5.bat
- Mlwr.dat

A word processing program may also be used to edit the files as long as the files are edited and saved as ASCII files. If you use a word processing program to edit the files, DO NOT SAVE THE FILES IN THE WORD PROCESSOR'S FORMAT AFTER THEY ARE EDITED. If you save the files in the word processor's format they will not function properly.

Batch files

The batch files (Habit.bat, Cb.bat, Ch.bat, Ex.bat, Fp.bat, and T5.bat) are used to give commands to the computer and start execution of programs when requested. These files all contain statements that set the path to the appropriate program. These statements must be modified if you install HABIT V1.1 in a directory other than C:\habit11\. The files also contain statements that ensure that the monitor screen is set to display 50 lines of text. These statements must also be modified.

The statement that sets the path to the programs

```
set exepath=C:\habit11\
```

is in the first section of the batch file. If you do not install HABIT V1.1 in C:\habit11\, you will have to modify this statement to give the correct path. The modification may be as simple as changing the drive specification C:\ to D:\ or E:\, or it may involve entering both a drive specification and directory names.

The statements that set the screen to 50 lines are in the second section of the batch file. As a default, the files assume that HABIT V1.1 will be run under DOS 7.0 distributed with Windows95. If this is not the case, the file must be edited to run with appropriate operating system. The following line in the batch file sets the screen.

```
C:\WINDOWS\COMMAND\mode con lines=50
```

If you are using an operating system other than DOS 7.0, insert a colon at the beginning of the line. Then if you are using an earlier version of DOS, remove the colon at the beginning of the following line:

```
:mode con lines=50
```

If you are using OS-2, remove the colon at the beginning of the line

```
:mode co80,50
```

If you do not set the screen to the 50-line mode, you will not be able to see the bottom of the HABIT screens.

Habit.bat also includes commands to reset the screen to the 25-line mode. If you change the command setting the 50-line mode, you must change command resetting the 25-line mode. These commands are found in the last section of Habit.bat. The procedure for changing the command is the same as for changing the command that sets the 50-line mode.

MLWR.DAT

The MLWR.DAT file contains a list of radionuclide data file names for use in TACT5 and CONHAB. If the files are stored in a directory other than the directory with the HABIT V1.1 program files, the path to the radionuclide data files must be included in the file names. In a default installation of HABIT V1.1, the files will be stored in C:\habit11\nfls\. Edit the path names in the MLWR.DAT file if the radionuclide data files are moved to another location.

1.4 Starting HABIT V1.1

HABIT V1.1 is an MS-DOS program. It will run under DOS 5.1 or later, or in a DOS window in either Windows or Windows95. The method for starting the program depends on the specific operating environment; methods appropriate to the three operating environments listed above are describe in the following paragraphs.

1.4.1 Windows95/98

In Windows 95 and Windows 98, there are several options for running HABIT V1.1. It can be run by clicking on the Start button and then selecting the Run option from the menu that appears. When the Run option is selected, a dialog box will open. Enter the full path to HABIT.BAT in the space following Open: and press enter. It can also be run by opening an MSDOS window, changing directories to the HABIT11 directory and typing HABIT on the command line. However, starting HABIT can be simplified by placing a shortcut to HABIT.BAT on the desktop. Once the shortcut is in place, HABIT can be started by double clicking on the shortcut icon.

To create a shortcut to HABIT.BAT, first open Explorer and go to the HABIT11 folder. Find the HABIT.BAT icon and select it by clicking once with the left button on the mouse. After the HABIT.BAT icon has been selected place the cursor on the HABIT.BAT and click once with the right button on the mouse. A menu will appear after the right button is clicked. Select Create Shortcut on the menu by placing the cursor on Create Shortcut and clicking with the mouse's left button. A file named "Shortcut to Habit.bat" will appear at the bottom of the list of files. Place the cursor on the shortcut icon, click and hold the left button on the mouse then drag the icon to the desktop without

releasing the left button. When the icon is in place on desktop, release the button. Double clicking on the shortcut icon should start HABIT V1.1.

1.4.2 Windows

Windows 3.1 has several methods for running HABIT V1.1. The methods are similar to the methods available in WINDOWS 95 and WINDOWS 98. HABIT may be started using the Run command from the File menu in Program Manager, or by opening a DOS window. It may also be started by double clicking on the program (HABIT.BAT) icon in Program Manager.

1.4.3 DOS

Assuming that you have successfully installed HABIT V1.1 using the installation program that is provided, you should see the prompt:

```
C:\habit11>
```

Now type the word habit following the prompt, and press return. The HABIT V1.1 program should begin. You can also start HABIT V1.1 from any location by typing the full path to the programs following the DOS prompt. For example, if HABIT V1.1 has been installed using the installation program, the command to run HABIT would be

C:\habit11\habit

Alternatively, you can add the path to the directory containing the HABIT code to the PATH command in your AUTOEXEC.BAT file. If you do this, you can start HABIT by typing HABIT without worrying about the current directory.

1.5 Troubleshooting

Section 1.8 of NUREG/CR-6210 discusses the remedies to three problems that might be encountered when trying to run HABIT V1.0 -- Out of Memory, Incorrect Output of Time Steps, and Out of Environment Space. The computational codes in HABIT V1.0 were 16-bit executable codes. The computational portions of HABIT V1.1 have been compiled and linked using Microsoft MS-DOS FORTRAN PowerStation Version 1.0a. The resulting executable codes are not limited to 640 kb address space; they are 32-bit executable codes that can address the full available memory. This change should eliminate some of the memory problems associated with HABIT V1.0. However, the change in FORTRAN compilers has introduced two sources of error not discussed in Section 1.8 of NUREG/CR-6210. These errors are described below.

1.5.1 Missing DOSXMSF.EXE file

The HABIT computational codes include a special version of the Phar Lap MS-DOS extender. They will not run unless the file DOSXMSF.EXE is available to the programs. This file, which is included with HABIT V1.1, is in the same directory as the HABIT computational codes. It may be moved to a directory that is included in the DOS PATH command. If the computational programs do not find the DOSXMSF.EXE file a diagnostic message to that effect will be displayed.

1.5.2 Incompatible Math Coprocessor

The computational codes in HABIT V1.1 expect a 32-bit math coprocessor. Some computers with 80386 and 80486 processors do not have a coprocessor. On these computers, the code will emulate the coprocessor. Other computers combine a 80386 processor with a 80287 math coprocessor. Some of the HABIT V1.1 floating point arithmetic operations will not work correctly on computers that use a 80287 coprocessor.

1.5.3 Insufficient ISAM Buffers

The HABIT V1.1 user interface uses the Indexed Sequential Access Method (ISAM) for storing time-dependent data. Data are stored in buffers during data entry and are written to a data file when data entry is complete. Conventional memory may not be sufficient to hold the time-dependent data for a complex problem. If expanded memory is available, ISAM will use up to 1.2 megabytes for data buffers. If, while entering data, HABIT V1.1 stops and the message that appears indicates that there are insufficient ISAM buffers, it is likely that there is no expanded memory available for HABIT. Refer to your computer operating system or memory management software for instructions on setting up expanded memory.

1.6 Verification and Validation

The modifications to TACT5 and CONHAB in HABIT V1.1 did not include any changes to the fundamental computational algorithms that solve the coupled differential equations. Therefore, the codes should give the same results in HABIT V1.1 as they did in HABIT V1.0 if the input describing a problem is identical. As a check, the example problems in NUREG/CR-5106 (West and Gilpin 1988) and NUREG/CR-6210 (Stage 1996) have been rerun. These problems are included as Sample Problems 1 through 3 in Chapter 5. Some of the results of the computations are included in Chapter 5; the full primary output from TACT5 and CONHAB for these problems is included on the HABIT V1.1 distribution disks. Within the precision of the doses presented in the output files, the results of HABIT V1.1 calculations are identical to the results of the earlier codes.

The development version of HABIT V1.1 has been run in parallel with RADTRAD code being developed for the NRC by Sandia National Laboratory on a series of test problems (Humphreys 1998). Although, the RADTRAD code uses a different method of solving the relevant equations, on 25 test problems, the differences in the computational results were generally less than one percent, and in most cases were ±1 or 2 in the least significant digit. The tests included calculations for single isotopes and mixes of isotopes with and without decay, simulation of filters, simulation of natural deposition, and simulation of sprays. These tests also included comparisons with analytic solutions for simple problems. The results of the tests are included in the RADTRAD documentation..

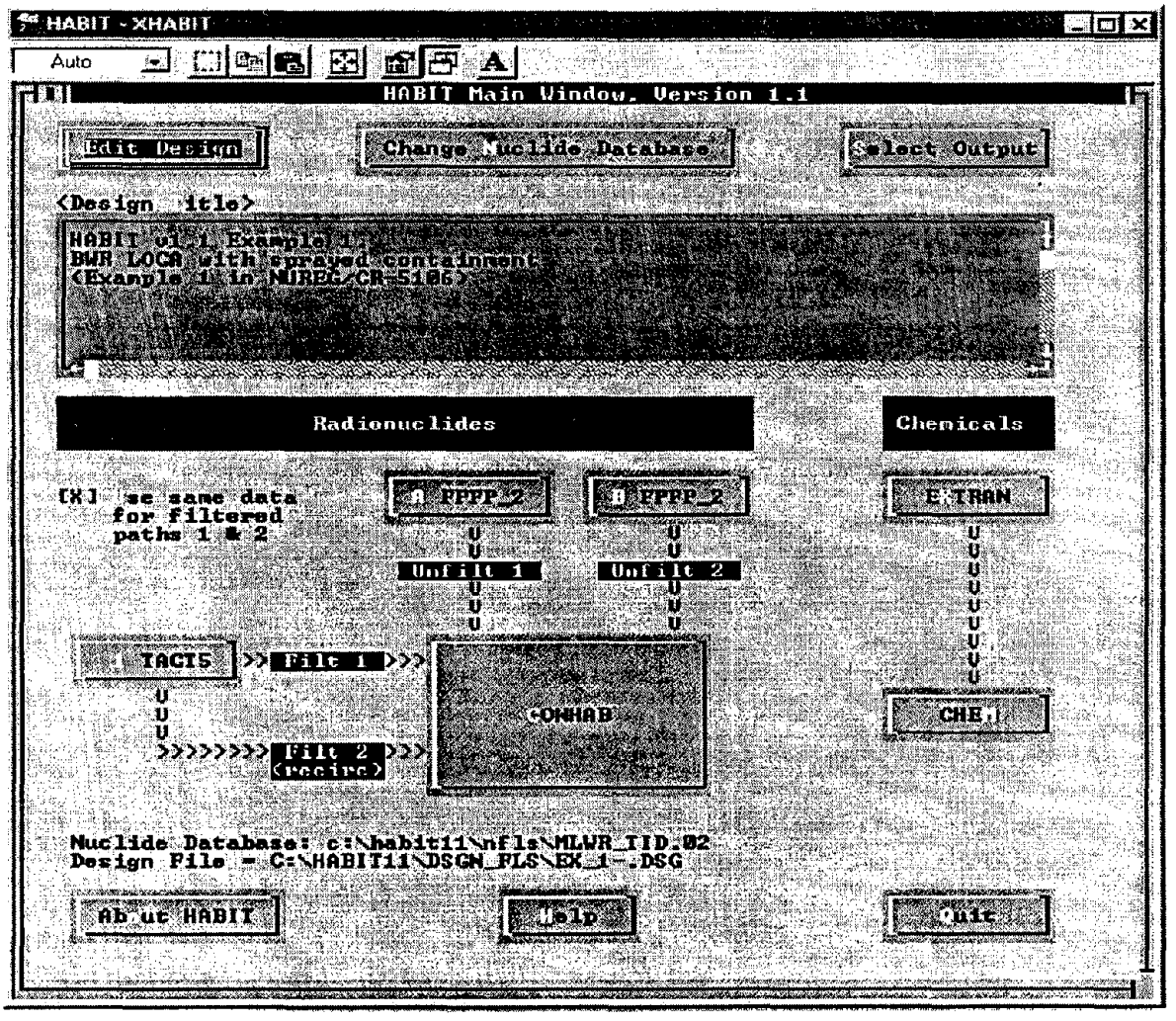
Appendix I describes changes to the EXTRAN code. These changes correct an error made in adaptation of the code for HABIT V1.0 and minor inconsistencies in the EXTRAN algorithms. Following completion of the corrections, the example problems included in NUREG/CR-5656 were rerun using the both version of EXTRAN in HABIT V1.0 and the corrected version included with HABIT V1.1. Results of the calculations are compared in the Appendix.

2 Changes in the HABIT V1.1 User Interface

This chapter describes the changes to the HABIT User Interface. It covers the changes to the main screen and to the method for selecting the radionuclide data files. It also covers the selection of output options.

2.1 The HABIT V1.1 Main Screen

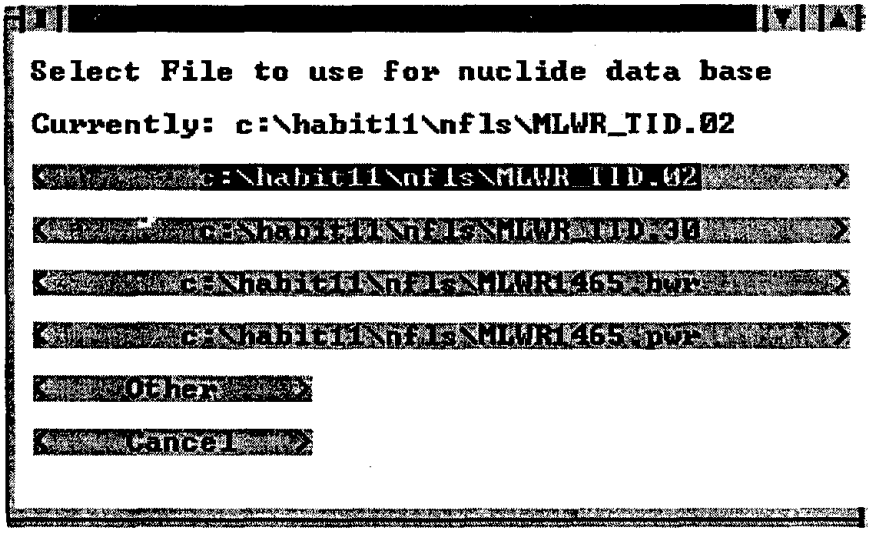
Although there have been relatively major changes in HABIT to produce HABIT V1.1, the changes to the HABIT main window have been relatively minor. Figure 2.1 shows the main window for HABIT V1.1. The changes in the screen are 1) the name indicating that the code is HABIT V1.1, 2) the lines showing design information have been revised and moved to the bottom of the screen, 3) a large button has been added at the top of the window that permits users to change the radionuclide database prior to entering TACT5, and 4) a button has been added at the top of the screen that provides access to the output selection screen. The functions of these buttons are described in detail in the next two sections.



2.2 Radionuclide Data Base Selection

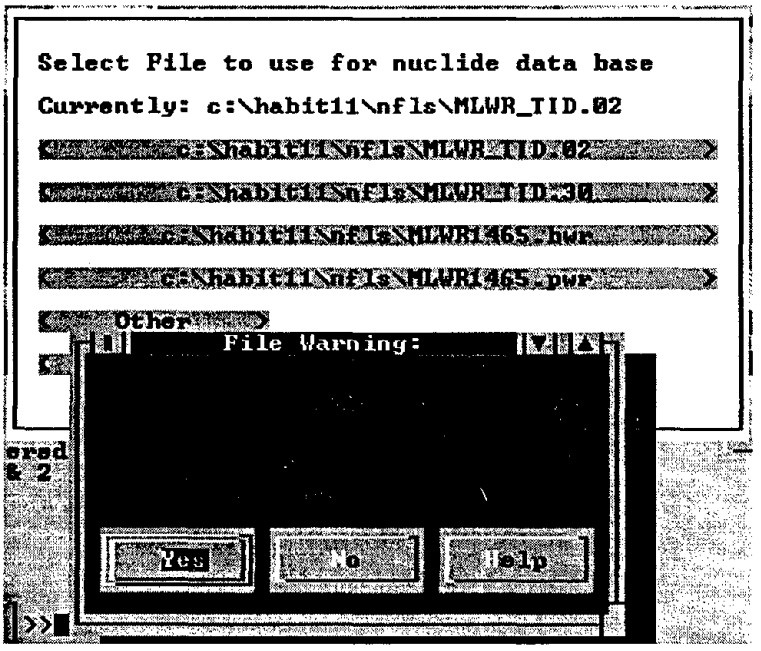
HABIT V1.1 uses a single file to enter all required radionuclide related data. These data include the radionuclide name, chemical group, decay constant, and normalized reactor core activity. The data also include internal and external dose factors, and daughter radionuclides and branching fractions. Four isotope data files are included with HABIT V1.1. These files differ from one another in the groupings of radionuclides, the dose factors and their sources, and the normalized reactor core inventories. The four files and their structure are described in Appendix A.

When the **Change Nuclide Database** button on the HABIT V1.1 main screen is activated, the following screen appears:



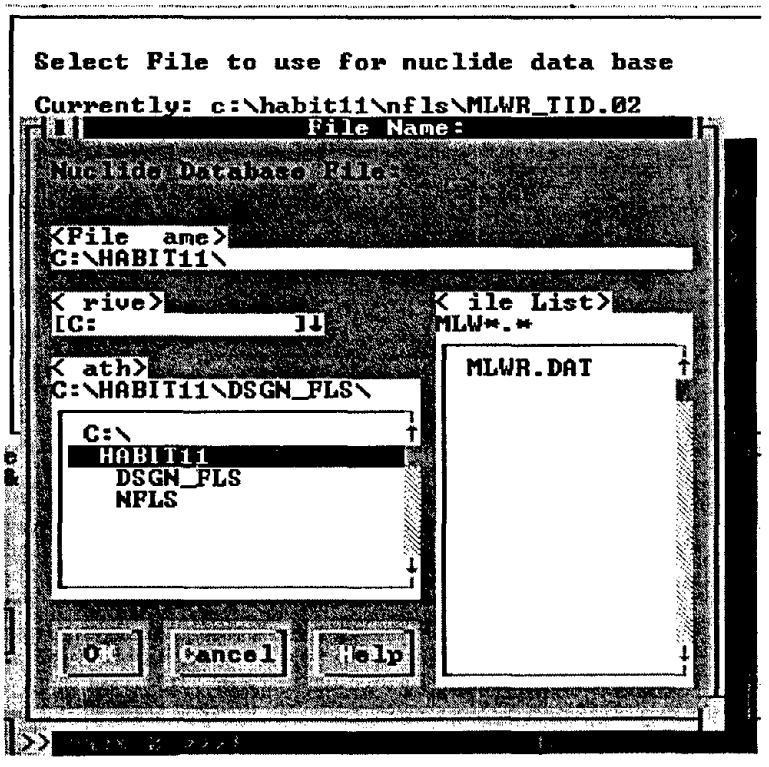
This screen contains the names of the radionuclide data files that are known to HABIT V1.1. Radionuclide data files are made known to HABIT by listing the file name in the MLWR.DAT file, which is read by HABIT V1.1 to determine the isotope data available to the user. The MLWR.DAT file must be located in the directory with the program files. It is an ASCII file that can be edited to add new file names or delete the names of files no longer needed. Whereas the MLWR.DAT file must be located in the directory with the program files, the radionuclide data files may be located in other directories.

The currently selected radionuclide data file is shown at the top of the screen. In this example, the current file is MLWR_TID.02, which is located in the C:\habit11\nfls\ folder. A new file is selected by placing the cursor on the file name and clicking the left mouse button. The following dialog box will appear when you selected the new file.



It requests permission to overwrite the design file. If you click on the **Yes** button, your selection will be made final, and the design file will be updated. If you click on the **No** button, you may select another file.

If **Other** is selected, the following dialog box is opened:



The dialog box permits you to search for radionuclide data files that might be located in other directories. As a default, the box suggests that isotope data file names begin with "MLW." File names with other beginnings may be used. To see all files in a directory, delete the "MLW," leaving only *.* . Names of all files in the directory should appear in the dialog box.

If you select **Cancel**, you will return to the HABIT main screen without changing the radionuclide data file.

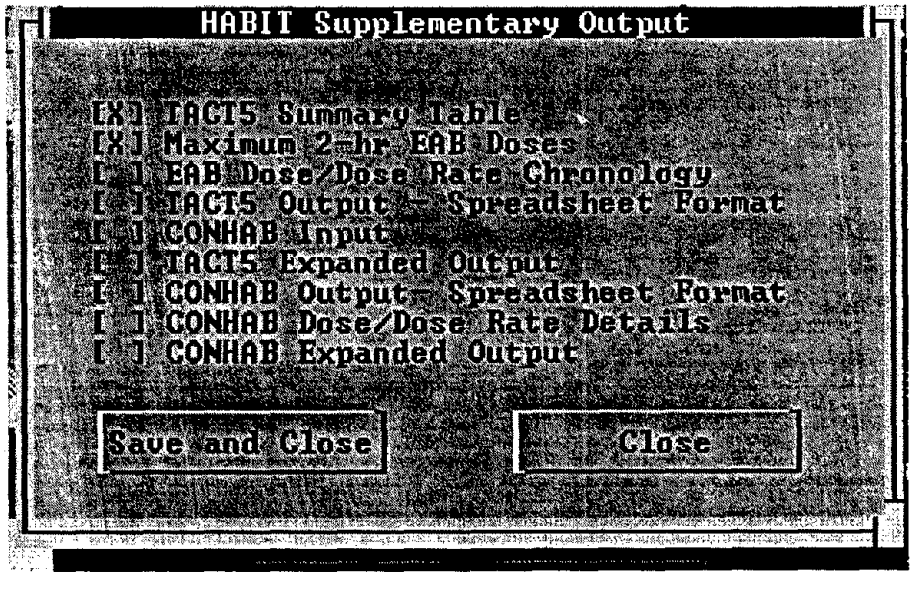
The structure and content of radionuclide data files are described in Appendix A.

2.3 Output Control

The TACT5 and CONHAB programs in HABIT V1.0 produce a large volume of output. Most of this output is not required for routine applications. Some of the data in the output files contains detailed information that was needed for program development and testing, and other data provides doses by isotope. Consequently, the output files are large -- they may require several megabytes of disk space, and the essential computational results may be difficult to find.

In HABIT V1.1, the primary output files of TACT5 and CONHAB are limited to listings of the input to and the final result of the calculations. These files have a .tab extension in the file name. For example, if the five-character design name is DESG1, the primary output from TACT5 will be named DESG1t5a.tab, and the primary output from CONHAB will be DESG1cb.tab. Each of these files should end with a message indicating that the program has reached a successful conclusion.

Additional output is obtained using the output selection screen that is accessed by clicking on the **Select Output** button on the main HABIT screen. When you click on the **Select Output** button, the following screen appears.



The output control screen contains nine options. You may select any or all of the options. All of the information in the output files produced by HABIT V1.0 is available by making the proper selections. However, under normal circumstances most of the output can be turned off. Reducing the output not only saves disk space, but it also speeds up execution of the programs. The reduction in computational time for CONHAB associated with reduction of the amount of output is particularly noticeable. The following paragraphs provide brief descriptions of the effects of each selection. Chapters 3 and 4 provided detailed description of output files from TACT5 and CONHAB, respectively.

Selection of the **TACT 5 Summary Table** causes TACT5 to create a file that contains the results of TACT5 calculations without the listing of the input dat. The file is identified by a .sum file extension. For the DESG1 design, the file name would be DESG1t5a.sum. This file is in addition to the primary output file (DESG1t5a.tab). It does not replace the primary output file.

Selection of **Maximum 2-hr EAB Doses** causes TACT5 to calculate doses with sufficient frequency to estimate the maximum two-hour dose at the exclusion area boundary (EAB). However, these doses are estimated only if a dilution factor is entered for the EAB at time 0 and not changed during the course of the analysis. When **Maximum 2-hr EAB Doses** is selected, the results of the two-hour EAB dose calculation are included in the primary output, the TACT5 Summary Table, and, if selected, in the EAB dose chronology. Maximum 2-hr EAB doses are based on doses calculated at 6 minute intervals during the first 8 hours and every hour for the next 16 hours. If the maximum dose rate appears to occur after 24 hours, you must enter times for dose calculations manually in TACT5 to obtain an estimate of the maximum 2-hr doses.

Selection of **EAB Dose/Dose Rate Chronology** causes TACT5 to create a file containing the doses and dose rates at the EAB at selected intervals during the course of the event if **Maximum 2-hr EAB Doses** is also selected. The **EAB Dose/Dose Rate Chronology** file will not be created if **Maximum 2-hr EAB Doses** is not selected. The name of the **EAB Dose/Dose Rate Chronology** file for the DESG1 design would be DESG1t5a.cr1.

Selection of the **TACT Output — Spreadsheet Format** will cause TACT5 to create files that contain copies of the **TACT5 Summary Table** and **EAB Dose/Dose Rate Chronology** in quote and comma delimited format for use with spreadsheets if the corresponding **TACT5 Summary Table** and **EAB Dose/Dose Rate Chronology** are selected. The name for the file with the quote and comma delimited **TACT5 Summary Table** for the DESG1 design would be DESG1t5a.spd. The file name for the quote and comma delimited **EAB Dose/Dose Rate Chronology** would be DESG1t5a.cr2.

Selection of **CONHAB Input** causes TACT5 to create an input file to CONHAB. The CONHAB input file can be created whether or not the **Time Steps for CONHAB** option is selected as part of the TACT5 input. However, use of the **Time Steps for CONHAB** option is recommended whenever it is likely that CONHAB will be run to ensure computational accuracy. If you attempt to run CONHAB after running TACT5 and CONHAB can't find an input file, **CONHAB Input** probably wasn't selected. CONHAB input files created by TACT5 have file names ending with a .cnx extension. For the DESG1 design, the file name would be DESG1t5a.cnx.

Selection of **TACT5 Expanded Output** causes TACT5 to write intermediate computational results to the primary output file. These intermediate results can expand the size of the file by an order of magnitude.

When expanded output is selected, the primary output file closely resembles the TACT5 output file in HABIT V1.0.

Selection of **CONHAB Output — Spreadsheet Format** causes CONHAB to create a quote and comma delimited file that contains the dose and dose rate chronology for the control room. This file is similar to the **EAB Dose/Dose Rate Chronology** file created by TACT5. It contains control room cumulative doses and dose rates as a function of time. It also contains the final (720-hr cumulative) doses by radionuclide group. For the DESG1 design, this file would be named DESG1cb.spd.

Selection of **CONHAB Dose/Dose Rate Details** causes CONHAB to create a file with all of the results of the dose calculations at every time step. It also contains dose rates as a function of time by radionuclide form and for each form by radionuclide. Consequently this file, named DESG1cb.cnx for design DESG1, can be a large file because time steps near the beginning of the release are small.

Selection of **CONHAB Expanded Output** causes CONHAB to add intermediate dose calculation results to the primary output file. The added information includes the chronology of radionuclide activity by form and location and doses by isotope, form and location. This additional output can increase the size of the primary output file by more than two orders of magnitude.

The following table shows the approximate sizes of files created by TACT5 and CONHAB for the DEMO2 sample problem in NUREG/CR-6210.

File	Normal	Expanded
TACT5 Primary Output	17 kb	61 kb
TACT5 Summary Table	8 kb	
TACT5 EAB Chronology	8 kb	
TACT5 Summary, Spreadsheet	8 kb	
TACT5 EAB Chronology, Spreadsheet	8 kb	
TACT5 CONHAB Input	478 kb	
CONHAB Primary Output	10 kb	1,182 kb
CONHAB Spreadsheet	43 kb	
CONHAB Dose Details	2,988 kb	

A file named OUTOPT.DAT, located in the directory with the program files, controls TACT5 and CONHAB output. This file contains nine records. The first character in each record is a logical switch that turns the output on and off. An F turns the output off, and a T turns it on. An example of an OUTOPT.DAT file is shown below. Exclamation points separate the switches from comments that describe the type output controlled by the switch.

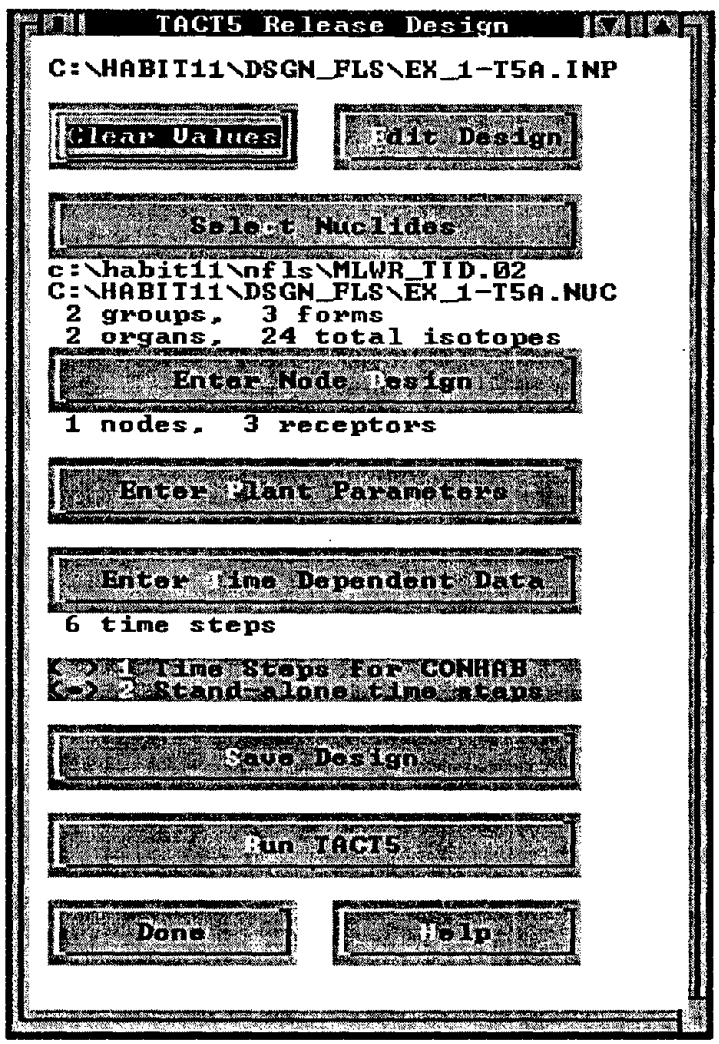
```
F ! TACT5 Summary Tables (*t5a.sum)
F ! Calculate maximum 2-hr EAB dose
F ! TACT5 EAB dose/dose rate chronology (*t5a.cr1 and *t5a.cr2)
F ! Comma delimited TACT5 summary for input to spreadsheet programs (*t5a.spd)
T ! TACT5 Input to CONHAB (*t5a.cnx)
F ! TACT5 expanded output (expanded *t5a.tab)
F ! CONHAB dose/dose rate spreadsheet file (*cb-.spd)
F ! CONHAB detailed dose/dose rate file (*cb-.cnx)
F ! CONHAB expanded output (expanded *cb-.tab)
```

3 TACT5

This chapter describes the revision to the TACT5. It covers changes to data input and the new output files.

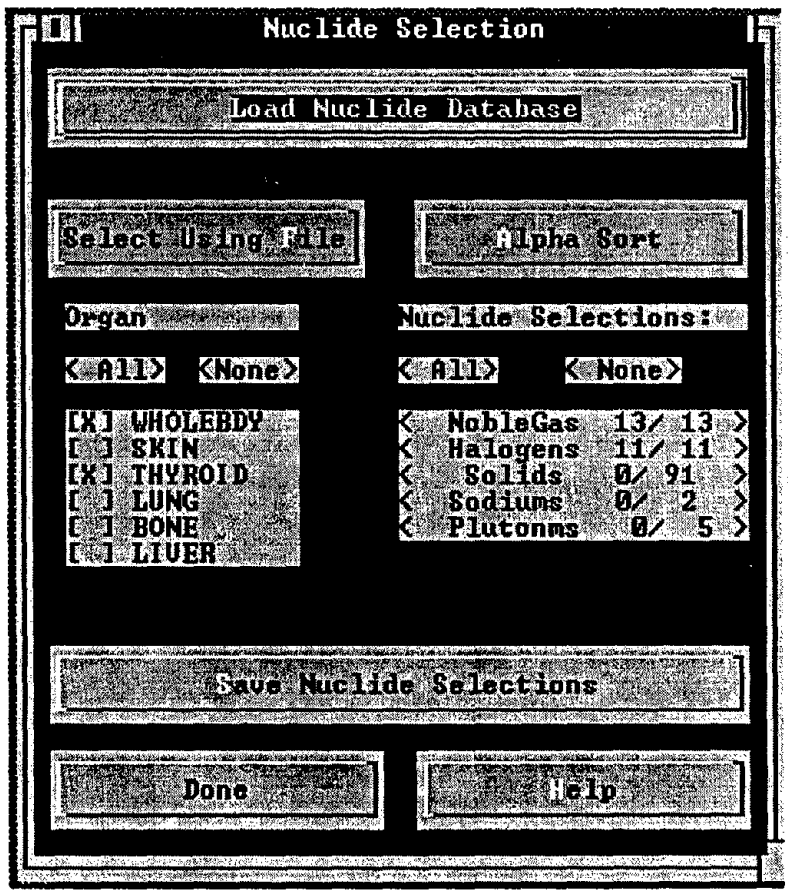
3.1 Revisions to Data Input

The changes to the TACT5 user interface have not been significant. The HABIT V1.1 TACT5 Release Design form is



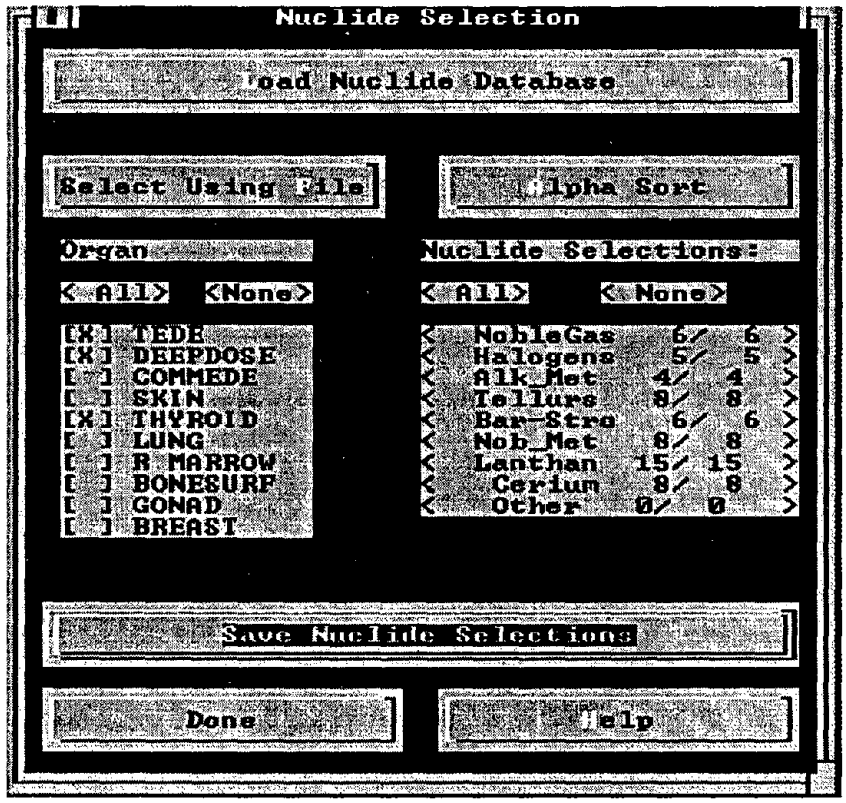
This form is similar to the HABIT V1.0 TACT5 Release Design form. The only difference is that the current radionuclide design file is listed directly below the **Select Nuclides** button in the new form. In general, the radionuclide data file should be selected using the **Change Nuclide Database** button on the HABIT V1.1 main screen.

The **Select Nuclides** button on the TACT5 Release Design form is used primarily to activate the screen used to select radionuclides from the chosen database. When you click on the Select Nuclides button this screen appears:



Its appearance is similar to that of the nuclide selection screen in HABIT V1.0. However new controls have been added to the screen to permit you to select or deselect all organs or radionuclides with a single action. In this context, the word organ is used to identify the type dose to be calculated and includes whole body doses, committed effective dose equivalents, and total effective dose equivalents. The controls are located immediately above the organ and radionuclide group lists. The organs and radionuclide groups in the lists are determined by the radionuclide data file.

The radionuclide data files created from data files that accompanied earlier versions of TACT5 have the organs and radionuclide groups shown above. New files have been prepared that include dose factors from Federal Guidance Reports 11 and 12 (Eckerman et al. 1988: Eckerman and Ryman 1993) and radionuclide groups listed in NUREG-1465 (Soffer et al. 1995). In addition, the new files have updated estimates core specific activity for pressurized-water reactors (PWRs) and boiling water reactors (BWRs) based on ORIGEN calculations (Alpert et al. 1986; Chanin et al. 1990). When one of these files is selected, the following nuclide selection screen will appear.



The method of selecting the individual radionuclides has not been changed.

A note of caution related to the selection of radionuclides is appropriate at this time. HABIT V1.1, like HABIT V1.0, shows all radionuclides listed in the selected radionuclide data. However, selecting a radionuclide does not ensure that the radionuclide will contribute to calculated doses. The radionuclide files distributed with the 1988 version TACT5 listed 122 radionuclides, but the files did not include a complete set of dose factors. For example, there were thyroid dose factors for only 24 radionuclides, and there were no dose factors at all for 12 radionuclides. No new dose factors have been added to the HABIT V1.1 radionuclide data files that are based on the earlier TACT5 files. Before you use these files for a specific purpose, you should check to see that the files contain dose factors for the organs and radionuclides that are of concern.

The new radionuclide data files list 60 radionuclides. All of the dose factors in Federal Guidance Reports 11 and 12 are included in the files. Core specific activities are provided for the 54 radionuclides identified as important in WASH-1400 (NRC 1975) and the additional 6 radionuclides that are used in the MACCS computer codes (Alpert et al. 1986; Chanin et al. 1990).

3.2 Revised TACT5 Output Files

Output files from TACT5 have been revised to offer users faster access to the computational results. The following paragraphs describe the revised files.

3.2.1 Primary Data Output

The primary output file for TACT5 is *T5A.TAB, where the * represents the five character string that you assigned to the design. This file, which has been significantly modified in HABIT Version 1.1, consists of a heading, two input sections, and the essential results of the TACT5 computations.

The TACT5 output heading found at the top of the first page of primary output file is shown below.

```
============================================================

                    HABIT Version 1.1
                    TACT5 Revision 5/19/1998
                    Run  2/ 6/1998 at 11: 9:47

============================================================
```

Note that the heading contains the HABIT Version, the TACT5 version and date, and the date and time that the code was run. This information clearly identifies the code used for calculations. However, the run date and time are only as good as the internal clock on the computer used for the calculations.

The heading is followed by two sections that describe the input used in the TACT5 calculations. The first of these sections lists the files used for input and output, and the second lists the data entered directly by the user through the HABIT/TACT5 data entry program.

Here is an example of the file usage section. The data input files are listed first. Each input file name, including path, is given immediately following the input file banner. The list of file names is followed by the headers from the input files. The header for the radionuclide data file is not shown in its entirety; the full heading can be seen in Appendix B.

A list of output files follows the input file headers. This list provides file names, including paths, for those type of output selected. The list also identifies the output not selected. If, for example, you did not select the CONHAB output, the file list would contain the line shown below.

CONHAB output file not selected

If you run TACT5 and can't find the output files that you want, check the output file list.

```
 ============================
 == TACT5 Input Data Files ==
 ============================

 TACT5, nuclide selection file:
     C:\HABIT11\DSGN_FLS\EX_1-T5A.NUC
 TACT5, run design file:
     C:\HABIT11\DSGN_FLS\EX_1-T5A.INP

 ------------------------------------------------------------
 Radionuclide File Header:

FILENAME:      MLWR_TID.02

Organs:        Whole Body, Skin, Thyroid, Lung, Bone, Liver

Source Term:   TID 14844 groups.

               The core specific activities (Ci/MWt) in the file are the
               same as listed in NUREG/CR-5106. The core specific activities
               for I-131, I-132, I-133, I-134, and I-135 come directly
               from Table I of TID-14844.  Those for the isotopes of Xe,
               Kr-85m and Kr-88 appear to have been calculated from the data
               in Table IV. of TID-14844.  The origin of the remaining
               specific activities is uncertain.  However, they may be based
               on data published by Blomeke and Todd in 1958 (TID-14844
               reference 11).

               Note that except for the iodines and noble gases, there
               were significant changes in specific activities from the
               radionuclide library associated with TACT3 (NUREG/CR-3287)
               to the library for TACT5 published in NUREG/CR-5106.

Dose Factors: ICRP 2 Methodology.

...

 ------------------------------------------------------------
 TACT5 User Input File Header:

 TACT5A release.
 HABIT release design specification file 07:53:52 11-06-1997
 HABIT V1.1  Sample Problem 1


 ============================
 == TACT5 Output Data Files ==
 ============================

 Normal table output file:
     C:\HABIT11\DSGN_FLS\EX_1-T5A.TAB
 CONHAB output file:
     C:\HABIT11\DSGN_FLS\EX_1-T5A.CNX
 •       Spreadsheet output file:
     C:\HABIT11\DSGN_FLS\EX_1-T5A.SPD
 Summary output file:
     C:\HABIT11\DSGN_FLS\EX_1-T5A.SUM
 EAB Chronology spreadsheet file:
     C:\HABIT11\DSGN_FLS\EX_1-T5A.CR2
 EAB Chronology summary file:
     C:\HABIT11\DSGN_FLS\EX_1-T5A.CR1
```

The second input section lists the data entered by the user in the HABIT/TACT5 data entry forms. Presentation of the data begins with a listing of the time-independent data. Time-independent data are not allowed to change in TACT5. These data consist of the following:

- time-step selection (Stand-alone time steps or Time steps for use by CONHAB)
- radionuclides, core inventories, and dose factors
- reactor power and delay between shutdown and start of release
- release path design
- fractions of activity initially released from core, plating out, and remaining airborne
- distribution of activity in each group by physical/chemical form
- number of user-defined time steps and dose evaluation points.

Here is an excerpt from the time-independent data section for sample problem 1.

```
============================================================

TIME INDEPENDENT DATA:

Time steps for stand-alone use

------------------------------------------------------------
Radionuclides by Form with Dose Factors

...
KR  85M     EL  1.30E+04 ext  3.720E-02 0.000E+00
                         int  0.000E+00 0.000E+00
KR  85      EL  4.10E+02 ext  5.250E-04 0.000E+00
                         int  0.000E+00 0.000E+00
...
I  131      EL  2.40E+04 ext  8.720E-02 0.000E+00
                         int  0.000E+00 1.485E+06
I  131       O  6.27E+02 ext  8.720E-02 0.000E+00
                         int  0.000E+00 1.485E+06
I  131      PA  5.02E+02 ext  8.720E-02 0.000E+00
                         int  0.000E+00 1.485E+06
...
------------------------------------------------------------
User Input

Reactor Power (MWt)                      2700.0
Release Delay (hr)                          .00
Number of defined nodes:                   1
Node Volumes (ft^3):
    Node 1:  contain                       1.800E+06

Fractions of Activity from Core, Plating out, and Initially Airborne
                                         From Core    Plateout    Airborne
    NobleGas:                            1.000E+00   0.000E+00   1.000E+00
    Halogens:                            2.500E-01   0.000E+00   2.500E-01

Distribution of Activity by Form
                                             ELEM.        ORG.        PART.
    NobleGas:                            1.000E+00   0.000E+00   0.000E+00
    Halogens:                            9.550E-01   2.500E-02   2.000E-02

Number of User-Defined Time Steps:         6
Number of Dose Evalulation Points:         3
```

The radionuclide data are listed by form. In general, each radionuclide should be listed just once. For noble gases, the isotope names should be followed by an EL to indicate that isotopes are to be treated in the elemental form. For all other groups, except the halogens, the isotope names should be followed by PA to indicate that the isotopes are in the particulate form. Isotopes of elements in the halogen group are the exception to the general rule. The halogens, iodine in particular, may be treated in three forms, elemental, particulate, or organic (O). If the halogens are treated in more than one form, each isotope will be listed once for each form. The isotope name and form are followed by the core inventory (Ci/MW_f) and the external (ext) dose factors for the organs selected by the user. The internal dose factors (int) are on the following line. These dose factors are listed in the order of the dose factors in the radionuclide data file.

Time-dependent data follow the time-independent data. These data are listed using records with a fixed format. The first entry in each record is a key word. The key word describes the kind of information in the record. TACT5 recognizes 14 key words. These are

TIME INTERVAL	INITIAL FRACTION	RELEASE FRACTION	INITIAL CURIES
RELEASE CURIES	REMOVAL RATE	FILTER EFF	TRANSFER CFM
TRANSFER PERCENT	TRAVEL TIME	X/Q	BREATH RATE
LEAK RATE	END		

The key word is followed by five integers. The first four of these integers give the group, form, isotope, and node to which the data apply. If this information is not needed, the first four integers may be zero. The last integer gives the number of data entries in the record. The integers are followed by the data. Here is the time-dependent data section from sample problem 1.

```
============================================================

 TIME DEPENDENT DATA:

 TIME INTERVAL      0 0 0 0 2   0.000E+00   2.000E+00
 INITIAL FRACTION   1 0 0 0 1   1.000E+00
 INITIAL FRACTION   2 0 0 0 1   1.000E+00
 TRANSFER PERCENT   0 0 0 1 2   1.400E-01  -9.990E+02
 LEAK RATE          0 0 0 0 1   1.400E-01
 X/Q                0 0 0 0 3   3.700E-04   1.900E-05  -9.990E+02
 BREATH RATE        0 0 0 0 3   3.470E-04   3.470E-04  -9.990E+02
 TIME INTERVAL      0 0 0 0 2   2.000E+00   8.000E+00
 TIME INTERVAL      0 0 0 0 2   8.000E+00   2.400E+01
 X/Q                0 0 0 0 3  -9.990E+02   9.700E-06  -9.990E+02
 BREATH RATE        0 0 0 0 3  -9.990E+02   1.750E-04  -9.990E+02
 TIME INTERVAL      0 0 0 0 2   2.400E+01   9.600E+01
 TRANSFER PERCENT   0 0 0 1 2   7.000E-02  -9.990E+02
 LEAK RATE          0 0 0 0 1   7.000E-02
 X/Q                0 0 0 0 3  -9.990E+02   5.300E-06  -9.990E+02
 BREATH RATE        0 0 0 0 3  -9.990E+02   2.320E-04  -9.990E+02
 TIME INTERVAL      0 0 0 0 2   9.600E+01   7.200E+02
 X/Q                0 0 0 0 3  -9.990E+02   1.200E-06  -9.990E+02
 TIME INTERVAL      0 0 0 0 2   7.200E+02   7.200E+02

============================================================
```

The first time-dependent data record always defines a time interval. There are two data entries in the record. The first entry is the beginning time of the interval, and the second is the end time. The time interval record is followed by records that contain data entries for the beginning of the interval. For subsequent time intervals, records are printed only for those variable that have changed. Blanks in the

data are treated by TACT5 as zero, and are shown in the list as -9.990E+02.

The number of data elements in each record is determined by the compartment design being evaluated. For most records related to releases (INITIAL FRACTION, RELEASE FRACTION, INITIAL CURIES, RELEASE CURIES), there will be one element for each node defined by the user. The order of the elements will correspond to the order in which the nodes are defined. This order is shown in the time-independent data list. If a direct leak from containment to the environment is modeled using the unreduced dose option described in the HABIT V1.0 documentation, the leak rate will be given in a single data element following the LEAK RATE key word. Data elements in records for removal coefficients (REMOVAL RATE) follow the same order as those in records related to releases.

For records related to the transfer of material among the nodes and between the nodes and the environment (TRANSFER CFM, FILTER EFF, TRANSFER PERCENT), there will be one element for each node and an additional element for the environment. The node from which the transfer occurs is shown in the fourth integer after the key word. The first data element is for transfer to the environment. The remaining elements are for transfer to the user-defined nodes in the order in which they were defined.

The three remaining key words that are followed by data (X/Q, BREATH RATE, TRAVEL TIME), identify records that list data related to dose calculations. In these records, there is one data element for each dose calculation point. The order of the records is Exclusion Area Boundary, Low Population Zone, and Other, which is typically used to represent the Control Room Intake.

The remainder of the TACT5 primary output file contains the essential results of the calculations. These results are doses for each dose evaluation point as a function of time by organ. There are two parts of the results section. The first part gives doses for a direct release from containment to the environment assuming no engineered safety features. These doses are calculated if a leak rate and travel times are entered using the HABIT/TACT5 data entry forms.

Sample Problem 1, described in Chapter 5 performs calculations for pathways both with and without engineered safety features. Here are the results of the calculations made for EAB for the pathway without engineered safety features.

```
DOSE SUMMARIES BY ORGAN:

Dose summary for multinode containment with no ESF

Exclusion Area Boundary

 Time (hr)          2.0         8.0        24.0        96.0       720.0
    ORGAN
  WHOLEBDY     4.387E+00   9.732E+00   1.448E+01   1.732E+01   2.179E+01
   THYROID     6.750E+02   2.493E+03   6.520E+03   1.270E+04   2.923E+04

-------------------------------------------------------------
```

The results for calculations for the Low Population Zone boundary and the Other receptor location (control room air intake) are presented in similar tables. If a leak rate or travel time isn't included in the user input, the primary output file will contain the following message in place of the computed doses.

```
============================================
Doses in absence of ESF are zero for this case.
The leak rate of primary containment may be 0.
============================================
```

The second part gives doses from releases through user-specified release pathways. These pathways may include various engineered safety features including sprays and filters. Here are the doses for the user specified release path in Sample Problem 1.

Dose summary for multinode containment with ESF

Exclusion Area Boundary

Time (hr)	2.0	8.0	24.0	96.0	720.0
ORGAN					
WHOLEBDY	4.387E+00	9.732E+00	1.448E+01	1.732E+01	2.179E+01
THYROID	6.750E+02	2.493E+03	6.520E+03	1.270E+04	2.923E+04

Low Population Zone

Time (hr)	2.0	8.0	24.0	96.0	720.0
ORGAN					
WHOLEBDY	2.253E-01	4.998E-01	6.242E-01	6.649E-01	6.794E-01
THYROID	3.466E+01	1.280E+02	1.812E+02	2.404E+02	2.762E+02

Control Room Intake

Time (hr)	2.0	8.0	24.0	96.0	720.0
ORGAN					
WHOLEBDY	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
THYROID	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

The dose times, which are set in the TACT5 code, correspond to times used in current NRC guidance for changes in atmospheric dispersion, breathing rates, and control room occupancy factors. Doses will be reported only if these times are called out explicitly in the HABIT/TACT5 data entry forms. Doses of zero will be printed for the times not explicitly called out by the user. The control room intake doses are zero because the sample problem did not specify input needed for calculation of doses at the control room intake.

If the problem does not include a pathway with engineered safety features, the second part of the results section will contain a message to the effect that the doses are zero. The message is similar to the one shown above for the pathway without engineered safety features.

As mentioned earlier, HABIT V1.1 includes an option to calculate maximum two-hour doses during the course of an event. To ensure that the maximum two-hour doses are calculated, the dilution factors must not be changed during the event. If this option is selected, the doses shown in the table for the EAB will be unrealistically large after the first few hours. They should be ignored. The EAB doses of interest will be shown in a separate table. Here is an example of that table from Sample Problem 1.

```
Maximum 2-hr EAB Dose Information

  ORGAN       Dose (rem)        % TEDE     Time (hr)
WHOLEBDY       4.387E+00                       .00
 THYROID       6.750E+02                       .00
```

Note that since TEDE doses were not calculated, the %TEDE column is blank.

In general, if the release progression outlined in TID-14844 (DiNunno 1962) is followed, the maximum two-hour doses all start at time zero because the maximum release to the environment occurs then. When the release progression follows other scenarios, for example NUREG-1465, the maximum two-hour doses are likely to occur later in the event. This is illustrated in the following table from Sample Problem 5.

```
Maximum 2-hr EAB Dose Information

  ORGAN       Dose (rem)        % TEDE     Time (hr)
   TEDE       3.937E+01         100.0         1.40
DEEPDOSE      3.341E+00           8.4         1.20
 THYROID      8.382E+02          63.9         1.40
```

If the maximum two-hour dose option is not selected, the maximum two-hour dose table is replaced by the following message:

```
==========================================
==    Maximum 2-hour dose calculation   ==
==            not selected              ==
==========================================
```

The last portion of the primary output file consists of tables that list the contributions of each element group to the doses at the receptor locations. Here is an example of those tables:

```
WHOLEBDY   Doses by Element Group

                EAB          LPZ        Other
NobleGas    2.57E+00     3.45E-01     0.00E+00
Halogens    1.81E+00     3.34E-01     0.00E+00
   Total    4.39E+00     6.79E-01     0.00E+00

 THYROID   Doses by Element Group

                EAB          LPZ        Other
NobleGas    0.00E+00     0.00E+00     0.00E+00
Halogens    6.75E+02     2.76E+02     0.00E+00
   Total    6.75E+02     2.76E+02     0.00E+00

======================================
=== TACT5, successful termination. ===
======================================
```

In these tables, if the maximum 2-hour EAB dose option has been selected, only the doses during the maximum 2-hour period are considered. Otherwise, the doses are for the full course of the event. The last bit of information in the file should be the successful termination message.

A large amount of information included in the TACT5 primary output file in HABIT V1.0 is not normally included in the primary output file for HABIT V1.1. This output, which was used specifically for code development, has not been deleted; it has been made optional. The output can be obtained by selecting the TACT5 debug output in the OUTOPT.DAT file. Output control in HABIT Version 1.1 was discussed in Section 2.3.

3.2.2 Summary Table Files

HABIT V1.1 provides two optional files that summarize the results of TACT5 dose calculations. These files must be selected using the OUTOPT.DAT file. One of the files is in standard ASCII format and is suitable for printing or inserting in documents. The other file is a "quote and comma delimited" file. This file is intended for use as input to a spreadsheet program where the data may be graphed.

The Summary Table file heading is limited to identification of the code and the heading from the TACT5 design file. The heading for Sample Problem 1 is shown here.

```
                    HABIT Version 1.1
                    TACT5 Revision 1/12/1998
                    Run  2/ 6/1998 at 11: 9:47

TACT5A release.
HABIT release design specification file 07:53:52 11-06-1997
HABIT V1.1  Sample Problem 1
```

The file then lists the doses by organ; first for a release pathway without engineered safety features, and then for a pathway with engineered safety features. The format for the lists differs from that in the primary output file. Columns are used for the receptor locations, and rows are used for time. Doses are given for each time called out by the user in the TACT5 time-dependent data entry section. Here are excerpts from the summary table output for Sample Problem 1.

```
Dose summary for multinode containment with no ESF

WHOLEBDY dose commitment during step (rem)
Cumulative committed dose (rem)

     End       EAB       EAB       LPZ       LPZ     Other     Other
    Time      Step       Cum      Step       Cum      Step       Cum
   (hrs)      Dose      Dose      Dose      Dose      Dose      Dose
-------- -------- -------- -------- -------- -------- --------
   2.000 4.39E+00 4.39E+00 2.25E-01 2.25E-01 0.00E+00 0.00E+00
   8.000 5.35E+00 9.73E+00 2.75E-01 5.00E-01 0.00E+00 0.00E+00
  24.000 4.75E+00 1.45E+01 1.24E-01 6.24E-01 0.00E+00 0.00E+00
  96.000 2.84E+00 1.73E+01 4.07E-02 6.65E-01 0.00E+00 0.00E+00
 720.000 4.46E+00 2.18E+01 1.45E-02 6.79E-01 0.00E+00 0.00E+00
-------- -------- -------- -------- -------- -------- --------

 ...

Dose summary for multinode containment with ESF
 ...
```

THYROID dose commitment during step (rem)
Cumulative committed dose (rem)

End Time (hrs)	EAB Step Dose	EAB Cum Dose	LPZ Step Dose	LPZ Cum Dose	Other Step Dose	Other Cum Dose
2.000	6.75E+02	6.75E+02	3.47E+01	3.47E+01	0.00E+00	0.00E+00
8.000	1.82E+03	2.49E+03	9.33E+01	1.28E+02	0.00E+00	0.00E+00
24.000	4.03E+03	6.52E+03	5.33E+01	1.81E+02	0.00E+00	0.00E+00
96.000	6.18E+03	1.27E+04	5.91E+01	2.40E+02	0.00E+00	0.00E+00
720.000	1.65E+04	2.92E+04	3.58E+01	2.76E+02	0.00E+00	0.00E+00

These tables include doses for each period as well as the cumulative doses from the beginning of the event. These doses may be used to obtain gross estimates of dose rates. The dose chronology output described in the next section provides more precise dose estimates.

If the maximum two-hour EAB dose option is selected, a summary of doses will be included in the tables that lists the maximum two-hour EAB doses in addition to the doses for the full course of the event for the other receptor locations. For Sample Problem 1, these tables are

Summary of Doses (rem)

	Max 2 hour EAB (rem)	720.00 hour LPZ (rem)	720.00 hour Other (rem)
WHOLEBDY	4.39E+00	6.79E-01	0.00E+00
THYROID	6.75E+02	2.76E+02	0.00E+00

Starting Time of Max Dose Interval (hr)

	Max 2 hour EAB
WHOLEBDY	.00
THYROID	.00

The same caution applies to use of the EAB doses in the summary table as applies in the primary output. If the maximum two-hour EAB dose option is selected, do not use the EAB doses given in the first set of table beyond the first few hours. Use the EAB doses in the maximum two-hour dose tables instead.

The last set of tables in the summary table files lists the contributions to each dose by element groups. In these tables, the contributions to the EAB dose are for the period of the maximum 2-hr dose if that option has been selected. Otherwise the contributions are to the dose for the full period of the event. The doses and dose contributions for locations other than the EAB are for the full period of the event. Here is the table for Sample Problem 1.

```
WHOLEBDY   Doses by Element Group

                EAB          LPZ        Other
NobleGas    2.57E+00     3.45E-01     0.00E+00
Halogens    1.81E+00     3.34E-01     0.00E+00
   Total    4.39E+00     6.79E-01     0.00E+00

 THYROID   Doses by Element Group

                EAB          LPZ        Other
NobleGas    0.00E+00     0.00E+00     0.00E+00
Halogens    6.75E+02     2.76E+02     0.00E+00
   Total    6.75E+02     2.76E+02     0.00E+00
```

3.2.3 Exclusion Area Boundary Dose Chronology File

With the publication of NUREG-1465 and revision to 10 CFR Parts 50 and 100, there has been increased interest in the timing of the maximum dose at the exclusion area boundary. When the maximum release rate to the environment does not occur at the beginning of a event, but it is a function of the release scenario instead, it becomes necessary to search for the time of the maximum release rate and calculate the doses for that period. TACT5 in HABIT V1.1 has been modified to perform that search. The EAB Dose Chronology File contains the doses used in that search.

```
                    HABIT Version 1.1
                    TACT5 Revision 1/12/1998
                    Run  2/ 6/1998 at 11: 9:47

TACT5A release.
HABIT release design specification file 07:53:52 11-06-1997
HABIT V1.1  Sample Problem 1
      End WHOLEBDY WHOLEBDY  THYROID  THYROID
     Time     Dose      Cum     Dose      Cum
    (hrs)     Rate     Dose     Rate     Dose
 -------- -------- -------- -------- --------
      .10 1.14E-05 4.12E-01 9.75E-04 3.51E+01
      .20 9.20E-06 7.43E-01 9.70E-04 7.00E+01
      .30 8.18E-06 1.04E+00 9.65E-04 1.05E+02
...
     2.10 4.09E-06 4.53E+00 9.04E-04 7.08E+02
     2.20 3.99E-06 4.68E+00 9.01E-04 7.40E+02
     2.30 3.90E-06 4.82E+00 8.98E-04 7.72E+02
...
     8.00 1.54E-06 9.73E+00 7.90E-04 2.49E+03
     9.00 1.44E-06 1.03E+01 7.82E-04 2.77E+03
    10.00 1.29E-06 1.07E+01 7.69E-04 3.05E+03
...
    24.00 4.90E-07 1.45E+01 6.31E-04 6.52E+03
    30.00 2.12E-07 1.49E+01 3.04E-04 7.18E+03
    36.00 1.70E-07 1.53E+01 2.86E-04 7.79E+03
...
    96.00 6.57E-08 1.73E+01 1.94E-04 1.27E+04
   120.00 5.87E-08 1.78E+01 1.81E-04 1.43E+04
...
   720.00 4.31E-09 2.18E+01 2.02E-05 2.92E+04

    Dose Rates (rem/hr) and Cumulative Dose (rem)
```

4 CONHAB

This chapter describes the revisions to CONHAB. It covers changes to the data input and the new output files.

4.1 Input Files

The changes to the CONHAB user interface have been limited to two areas. Users now have control of the extent and type of output from CONHAB. This control is exercised through the output control on the main HABIT input screen described in Section 2.2. The other change in the user interface is to the plant data input screen. The radionuclide groups that appear on the portion of the screen associated with FPFP_2 input are determined by the radionuclide data file. If the file contains TID-14844 source term data, the TID group names will appear, and if the file contains NUREG-1465 source term data, the NUREG-1465 group names will appear.

In HABIT V1.0, CONHAB and TACT5 used different radionuclide data files. This is no longer the case. CONHAB has been modified to read the same radionuclide data file used by TACT5. This change should not be of concern to casual users.

4.2 Output Files

As with TACT5, the CONHAB output files have been revised in HABIT V1.0. The primary output file has been reduced in size, and an additional file has been added for the intermediate results. The CONHAB output is controlled through the Output Control of the HABIT main input screen.

4.2.1 Primary Output File

The primary output for CONHAB is *CB.tab, where the * represents the five-character string assigned to the design. This file, which has been modified in HABIT V1.1, consists of a heading, three input sections, the results, and a successful completion message.

The CONHAB output heading is found at the top of the file. It identifies the HABIT version, the CONHAB version, and the date and time that CONHAB was run. An example of the output heading is shown below.

```
============================================================

                    HABIT V1.1
                    CONHAB  Revision 1/9/1998

                    Run 02/06/1998  15:17:40

============================================================
```

Note that the date and time of the calculations are only as accurate as the setting of the internal clock on the computer used.

The heading is followed by three sections that reflect user input to CONHAB. The first of these sections contains information about CONHAB input files. This section is rather lengthy when the input files have complete header information. The order of input files is

- radionuclide data file name and header
- CONHAB input file name and header from the user interface (*CB.inp)
- FPFP_2 input file # 1 (Unfiltered source # 1) name and header (*FPA.cnx)
- FPFP_2 input file # 2 (Unfiltered source # 2) name and header (*FPB.cnx)
- TACT5 input file # 1 (Filtered source # 1) name and header (*T5A.cnx)
- TACT5 input file # 2 (Filtered source # 2) name and header (*T5B.cnx).

If a name for an input file is not included in the CONHAB input file created by the user interface, generally because there is no flow to the control room from the source, CONHAB will include a message that the input file was not found in place of the header. An example of part of this section of the primary output file is shown below:

```
====================================
== INPUT DATA FILES FOR THIS CASE: ==
====================================

------------------------------------------------------------
Nuclide database file:  c:\habit11\nfls\MLWR_TID.30

Nuclide Database file is in HABIT 1.1 format

FILENAME:     MLWR_TID.30

Organs:       Whole Body, Skin, Thyroid, Lung, Bone, Liver

Source Term:  TID 14844 groups. ...

...

------------------------------------------------------------
Meteorology and system flow data file:  C:\HABIT11\DSGN_FLS\EX_3-CB.inp
  CONHAB release. Used by CHEM and CONHAB.
  HABIT release design specification file 09:43:07 11-06-1997

  HABIT V1.1 Sample Problem 3
  LOCA with Sprays -- Control Room Dose
  (NUREG/CR-6210 Demo 2)
------------------------------------------------------------

...

Unfiltered source file #1: C:\HABIT11\DSGN_FLS\EX_3-FPA.CNX

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXX                                     XXX
XXX      INPUT FILE NOT FOUND           XXX
XXX   Assume no contaminants flow       XXX
XXX        through this path.           XXX
XXX                                     XXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

...
```

```
------------------------------------------------------------
Source to filtered intake #1: C:\HABIT11\DSGN_FLS\EX_3-T5A.CNX
   TACT5 output file for use by CONHAB.
   Rate of activity release to the environment.
   Program run 02/06/1998  11:27:40
  TACT5A release.
  HABIT release design specification file 09:43:07 11-06-1997

  HABIT V1.1 Sample Problem 3
  LOCA with Sprays -- Control Room Dose
  (NUREG/CR-6210 Demo 2)

------------------------------------------------------------
```

The next section of the primary output file lists the output files that should have been created by CONHAB. The first file in the list will be the primary output file, *CB.tab. This file will always be created. If additional output is requested through the output control, it will be shown following the primary output file name. The example shown below indicates that the results of dose calculations for intermediate times have been requested, the results were requested in a "quote and comma delimited" format for use with a spreadsheet. The two files that result from these options contain the same information -- doses and dose rates for each organ for each time step.

```
================================
== OUTPUT FILES FOR THIS CASE: ==
================================

Table output:  C:\HABIT11\DSGN_FLS\EX_3-CB.tab
Output of dose history:  C:\HABIT11\DSGN_FLS\EX_3-CB.cnx
Output to spreadsheet:  C:\HABIT11\DSGN_FLS\EX_3-CB.spd

============================================================
```

If the output of these files are selected, the messages "Output of dose history NOT selected" and "Output to spreadsheet Not selected" will appear in this section of the primary output file.

The last section of the primary output file prior to the computational results contains the time-independent and time-dependent data entered through the CONHAB data entry screens in HABIT. This portion of the file is easier to comprehend than the corresponding portion of the TACT5 primary output file because each line starts with a description of the information follows. In most cases, the descriptions include the engineering units expected by the CONHAB computational program. In most cases the CONHAB data entry portion of the HABIT interface permits data entry in either English or S.I. units and makes unit conversions, if required. An example of the user input portion of the primary output file is shown below. Note that CONHAB uses filter efficiencies expressed as fractions (0.0 to 1.0), not percentages (0.0 to 100.0). This is opposite TACT5, which uses filter efficiencies expressed in percentage.

```
 TIME INDEPENDENT DATA:

Control Room Volume (m^3):     3.540E+03
Breathing Rate (m^3/s):        3.47E-04

 ============================================================

 TIME DEPENDENT DATA:

 TIME (hours):                                    .000
 Manually Entered X/Q:                           1.1140E-03
 Flow in from unfiltered source 1 (m^3/s):        .000
 Flow in from unfiltered source 2 (m^3/s):        .000
 Filtered intake flow source 1 (m^3/s):           .015
 Filter efficiency #1 (ele,org,part frac):        .0000      .0000      .0000
 Recirculation flow rate (m^3/s):                 .714
 Recirc filter efficiency (e,o,p frac):           .9500      .9500      .9500
 Filtered intake flow 2 (feeds recirc):           .268
 Intake 2 filter efficiency (e,o,p frac):         .0000      .0000      .0000
 Bottled air flow rate (m^3/s):                   .000
 Control room occupancy factor:                  1.000

 TIME (hours):                                   8.000
 Manually Entered X/Q:                           6.8900E-04

 TIME (hours):                                  24.000
 Manually Entered X/Q:                           2.4750E-04

 TIME (hours):                                  96.000
 Manually Entered X/Q:                           5.8200E-05

 ============================================================
```

The user input section of the primary output file is followed by a summary of the computational results of CONHAB. The results are presented in two tables. The first table gives control-room operator doses by organ as a function of time. The second table gives the contribution of each element group to the cumulative doses at the end of the computational period. An example of the computational results section of the primary output file is shown below.

Control Room Cumulative Doses by Organ (rem)

TIME (hr)	2.	8.	24.	96.	720.
ORGAN					
WHOLEBDY	4.550E-02	2.139E-01	3.219E-01	3.444E-01	3.543E-01
SKIN	8.567E-01	4.163E+00	7.475E+00	8.466E+00	9.231E+00
THYROID	4.617E+00	1.772E+01	3.591E+01	4.702E+01	5.653E+01
LUNG	3.679E-02	1.822E-01	3.056E-01	3.501E-01	3.801E-01
BONE	1.887E-02	6.922E-02	1.334E-01	1.680E-01	1.953E-01
LIVER	3.204E-02	1.142E-01	2.139E-01	2.646E-01	3.034E-01

Final Organ Doses by Element Group

Group	WHOLEBDY	SKIN	THYROID	LUNG	BONE	LIVER
NobleGas	3.52E-01	9.21E+00	0.00E+00	3.80E-01	0.00E+00	0.00E+00
Halogens	2.19E-03	2.53E-02	5.65E+01	0.00E+00	1.95E-01	3.03E-01
Solids	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sodiums	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Plutonms	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	3.54E-01	9.23E+00	5.65E+01	3.80E-01	1.95E-01	3.03E-01

If CONHAB does not encounter any computational problems, the final section of the primary output file will be a banner that states that the program terminated successfully. If the banner, shown below, does not appear at the bottom of the file, something has gone wrong with the program, and the computational results should not be used.

```
================================================
=== CONHAB, successful program termination. ===
================================================
```

4.2.2 Control Room Dose Chronology Files

HABIT V1.1 provides two options for obtaining a chronology of doses in the control room. These options are found in the Output Control on the HABIT main screen. They are the

- CONHAB Dose/Dose Rate Details
- CONHAB Output--- Spreadsheet Format

options on the HABIT Supplemental Output form. If the first of these options is selected, the dose chronology file (*CB.cnx) will be created. This file gives the organ doses and dose rates for each time step in the calculations. An example of part of one of these files is shown on the next page.

The example shows very short time steps at the beginning, and the gradual increase in duration as time increases. In this example, the maximum time step for the first 8 hours is 0.1 hour because the option to find the maximum two-hour EAB dose was selected. This option also limited maximum time steps to 1 hour for the next 16 hours, to 6 hours for the second through fourth days, and to 24 hours after the fourth day. As a result of the limits on the maximum time step and the complexity of the problem, the file from which the example was taken contained doses for 229 time periods.

The second option provides the same information as the first, except that the information is presented in "quote and comma delimited" format (*CB.spd). This format expedited assimilation of the data into spreadsheets. When the file is imported into a spreadsheet, the data should automatically be arranged in columns and rows as it is in the file.

4.2.3 Expanded Files

The Output Control on the HABIT main screen provides one more output option for CONHAB. That option is called CONHAB Debug Output on the form. When the option is selected, the results of a large number of intermediate calculations are added to the primary output file. As a result, the file size may increase several orders of magnitude with a similar increase in difficulty in finding specific pieces of information. For Sample Problem 6, discussed in Chapter 5, the primary output file increases from about 11 kilobytes to over 5 megabytes when the debug output is selected.

Selecting the debug output also expands the dose chronology file (*CB.cnx). The doses in the normal file are broken down into contributions from each radionuclide and radionuclide form. For example, in Sample Problem 6, the file size increased from about 62 kilobytes to more than 2.3 megabytes.

This file written by CONHAB. 06/19/1998 12:38:17

CONHAB release. Used by CHEM and CONHAB.
HABIT release design specification file 14:14:28 02-06-1998

HABIT V1.1 Sample Problem 6
PWR with sprays and filtered vent

TABLE: 1 CUMULATIVE DOSE HISTORY (at end of time steps)

BegTime (hr)	EndTime (hr)	TEDE (rem)	DEEPDOSE (rem)	COMMEDE (rem)	SKIN (rem)	THYROID (rem)	LUNG (rem)	R MARROW (rem)	BONESURF (rem)	GONAD (rem)	BREAST (rem)
.0000	.0278	1.498E-06	8.259E-08	1.415E-06	4.176E-06	3.838E-05	5.672E-07	2.146E-07	2.009E-07	2.247E-07	2.015E-07
.0278	.0629	1.283E-05	8.181E-07	1.201E-05	4.144E-05	3.271E-04	4.781E-06	1.783E-06	1.669E-06	1.866E-06	1.675E-06
.0629	.0976	4.346E-05	3.054E-06	4.040E-05	1.548E-04	1.103E-03	1.600E-05	5.911E-06	5.531E-06	6.180E-06	5.552E-06
.0976	.1000	4.651E-05	3.287E-06	4.322E-05	1.667E-04	1.180E-03	1.711E-05	6.318E-06	5.912E-06	6.606E-06	5.935E-06
.1000	.1361	1.110E-04	8.561E-06	1.024E-04	4.343E-04	2.803E-03	4.034E-05	1.476E-05	1.381E-05	1.543E-05	1.387E-05
.1361	.1667	1.963E-04	1.620E-05	1.801E-04	8.220E-04	4.941E-03	7.070E-05	2.569E-05	2.404E-05	2.683E-05	2.415E-05
.1667	.2000	3.272E-04	2.891E-05	2.983E-04	1.467E-03	8.199E-03	1.166E-04	4.205E-05	3.934E-05	4.389E-05	3.953E-05
.2000	.2357	5.171E-04	4.892E-05	4.681E-04	2.483E-03	1.289E-02	1.822E-04	6.517E-05	6.098E-05	6.799E-05	6.128E-05
.2357	.2733	7.794E-04	7.886E-05	7.006E-04	4.003E-03	1.934E-02	2.715E-04	9.629E-05	9.009E-05	1.004E-04	9.057E-05
.2733	.2778	8.149E-04	8.307E-05	7.318E-04	4.217E-03	2.021E-02	2.834E-04	1.004E-04	9.397E-05	1.047E-04	9.448E-05
.2778	.3000	1.001E-03	1.050E-04	8.961E-04	5.329E-03	2.476E-02	3.465E-04	1.225E-04	1.146E-04	1.277E-04	1.152E-04
.3000	.3410	1.386E-03	1.491E-04	1.237E-03	7.565E-03	3.418E-02	4.782E-04	1.695E-04	1.586E-04	1.768E-04	1.595E-04
...											
3.0000	3.1000	1.360E-01	9.652E-02	3.948E-02	4.705E+00	1.018E+00	3.723E-02	5.163E-03	1.732E-02	4.113E-03	3.576E-03
3.1000	3.2000	1.422E-01	1.022E-01	3.998E-02	4.978E+00	1.033E+00	3.752E-02	5.193E-03	1.743E-02	4.134E-03	3.597E-03
3.2000	3.3000	1.484E-01	1.079E-01	4.047E-02	5.253E+00	1.047E+00	3.779E-02	5.221E-03	1.753E-02	4.153E-03	3.616E-03
3.3000	3.4000	1.546E-01	1.136E-01	4.094E-02	5.529E+00	1.061E+00	3.804E-02	5.245E-03	1.762E-02	4.171E-03	3.633E-03
3.4000	3.5000	1.608E-01	1.194E-01	4.141E-02	5.806E+00	1.075E+00	3.827E-02	5.268E-03	1.769E-02	4.187E-03	3.649E-03
...											
84.0000	90.0000	1.019E+00	8.525E-01	1.662E-01	5.289E+01	5.106E+00	6.005E-02	6.750E-03	2.001E-02	5.044E-03	5.229E-03
90.0000	96.0000	1.030E+00	8.608E-01	1.692E-01	5.363E+01	5.205E+00	6.030E-02	6.772E-03	2.003E-02	5.054E-03	5.257E-03
96.0000	106.7477	1.038E+00	8.664E-01	1.712E-01	5.413E+01	5.270E+00	6.046E-02	6.786E-03	2.005E-02	5.060E-03	5.275E-03
...											
600.0000	624.0000	1.159E+00	9.474E-01	2.113E-01	6.156E+01	6.586E+00	6.346E-02	7.069E-03	2.030E-02	5.174E-03	5.631E-03
624.0000	648.0000	1.160E+00	9.480E-01	2.119E-01	6.163E+01	6.605E+00	6.350E-02	7.073E-03	2.031E-02	5.176E-03	5.636E-03
648.0000	672.0000	1.161E+00	9.485E-01	2.124E-01	6.169E+01	6.623E+00	6.354E-02	7.077E-03	2.031E-02	5.177E-03	5.640E-03
672.0000	696.0000	1.162E+00	9.490E-01	2.129E-01	6.175E+01	6.639E+00	6.358E-02	7.080E-03	2.032E-02	5.179E-03	5.645E-03
696.0000	720.0000	1.163E+00	9.494E-01	2.133E-01	6.180E+01	6.653E+00	6.361E-02	7.083E-03	2.032E-02	5.180E-03	5.649E-03

Selecting CONHAB Debug Output does not change the contents of the spreadsheet file (*CB.spd).

It is clear from the increase in sizes of the primary output file and the dose chronology file that the CONHAB Debug Output option should not to be selected unless necessary. Frequent use of the option without deletion of old files will result in rapid loss of disk space.

5 Sample Problems

Chapters 2 through 4 describe the changes to the HABIT User Interface and to the TACT5 and CONHAB computer codes. This chapter presents six sample problems that illustrate the use of the revised portions of HABIT. The first three repeat problems included in the original TACT5 documentation (West and Gilpin 1988) and in the HABIT V1.0 documentation (Stage 1996). The output from these problems will demonstrate that the computational portions of the revised codes produce the same results as the earlier versions. The remaining problems illustrate new features of HABIT V1.1. Input files for and output files from TACT5 and CONHAB are included on the distribution HABIT V1.1 disks.

5.1 Standard Input

Some of the input required by the HABIT codes is standard. Rather than repeating the details of this standard input for each sample problem, the input is described in this section. The standard input includes the source term data and breathing rates and control room occupancy factors.

5.1.1 TID-14844 Source Term

Fission product releases specified in TID-14844 (DiNunno et al. 1962), as modified by NRC Regulatory Guides 1.3 and 1.4 (USNRC 1974; USNRC 1974), have been used to determine compliance with the NRC's reactor site criteria set forth in 10 CFR Part 100 and to evaluate other plant performance requirements. The original release assumptions were as follows:

1) Radionuclides are released from the reactor core to the reactor building or containment at the time of the postulated accident.

2) 100% of the noble gases (only krypton and xenon isotopes are treated explicitly), 50% of the halogens (only iodine isotopes are treated explicitly), and 1% of the solids (unspecified) in the the reactor fission product inventory are released. Only 50% of the iodine released from the core is assumed to be available for release to the environment.

3) Activity is gradually leaked to the environment at a constant leak rate of 0.1% of the building volume per day.

4) Fission products decay while confined but not after release to the environment.

The regulatory guides added assumptions about the form of the iodines. They changed the assumption about the leak rate to the environment, and they dropped all explicit references to solids.

The 1974 revisions to Regulatory Guides 1.3 and 1.4 assume that 91% of the iodine is elemental iodine, 5% of the iodine is associated with particles, and the remaining 4% is assumed to be in organic iodides.[1]

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[1] Safety Guide 4 (USAEC 1970) gives the partitioning as 85% elemental iodine, 5% particulate iodine, and 10% organic iodine.)

They also change the assumed leak rate from 0.1% per day to 100% of the technical specification leak rate for the first 24 hours and 50% of this leak rate for the remaining duration of the accident. The original assumptions, with these modifications, are collectively known as the TID source term.

The rationale for not including consideration of the 1% of the solid fission products in the regulatory guides is not known. However, it may be associated with differences in dose computations between TID-14844 and the regulatory guides. In TID-14844, thyroid doses are calculated from the iodine released to the environment, giving consideration to atmospheric dispersion, and whole body doses are calculated from gamma radiation from the containment building without credit for shielding. The contribution of gamma radiation from the plume to whole body doses is neglected. Solids only contribute to the whole body dose. In contrast, the procedures contained in the regulatory guides calculate both thyroid and whole body doses from the activity released to the environment, and neglect the gamma radiation from the containment.

The TACT series of codes were developed to make dose calculations using these assumptions. One of the consequences of this set of assumptions is that the release rate to the environment and the thyroid and whole body dose rates are a maximum at the time of the accident and decrease as various processes reduce the activity available for release. Thus, the doses at the exclusion area boundary for the first two hours of an accident are the maximum two-hour doses for the accident.

5.1.2 NUREG-1465 Source Term

Much of the impetus for revision of HABIT V1.0 so soon after its release came from initial attempts to make computations using the radionuclide source term described in NUREG-1465. The computations were possible, but several TACT5 runs and tedious manipulations of data files were required to reach the desired endpoints.

The basic release scenario in the NUREG-1465 source term is a gradual release of radionuclides from the reactor vessel to containment followed by release from containment to the environment. Consequently, the release to the environment is zero when the release from the reactor vessel begins and increases gradually as the activity in containment increases.

The NUREG-1465 source term groups radionuclides released from reactors during an accident into eight groups. The NUREG-1465 groups are the nine groups defined in the Source Term Code Package (STCP) (Gieseke et al. 1986) based on similarity in chemical behavior with the STCP groups for strontium and barium combined. HABIT V1.1 adds isotopes of uranium as a ninth group. These isotopes are generally greater hazards as heavy metals than they are as radioactive materials. The source term further classifies the releases by form based on chemical and physical characteristics of the effluent. The distribution (fraction) of the releases by form and group is shown in Table 5.1.

NUREG-1465 describes the release to the containment environment in five release phases and gives the duration for each phase for both PWRs and BWRs. The release phases are listed in Table 5.2. The activity released during the coolant activity phase is that associated with very small amounts of radioactivity dissolved in the coolant. It is not discussed any further.

Table 5.1 Radionuclide Forms by NUREG-1465 Group

	Form		
Group	Elemental	Organic	Particulate
Noble Gases	1.0		
Halogens	0.0485	0.0015	0.95
All Other Groups			1.00

Table 5.2 Release Phase Durations for the NUREG-1465 Source Term

Release Phase	PWR Duration (hr)	BWR Duration (hr)
Coolant Activity	10 to 30 sec*	30 sec*
Gap Activity	0.5	0.5
Early In-Vessel	1.3	1.5
Ex-Vessel	2	3
Late Ex-Vessel	10	10

* Without approval for leak-before-break. A duration of 0.17 hr is assumed with leak-before-break approval.

Core release fractions for the last four phases are given by radionuclide group in Tables 3.12 and 3.13 of NUREG-1465 for BWRs and PWRs, respectively. The release phase durations have been used to convert the release fractions to release rates for use in HABIT V1.1. These release rates are presented in Tables 5.3 and 5.4. Table 5.3 gives the rate of release (fraction/hr) for each group for BWRs as a function of time, and Table 5.4 gives the rates of release (fraction/hr) for PWR reactors.

Table 5.3 NUREG-1465 BWR Reactor Vessel Release Rates (fraction/hr)

	Time Period (hrs)			
Group	0 to 0.5	0.5 to 2.0	2.0 to 5.0	5.0 to 12.0
Noble Gases	0.1	6.33E-01	0.0	0.0
Halogens	0.1	1.67E-01	1.01E-01	1.00E-03
Alkali Metals	0.1	1.33E-01	1.18E-01	1.00E-03
Tellurium Group	0.0	3.33E-02	8.38E-02	5.00-04
Barium/Strontium	0.0	1.33E-02	3.33E-02	0.0
Noble Metals	0.0	1.67E-03	8.33E-04	0.0
Lanthanides	0.0	1.33E-04	1.67E-03	0.0
Cerium Group	0.0	3.33E-04	1.67E-03	0.0

Table 5.4 PWR Reactor Vessel Release Rates (fraction/hr)

	Time Period			
Group	0 to 0.5 hr	0.5 to 1.8 hr	1.8 to 3.8 hr	3.8 to 11.8 hr
Noble Gases	0.1	7.31E-01	0.0	0.0
Halogens	0.1	2.69E-01	1.35E-01	1.00E-02
Alkali Metals	0.1	1.92E-01	1.85E-01	1.00E-02
Tellurium Group	0.0	3.85E-02	1.255E-01	5.00-04
Barium/Strontium	0.0	1.54E-02	5.00E-02	0.0
Noble Metals	0.0	1.92E-03	1.25E-03	0.0
Lanthanides	0.0	1.54E-04	2.50E-03	0.0
Cerium Group	0.0	3.85E-04	2.50E-03	0.0

5.1.3 Breathing Rates and Occupancy Factors

Inhalation dose calculations require a breathing rate and exposure duration. Table 5.5 contains the accepted breathing rates and control room occupancy factors. Breathing rates must be entered for TACT5; in CONHAB the breathing rate is included as part of the code. If TACT5 is used to estimate control room operator doses, the breathing rate entered for the control room (other) should include the occupancy factor.

Table 5.5 Breathing Rates and Occupancy Factors

Time (hr)	Breathing Rate (m^3/s)			Control Room	
	EAB	LPZ	Control Room	Occupancy Factor	Breathing Rate × Occupancy Factor
0	3.47 E-4	3.47 E-4	3.47 E-4	1.0	3.47 E-4
8		1.75 E-4			
24		2.32 E-4		0.6	2.082 E-4
96				0.4	1.388 E-4

5.1.4 Other Input Parameters

TACT5 and CONHAB require other parameters such as node volumes, removal rate coefficients, flows, filter efficiencies, and atmospheric dilution factors. These parameters vary from problem to problem. They are given in the sample problems as they are needed.

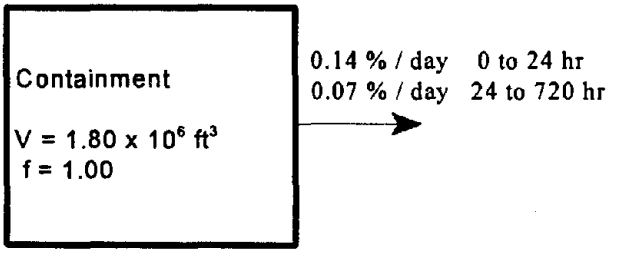
Information related to node volumes, flows, and filter efficiencies may be found in the plant description sections of safety analysis reports and environmental reports. Various vendor's manuals may also contain useful information.

There are numerous technical reports dealing with removal processes within containment. Simplified models for removal processes are described in three reports from Sandia National Laboratory. Powers and Burson (1993) discuss aerosol removal by sprays. Aerosol removal by natural deposition in containments is discussed in NUREG/CR-6189 by Powers et al. (1994), and decontamination of flows through BWR reactor steam suppression pools is discussed by Powers (1997).

Atmospheric dispersion factors (X/Q) are determined using meteorological data. The PAVAN code (Bander 1982) implements the procedure for calculating X/Qs for the EAB and LPZ that are described in Regulatory Guide 1.145. Atmospheric dispersion factors for use in control room habitability assessments may be estimated using the Murphy-Campe (1974) procedure referenced in Standard Review Plan 6.4 or using the procedure implemented in ARCON96 (Ramsdell and Simonen 1997) within limitations set by NRC.

5.2 Sample Problem 1 -- Simple Release

The first sample problem is a repeat of Example 1 presented by West and Gilpin (1988). It is a release from the reactor core to containment with subsequent leakage to the environment. Assume a 2700 MW_t reactor and a TID-14844 source term except for the iodine forms. Assume the iodine distribution is 0.955 elemental, 0.025 organic, and 0.02 particulate. The following diagram shows the containment node (volume = 1.8×10^6 ft^3) and an unfiltered release path. Note that the release rate decreases after 24 hours. Iodine deposition in containment is accounted for by assuming that only 25% of the iodine is released. No additional credit for deposition is given. The f = 1.00 in the diagram indicates that 100% of the activity is released to containment.



Atmospheric dilution factors for the problem are given in the following table. Only one dilution factor is given for the EAB. It is used to find the maximum 2-hr doses at the EAB. The EAB dilution factor was set to 0.0 after 2 hr in HABIT V1.0 because HABIT V1.0 was developed for use with the TID-14844 source term. It is no longer necessary to set the value to 0.0. If the dilution factor is changed, TACT5 will not calculate maximum 2-hr doses. Use the ICRP-2 (ICRP 1959) dose factors to calculate whole body and thyroid doses.

Location	Time Period	Dilution Factor (s/m^3)
EAB	0 to 720 hr	3.70×10^{-4}
LPZ	0 to 8 hr	1.90×10^{-5}
	8 to 24 hr	9.70×10^{-6}
	24 to 96 hr	5.30×10^{-6}
	96 to 720 hr	1.20×10^{-6}
Control Room	NA	NA

If the problem is set up correctly and there are no errors in data entry, the following results should be obtained. The 2-hr doses at the EAB and the doses for the LPZ are identical to the doses presented in the TACT5 manual (West and Gilpin 1988).

Dose summary for multinode containment with ESF

WHOLEBDY dose commitment during step (rem)
Cumulative committed dose (rem)

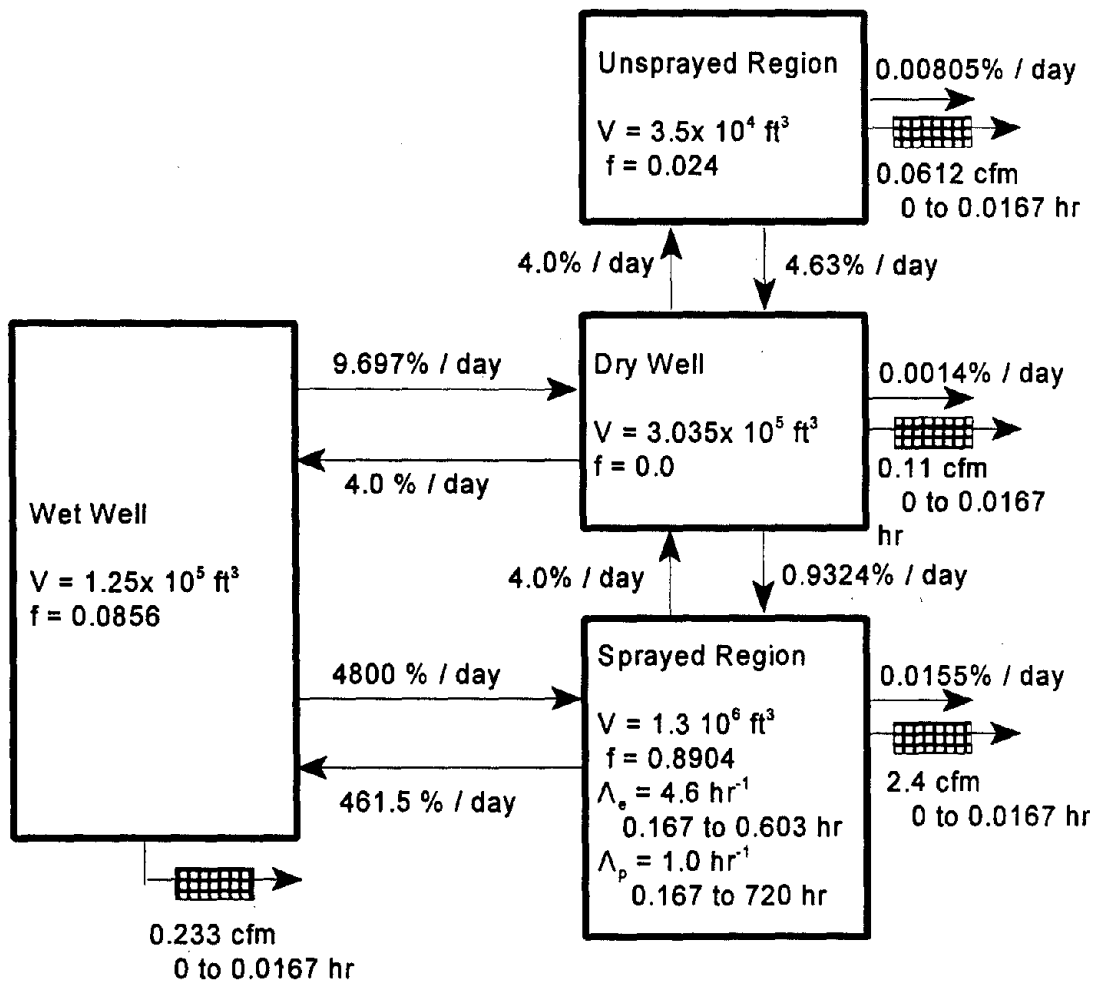
End Time (hrs)	EAB Step Dose	EAB Cum Dose	LPZ Step Dose	LPZ Cum Dose	Other Step Dose	Other Cum Dose
2.000	4.39E+00	4.39E+00	2.25E-01	2.25E-01	0.00E+00	0.00E+00
8.000	5.35E+00	9.73E+00	2.75E-01	5.00E-01	0.00E+00	0.00E+00
24.000	4.75E+00	1.45E+01	1.24E-01	6.24E-01	0.00E+00	0.00E+00
96.000	2.84E+00	1.73E+01	4.07E-02	6.65E-01	0.00E+00	0.00E+00
720.000	4.46E+00	2.18E+01	1.45E-02	6.79E-01	0.00E+00	0.00E+00

THYROID dose commitment during step (rem)
Cumulative committed dose (rem)

End Time (hrs)	EAB Step Dose	EAB Cum Dose	LPZ Step Dose	LPZ Cum Dose	Other Step Dose	Other Cum Dose
2.000	6.75E+02	6.75E+02	3.47E+01	3.47E+01	0.00E+00	0.00E+00
8.000	1.82E+03	2.49E+03	9.33E+01	1.28E+02	0.00E+00	0.00E+00
24.000	4.03E+03	6.52E+03	5.33E+01	1.81E+02	0.00E+00	0.00E+00
96.000	6.18E+03	1.27E+04	5.91E+01	2.40E+02	0.00E+00	0.00E+00
720.000	1.65E+04	2.92E+04	3.58E+01	2.76E+02	0.00E+00	0.00E+00

5.3 Sample Problem 2 -- LOCA with Sprays

The second sample problem is example 2 from the TACT5 manual (West and Gilpin 1988). It is a more complex model in which containment is represented by four nodes. The diagram below shows the nodes. The activity (25% of the halogens and 100% of the noble gases) released from a 4100 MW_t reactor (TID-14844 source term) is distributed among three of the nodes and mixes to the other node. Flows between the nodes and from the nodes to the environment are indicated by the arrows. Sprays are used to reduce the airborne concentration of elemental halogens from 0.167 hr to 0.603 hr. The spray removal rate (Λ_e) is 4.6 hr^{-1}. In addition after 10 min, natural deposition processes deplete airborne halogen absorbed on particles with a removal rate of 1.0 hr^{-1}. In the TACT5 input file, West and Gilpin give the filter efficiency as 0.99 for all radionuclide groups and forms. This is a 0.99% filter efficiency because TACT5 requires that filter efficiencies be entered in percent. Calculate whole body and thyroid doses using ICRP-2 (ICRP 1959) dose factors and the atmospheric dilution factors given in the table.



Location	Time Period	Dilution Factor (s/m^3)
EAB	0 to 720 hr	6.90×10^{-4}
LPZ	0 to 8 hr	3.00×10^{-5}
	8 to 24 hr	2.00×10^{-5}
	24 to 96 hr	8.40×10^{-6}
	96 to 720 hr	2.40×10^{-6}
Control Room	NA	NA

The results of the TACT5 calculations for this problem are shown in the following output. The doses have been compared with and are identical to doses in the TACT5 output in Appendix D of the report by West and Gilpin.

```
Dose summary for multinode containment with ESF

WHOLEBDY dose commitment during step (rem)
Cumulative committed dose (rem)

     End       EAB       EAB       LPZ       LPZ     Other     Other
    Time      Step       Cum      Step       Cum      Step       Cum
   (hrs)      Dose      Dose      Dose      Dose      Dose      Dose
-------- --------- --------- --------- --------- --------- ---------
    .017 4.36E-01 4.36E-01 1.90E-02 1.90E-02 0.00E+00 0.00E+00
    .167 1.19E-01 5.55E-01 5.16E-03 2.41E-02 0.00E+00 0.00E+00
    .603 1.99E-01 7.54E-01 8.65E-03 3.28E-02 0.00E+00 0.00E+00
   2.000 3.61E-01 1.12E+00 1.57E-02 4.85E-02 0.00E+00 0.00E+00
   8.000 7.17E-01 1.83E+00 3.12E-02 7.97E-02 0.00E+00 0.00E+00
  24.000 5.34E-01 2.37E+00 1.55E-02 9.52E-02 0.00E+00 0.00E+00
  96.000 5.84E-01 2.95E+00 7.11E-03 1.02E-01 0.00E+00 0.00E+00
 720.000 8.72E-01 3.82E+00 3.03E-03 1.05E-01 0.00E+00 0.00E+00
-------- --------- --------- --------- --------- --------- ---------

 THYROID dose commitment during step (rem)
Cumulative committed dose (rem)

     End       EAB       EAB       LPZ       LPZ     Other     Other
    Time      Step       Cum      Step       Cum      Step       Cum
   (hrs)      Dose      Dose      Dose      Dose      Dose      Dose
-------- --------- --------- --------- --------- --------- ---------
    .017 3.25E+01 3.25E+01 1.41E+00 1.41E+00 0.00E+00 0.00E+00
    .167 1.12E+01 4.36E+01 4.85E-01 1.90E+00 0.00E+00 0.00E+00
    .603 1.57E+01 5.93E+01 6.83E-01 2.58E+00 0.00E+00 0.00E+00
   2.000 2.34E+01 8.28E+01 1.02E+00 3.60E+00 0.00E+00 0.00E+00
   8.000 8.91E+01 1.72E+02 3.88E+00 7.47E+00 0.00E+00 0.00E+00
  24.000 1.93E+02 3.65E+02 2.83E+00 1.03E+01 0.00E+00 0.00E+00
  96.000 5.72E+02 9.38E+02 4.66E+00 1.50E+01 0.00E+00 0.00E+00
 720.000 1.45E+03 2.39E+03 3.38E+00 1.83E+01 0.00E+00 0.00E+00
-------- --------- --------- --------- --------- --------- ---------
```

It is likely that the filter efficiency given above was supposed to be 99% rather than 0.99%. The sample problem was run a second time using 99% for the filter efficiency with the following results.

HABIT V1.1

Dose summary for multinode containment with ESF

WHOLEBDY dose commitment during step (rem)
Cumulative committed dose (rem)

End Time (hrs)	EAB Step Dose	EAB Cum Dose	LPZ Step Dose	LPZ Cum Dose	Other Step Dose	Other Cum Dose
.017	3.25E-01	3.25E-01	1.41E-02	1.41E-02	0.00E+00	0.00E+00
.167	1.19E-01	4.44E-01	5.16E-03	1.93E-02	0.00E+00	0.00E+00
.603	1.99E-01	6.43E-01	8.65E-03	2.80E-02	0.00E+00	0.00E+00
2.000	3.61E-01	1.00E+00	1.57E-02	4.37E-02	0.00E+00	0.00E+00
8.000	7.17E-01	1.72E+00	3.12E-02	7.49E-02	0.00E+00	0.00E+00
24.000	5.34E-01	2.26E+00	1.55E-02	9.03E-02	0.00E+00	0.00E+00
96.000	5.84E-01	2.84E+00	7.11E-03	9.75E-02	0.00E+00	0.00E+00
720.000	8.72E-01	3.71E+00	3.03E-03	1.00E-01	0.00E+00	0.00E+00

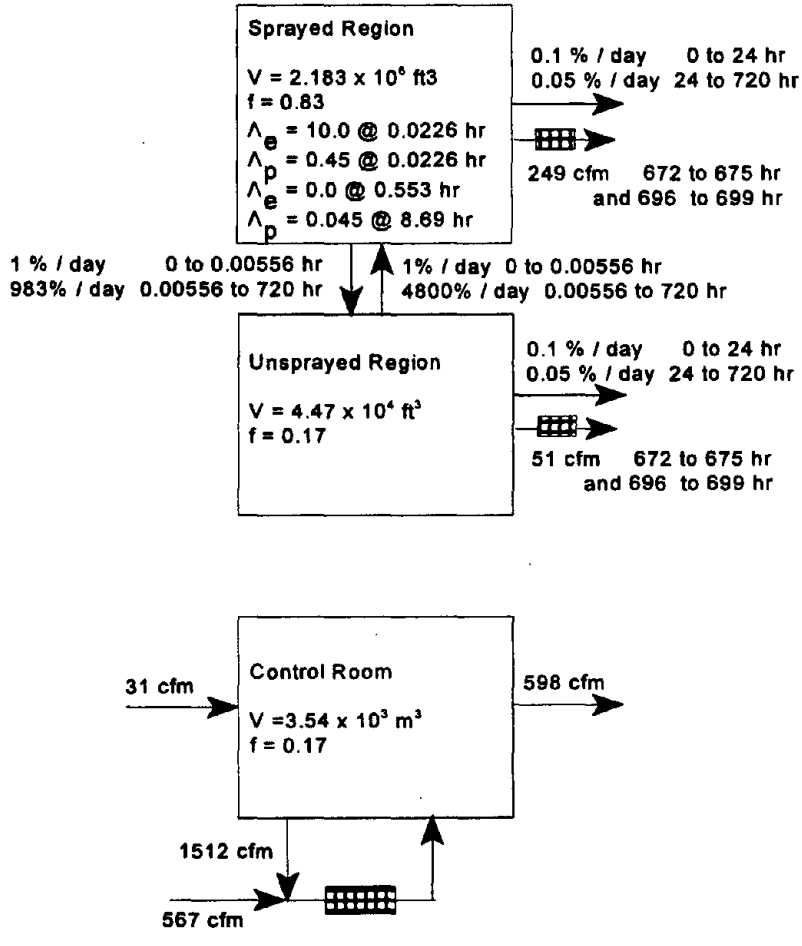
THYROID dose commitment during step (rem)
Cumulative committed dose (rem)

End Time (hrs)	EAB Step Dose	EAB Cum Dose	LPZ Step Dose	LPZ Cum Dose	Other Step Dose	Other Cum Dose
.017	1.56E+00	1.56E+00	6.78E-02	6.78E-02	0.00E+00	0.00E+00
.167	1.12E+01	1.27E+01	4.85E-01	5.53E-01	0.00E+00	0.00E+00
.603	1.57E+01	2.84E+01	6.83E-01	1.24E+00	0.00E+00	0.00E+00
2.000	2.34E+01	5.18E+01	1.02E+00	2.25E+00	0.00E+00	0.00E+00
8.000	8.91E+01	1.41E+02	3.88E+00	6.13E+00	0.00E+00	0.00E+00
24.000	1.93E+02	3.34E+02	2.83E+00	8.96E+00	0.00E+00	0.00E+00
96.000	5.72E+02	9.07E+02	4.66E+00	1.36E+01	0.00E+00	0.00E+00
720.000	1.45E+03	2.36E+03	3.38E+00	1.70E+01	0.00E+00	0.00E+00

Note that the differences in the doses are associated with the activity released during the first 0.017 hr (1 min).

5.4 Sample Problem 3 -- LOCA with Sprays and Control Room

Sample Problem 3 is a repeat of Demo 2 in the HABIT V1.0 manual. It is a release (TID-14844, 25% of the halogens and 100% of the noble gases) from a 3580 MW_t reactor to containment with reduction of airborne halogen concentrations by sprays and natural deposition. The node configuration for the problem is shown in the diagram. This problem goes beyond the previous problems by adding consideration of doses to control room operators.



Filter efficiencies for halogen are as follows:

		Form	
Containment:	elemental	organic	particulate
sprayed region	87.6%	68.13%	87.5%
unsprayed region	87.6%	68.13%	87.6%
Control room	95%	95%	95%

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Using the atmospheric dilution factors shown below and ICRP-30 (ICRP 1977) dose factors, calculate whole body and thyroid doses. Do not include occupancy factor in the breathing rate used for the control room (Other Location) in TACT5.

Location	Time Period	Dilution Factor (s/m^3)
EAB	0 to 720 hr	5.30×10^{-4}
LPZ	0 to 8 hr	2.40×10^{-4}
	8 to 24 hr	4.80×10^{-6}
	24 to 96 hr	1.50×10^{-6}
	96 to 720 hr	3.40×10^{-7}
Control Room	0 to 8 hr	1.114×10^{-3}
	8 to 24 hr	6.89×10^{-4}
	24 to 96 hr	2.475×10^{-4}
	96 to 720 hr	5.82×10^{-5}

The results of the dose calculations are as follows:

```
Dose summary for multinode containment with ESF

WHOLEBDY dose commitment during step (rem)
Cumulative committed dose (rem)

     End       EAB       EAB       LPZ       LPZ     Other     Other
    Time      Step       Cum      Step       Cum      Step       Cum
   (hrs)      Dose      Dose      Dose      Dose      Dose      Dose
-------- -------- -------- -------- -------- -------- --------
   2.000 1.60E+00 2.81E+00 7.24E-01 1.27E+00 3.36E+00 5.91E+00
   8.000 2.90E+00 5.72E+00 1.31E-01 1.41E+00 6.10E+00 1.20E+01
  24.000 1.74E+00 7.63E+00 1.58E-02 1.42E+00 2.27E+00 1.45E+01
  96.000 9.51E-01 8.59E+00 2.69E-03 1.43E+00 4.44E-01 1.50E+01
 720.000 7.39E-03 1.06E+01 4.74E-06 1.43E+00 8.12E-04 1.52E+01
-------- -------- -------- -------- -------- -------- --------

 THYROID dose commitment during step (rem)
Cumulative committed dose (rem)

     End       EAB       EAB       LPZ       LPZ     Other     Other
    Time      Step       Cum      Step       Cum      Step       Cum
   (hrs)      Dose      Dose      Dose      Dose      Dose      Dose
-------- -------- -------- -------- -------- -------- --------
   2.000 6.14E+01 1.18E+02 2.78E+01 5.35E+01 1.29E+02 2.48E+02
   8.000 2.08E+02 3.26E+02 9.42E+00 6.29E+01 4.37E+02 6.86E+02
  24.000 4.38E+02 7.86E+02 1.97E+00 6.50E+01 5.69E+02 1.28E+03
  96.000 7.59E+02 1.55E+03 1.44E+00 6.64E+01 3.55E+02 1.64E+03
 720.000 1.88E+01 4.03E+03 8.07E-03 6.75E+01 2.07E+00 1.91E+03
-------- -------- -------- -------- -------- -------- --------
```

Control Room Cumulative Doses by Organ (rem)

TIME (hr)	2.	8.	24.	96.	720.
ORGAN					
WHOLEBDY	4.550E-02	2.139E-01	3.219E-01	3.444E-01	3.543E-01
THYROID	4.617E+00	1.772E+01	3.591E+01	4.702E+01	5.653E+01

Note that during the initial time step, the convective flow from the sprayed region to the unsprayed region is 1%/day. This rate is with respect to the volume of the sprayed region. The flow from the unsprayed region to the sprayed region is also 1%/day. However, this flow is relative to the volume of the unsprayed region. More air is flowing from the sprayed region to the unsprayed region than is flowing from the unsprayed region to the sprayed region. TACT5 only maintains a balance of radionuclide activities. It does not attempt to maintain a mass balance for air, that is left to the user. Assuming that the flow from the sprayed region to the unsprayed region is correct, the flow from the unsprayed region should be 4.88%/day to maintain an air mass balance. Note also that the efficiency of the sprayed-region exhaust filter in removing particulate halogens is slightly different than the efficiency for the same filter for elemental halogens or the efficiencies for elemental and particulate halogens of the filter on the exhaust from the unsprayed region.

This sample problem was rerun with a 4.88%/day flow from the unsprayed region and an 87.6% efficiency for elemental and particulate halogens for the containment exhaust filters with the following results. Note the results are the same as the original to three significant figures.

Dose summary for multinode containment with ESF

WHOLEBDY dose commitment during step (rem)
Cumulative committed dose (rem)

End Time (hrs)	EAB Step Dose	EAB Cum Dose	LPZ Step Dose	LPZ Cum Dose	Other Step Dose	Other Cum Dose
2.000	1.60E+00	2.81E+00	7.24E-01	1.27E+00	3.36E+00	5.91E+00
8.000	2.90E+00	5.72E+00	1.31E-01	1.41E+00	6.10E+00	1.20E+01
24.000	1.74E+00	7.63E+00	1.58E-02	1.42E+00	2.27E+00	1.45E+01
96.000	9.51E-01	8.59E+00	2.69E-03	1.43E+00	4.44E-01	1.50E+01
720.000	7.39E-03	1.06E+01	4.74E-06	1.43E+00	8.12E-04	1.52E+01

THYROID dose commitment during step (rem)
Cumulative committed dose (rem)

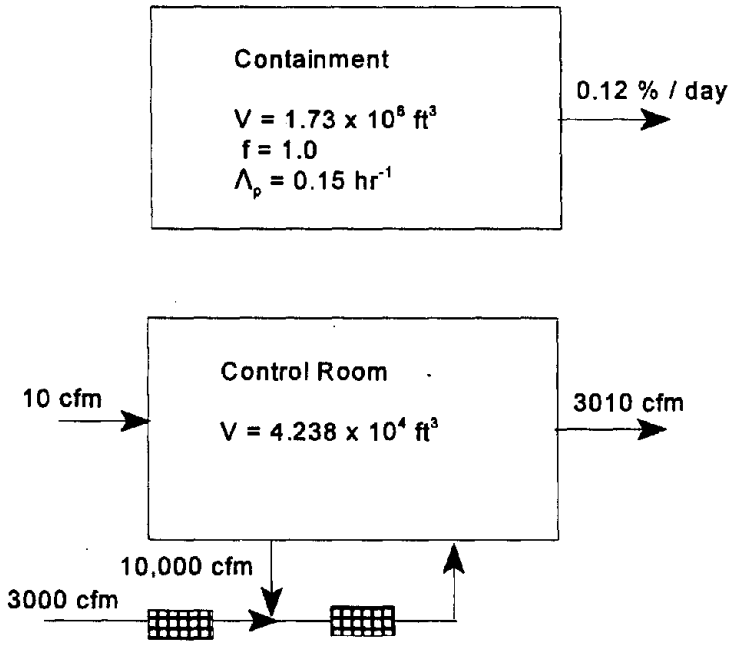
End Time (hrs)	EAB Step Dose	EAB Cum Dose	LPZ Step Dose	LPZ Cum Dose	Other Step Dose	Other Cum Dose
2.000	6.14E+01	1.18E+02	2.78E+01	5.35E+01	1.29E+02	2.48E+02
8.000	2.08E+02	3.26E+02	9.42E+00	6.29E+01	4.37E+02	6.86E+02
24.000	4.38E+02	7.86E+02	2.00E+00	6.50E+01	5.69E+02	1.28E+03
96.000	7.59E+02	1.55E+03	1.44E+00	6.65E+01	3.55E+02	1.64E+03
720.000	1.88E+01	4.03E+03	8.07E-03	6.76E+01	2.07E+00	1.91E+03

Control Room Cumulative Doses by Organ (rem)

TIME (hr)	2.	8.	24.	96.	720.
ORGAN					
WHOLEBDY	4.550E-02	2.139E-01	3.219E-01	3.444E-01	3.543E-01
THYROID	4.617E+00	1.772E+01	3.591E+01	4.702E+01	5.653E+01

5.5 Sample Problem 4 -- Simple Release, NUREG-1465 Source Term

Sample Problem 4 is a simple, single-node model to demonstrate the use of the NUREG-1465 source term. Activity is released to containment from a 1932 MW_t PWR and enters the environment by unfiltered leakage from containment. Assume natural deposition reduces the airborne particulate activity. Assume 90% efficiency for elemental and particulate halogens for the control room air filters.



Using the following atmospheric dilution factors and Federal Guidance Reports 11 & 12 dose factors, calculate TEDE and thyroid doses for EAB, LPZ, and the control room. Include the occupancy factor in calculating control room doses using TACT5. The ratio between the control room dose computed by TACT5 and the control room dose computed by CONHAB is an estimate of the iodine protection factor defined by Murphy and Campe (1974).

Location	Time Period	Dilution Factor (s/m^3)
EAB	0 to 720 hr	1.00×10^{-3}
LPZ	0 to 8 hr	1.35×10^{-4}
	8 to 24 hr	1.00×10^{-4}
	24 to 96 hr	5.40×10^{-5}
	96 to 720 hr	2.20×10^{-5}
Control Room	0 to 2 hr	2.20×10^{-3}
	2 to 8 hr	1.50×10^{-3}
	8 to 24 hr	1.30×10^{-3}
	24 to 96 hr	8.40×10^{-4}
	96 to 720 hr	4.80×10^{-4}

Dose summary for multinode containment with ESF

TEDE dose commitment during step (rem)
Cumulative committed dose (rem)

End Time (hrs)	EAB Step Dose	EAB Cum Dose	LPZ Step Dose	LPZ Cum Dose	Other Step Dose	Other Cum Dose
2.000	4.42E+00	2.20E+01	5.97E-01	2.97E+00	9.73E+00	4.83E+01
8.000	8.31E+01	1.05E+02	1.12E+01	1.42E+01	1.25E+02	1.73E+02
24.000	5.51E+01	1.60E+02	2.90E+00	1.71E+01	7.17E+01	2.45E+02
96.000	4.12E+01	2.01E+02	1.52E+00	1.86E+01	2.14E+01	2.66E+02
720.000	1.02E+02	3.03E+02	1.52E+00	2.01E+01	2.06E+01	2.87E+02

THYROID dose commitment during step (rem)
Cumulative committed dose (rem)

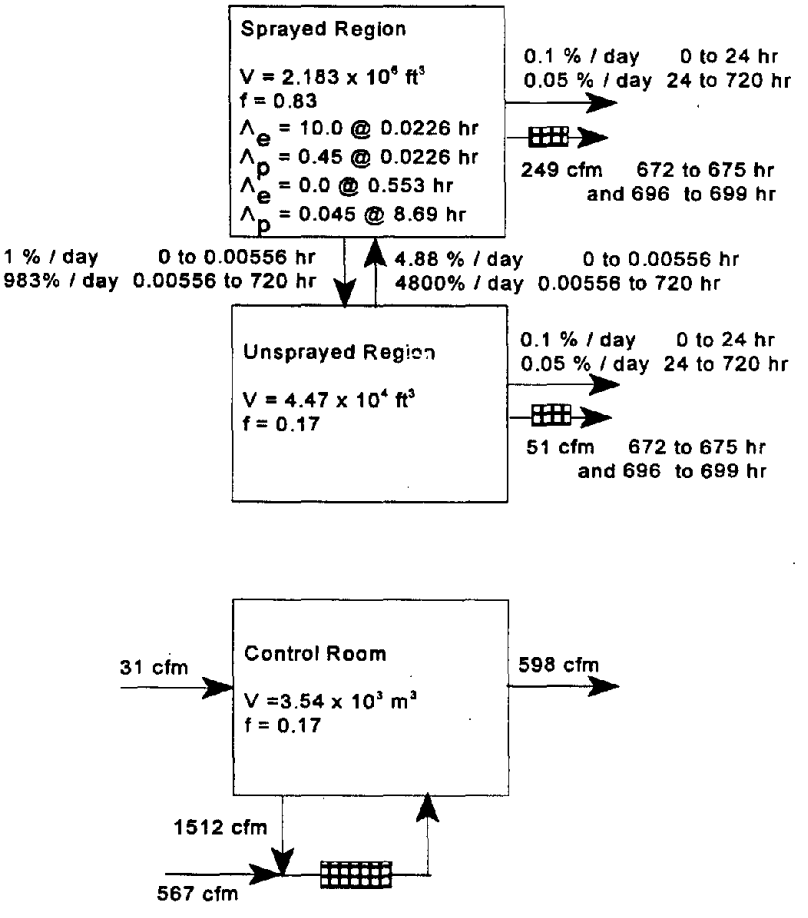
End Time (hrs)	EAB Step Dose	EAB Cum Dose	LPZ Step Dose	LPZ Cum Dose	Other Step Dose	Other Cum Dose
2.000	9.34E+01	4.68E+02	1.26E+01	6.32E+01	2.06E+02	1.03E+03
8.000	1.80E+03	2.27E+03	2.44E+02	3.07E+02	2.71E+03	3.74E+03
24.000	1.28E+03	3.55E+03	6.46E+01	3.71E+02	1.67E+03	5.40E+03
96.000	1.24E+03	4.79E+03	4.46E+01	4.16E+02	6.22E+02	6.02E+03
720.000	3.22E+03	8.01E+03	4.74E+01	4.63E+02	6.19E+02	6.64E+03

Control Room Cumulative Doses by Organ (rem)

TIME (hr)	2.	8.	24.	96.	720.
ORGAN					
TEDE	2.100E-01	9.163E-01	1.610E+00	2.230E+00	2.858E+00
THYROID	4.470E+00	2.029E+01	3.930E+01	5.865E+01	7.866E+01

5.6 Sample Problem 5 -- LOCA with Sprays, NUREG-1465 Source Term

Sample Problem 5 is a repeat of Sample Problem 3 using the NUREG-1465 BWR source term. Use balanced flow between the sprayed and unsprayed regions of containment, and assume a filter efficiency of 87.6% for the particulate releases from containment. The release path diagram for the problem and the atmospheric dilution factors are shown below.



Time Period	EAB	LPZ	Control Room
0 to 8 hr	5.30×10^{-4}	2.40×10^{-4}	1.114×10^{-3}
8 to 24 hr		4.80×10^{-6}	6.89×10^{-4}
24 to 96 hr		1.50×10^{-6}	2.475×10^{-4}
96 to 720 hr		3.40×10^{-7}	5.82×10^{-5}

The resulting doses are as follows:

Dose summary for multinode containment with ESF

TEDE dose commitment during step (rem)
Cumulative committed dose (rem)

End Time (hrs)	EAB Step Dose	EAB Cum Dose	LPZ Step Dose	LPZ Cum Dose	Other Step Dose	Other Cum Dose
2.000	1.23E+01	1.29E+01	5.55E+00	5.86E+00	2.58E+01	2.72E+01
8.000	3.35E+01	4.65E+01	1.52E+00	7.38E+00	7.05E+01	9.77E+01
24.000	1.76E+01	6.52E+01	8.61E-02	7.47E+00	2.28E+01	1.22E+02
96.000	1.61E+01	8.13E+01	3.13E-02	7.50E+00	7.52E+00	1.30E+02
720.000	2.44E-01	1.14E+02	1.06E-04	7.51E+00	2.68E-02	1.33E+02

THYROID dose commitment during step (rem)
Cumulative committed dose (rem)

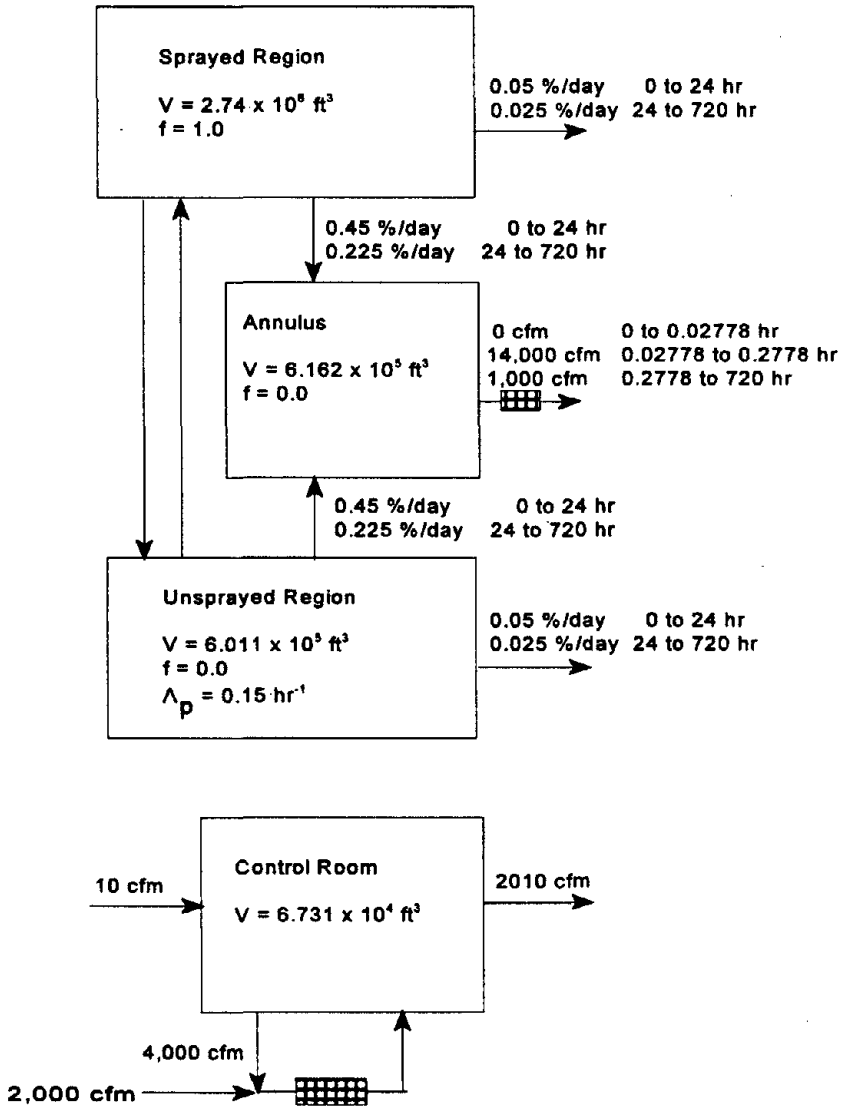
End Time (hrs)	EAB Step Dose	EAB Cum Dose	LPZ Step Dose	LPZ Cum Dose	Other Step Dose	Other Cum Dose
2.000	2.31E+02	2.46E+02	1.04E+02	1.11E+02	4.85E+02	5.17E+02
8.000	6.33E+02	8.79E+02	2.87E+01	1.40E+02	1.33E+03	1.85E+03
24.000	3.85E+02	1.29E+03	1.76E+00	1.42E+02	5.01E+02	2.38E+03
96.000	4.14E+02	1.70E+03	7.84E-01	1.43E+02	1.93E+02	2.57E+03
720.000	7.79E+00	2.69E+03	3.34E-03	1.43E+02	8.56E-01	2.68E+03

Control Room Cumulative Doses by Organ (rem)

TIME (hr)	2.	8.	24.	96.	720.
ORGAN					
TEDE	2.944E-01	2.487E+00	3.320E+00	3.576E+00	3.698E+00
THYROID	6.265E+00	4.990E+01	6.762E+01	7.392E+01	7.755E+01

5.7 Sample Problem 6 -- LOCA with Sprays and Natural Deposition

The last sample problem is a 3,992 MW_t PWR with a node containment model. The release to containment is assumed to occur in the sprayed region. There is convective flow from both the sprayed and unsprayed regions of containment to the annulus and between the sprayed and unsprayed regions. The flow rates to the annulus are shown in the flow diagram below. The flow rates between the sprayed and unsprayed regions are given in the following table along with the spray removal rates.



Time (hrs)	Convective Mixing (%/day)		Removal Rates (hr^{-1})
	Spray to Unsprayed	Unsprayed to Sprayed	Aerosol and Elemental except noble gases
0	1.053 E+3	4.8 E+3	1.5
0.1667	4.056 E+3	1.845 E+4	
0.5	4.425 E+3	2.016 E+4	12
1.175	2.951 E+3	1.344 E+4	
1.8	1.053 E+3	4.8 E+3	5
2			2
8			0.4

The efficiency of the filter between the annulus and the environment is 99% for particulate material (aerosols) and 0% for noble gases and elemental and organic halogens. The control room intake filter has a particulate efficiency of 99%, and an efficiency of 95% for elemental and organic halogens.

The atmospheric dilution factors are as follows:

Time	EAB	LPZ	Control Room
0 hr	1.00×10^{-3}	1.35×10^{-4}	2.20×10^{-3}
2 hr			1.50×10^{-3}
8 hr		1.00×10^{-4}	1.30×10^{-3}
24 hr		5.40×10^{-5}	8.40×10^{-4}
96 hr		2.20×10^{-5}	4.80×10^{-4}

The resulting doses are as follows:

Dose summary for multinode containment with ESF

TEDE dose commitment during step (rem)
Cumulative committed dose (rem)

End Time (hrs)	EAB Step Dose	EAB Cum Dose	LPZ Step Dose	LPZ Cum Dose	Other Step Dose	Other Cum Dose
2.000	4.43E-01	3.68E+00	5.98E-02	4.96E-01	9.74E-01	8.09E+00
8.000	8.13E+00	1.18E+01	1.10E+00	1.59E+00	1.22E+01	2.03E+01
24.000	1.02E+01	2.20E+01	8.95E-01	2.49E+00	1.33E+01	3.35E+01
96.000	1.34E+01	3.54E+01	6.30E-01	3.12E+00	9.50E+00	4.31E+01
720.000	2.56E+01	6.10E+01	4.73E-01	3.59E+00	8.71E+00	5.18E+01

THYROID dose commitment during step (rem)
Cumulative committed dose (rem)

End Time (hrs)	EAB Step Dose	EAB Cum Dose	LPZ Step Dose	LPZ Cum Dose	Other Step Dose	Other Cum Dose
2.000	5.06E+00	6.13E+01	6.83E-01	8.27E+00	1.11E+01	1.35E+02
8.000	3.82E+01	9.95E+01	5.16E+00	1.34E+01	5.73E+01	1.92E+02
24.000	8.05E+01	1.80E+02	4.06E+00	1.75E+01	1.05E+02	2.97E+02
96.000	1.69E+02	3.49E+02	6.10E+00	2.36E+01	8.52E+01	3.82E+02
720.000	4.10E+02	7.59E+02	6.02E+00	2.96E+01	7.86E+01	4.61E+02

Control Room Cumulative Doses by Organ (rem)

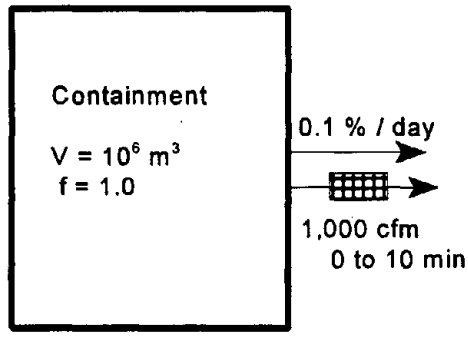
TIME (hr)	2.	8.	24.	96.	720.
ORGAN					
TEDE	6.628E-02	4.233E-01	8.302E-01	1.030E+00	1.163E+00
THYROID	7.770E-01	1.660E+00	3.596E+00	5.205E+00	6.653E+00

5.8 Templates

In preparation of the data input files for TACT5, it is frequently advantageous to start by copying existing files for a similar problem. The six sample problems provide files that may be copied. Initial design files for an additional four cases are included on the distribution disks for HABIT V1.1. The names of these template files start with "TMPL#" where # ranges from 1 through 4. The templates differ in source term and dose factors. The source term - dose factor combinations are shown in the following table:

Template	Source Term	Dose Factors
TMPL1	TID-14844	ICRP-2
TMPL2	TID-14844	ICRP-30
TMPL3	NUREG-1465 BWR	FGR 11 & 12
TMPL4	NUREG-1465 PWR	FGR 11 & 12

The scenario in the templates is a direct release of radionuclides to containment from a 3,000 MW_t reactor. The containment is vented to the atmosphere by a filtered pathway (1000 cfm) and has design leak rate of 0.1%/day. The vent fans shut down 10 minutes after the release to containment. The following diagram shows the release pathway.



Templates 1and 2 assume 50% of the halogens plate out immediately. Consequently, no other removal processes are modeled. Templates 3 and 4 include removal by natural deposition for particulate material and elemental halogens. A removal rate of 0.5 hr^{-1} is assumed. The filter efficiency is assumed to be 95% for particles and elemental halogens. Atmospheric dilution factors are given in the following table. Breathing rates are as given in the table in Section 5.1.3; the breathing rate for the control room includes the occupancy factor.

Time	EAB	LPZ	Control Room
0 to 8 hr	1.0×10^{-3}	1.0×10^{-4}	4.0×10^{-3}
8 to 24 hr		8.0×10^{-5}	3.0×10^{-3}
24 to 96 hr		2.0×10^{-5}	1.0×10^{-3}
96 to 720 hr		1.5×10^{-5}	7.0×10^{-4}

6 References

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Appendix A Radionuclide Data File Structure

The radionuclide data files provide the following input to HABIT:

- number of radionuclide groups and their names
- number of organs for dose calculations and their names
- contribution of the organ dose to TEDE
- number of physical forms for radionuclides in each group and the form names
- radionuclide name, group, and decay constant (s^{-1})
- specific core activity (Ci/MW_t)
- dose factors (both inhalation and submersion)
- flag to control correction of control room submersion doses for finite control room volume
- daughters and branching fractions.

Radionuclide data files are made known to HABIT Version 1.1 by including the names of the files in an ASCII file named MLWR.DAT. This file must be included in the directory that contains the HABIT Version 1.1 executable codes. This copy of the MLWR.DAT file distributed with HABIT V1.1 shows the names of the radionuclide data files that are included with HABIT V1.1.

C:\habit11\nfls\MLWR_TID.02
C:\habit11\nfls\MLWR_TID.30
C:\habit11\nfls\MLWR1465.bwr
C:\habit11\nfls\MLWR1465.pwr

The first two files in the list contain the radionuclide data that were included with TACT5 and HABIT V1.0. The files divide the radionuclides into five groups and three forms. The source term information is based on TID-14844 (DiNunno et al. 1962) and data presented by Blomeke and Todd (1958). Dose factors in the files are based on ICRP-2 (ICRP 1959)and ICRP-30 (ICRP 1977), respectively, and are provided for six "organs". The six organs are: wholebody, skin, thyroid, lung, bone, and liver.

The last two files divide the radionuclides into nine groups and three forms based on the chemical and physical properties of the element as outlined in NUREG-1465 (Soffer et al. 1995). Specific activities (Ci/MW_t) for radionuclides in the third file based on simulations for a boiling-water reactor, and those for radionuclides in the fourth file are for a pressurized-water reactor. Both sets of specific activities are taken from NUREG/CR-4467 (Alpert et al. 1986). The dose factors in the files are taken from Federal Guidance Reports 11 (Eckerman et. al. 1988) and Federal Guidance Reports 12 (Eckerman and Ryman 1993). Dose factors are provided for 10 "organs." The organs are: total effective dose equivalent (TEDE), deep dose, committed effective dose equivalent (CEDE), skin, thyroid, lung, red bone marrow, bone surface, gonads, and breast.

The files are divided into two sections. The first section contains notes related to the data in the file. The second section contains the data used by TACT5 and CONHAB. The first line of the file must start with the keyword "FILENAME:" beginning in the first column. This keyword indicates that the file as a HABIT Version 1.1 formatted file. The keyword "STARTDATA:" marks the end of the section and the beginning of the data. It must also start in the first column. None of the information between these keywords is used in computations. There is no required format for the information. However, the

information is copied to the primary output files of both TACT5 and CONHAB. Therefore, the section provides a good place to document the contents of the file. The following example shows the first section of a radionuclide data file.

```
FILENAME:     MLWR_TID.30

Organs:       Whole Body, Skin, Thyroid, Lung, Bone, Liver

Source Term:  TID 14844 groups.

        The core specific activities (Ci/Mwt) in the file are the
        same as listed in NUREG/CR-5106. The core specific activities
        for I-131, I-132, I-133, I-134, and I-135 come directly
        from Table I of TID-14844.  Those for the isotopes of Xe,
        Kr-85m and Kr-88 appear to have been calculated from the data
        in Table IV. of TID-14844.  The origin of the remaining
        specific activities is uncertain.  However, they may be based
        on data published by Blomeke and Todd in 1958 (TID-14844
        reference 11).

        Note that except for the iodines and noble gases, there
        were significant changes in specific activities from the
        radionuclide library associated with TACT3 (NUREG/CR-3287)
        to the library for TACT5 published in NUREG/CR-5106.

Dose Factors: ICRP 30 Methodology.

        Submersion dose factors are for the skin and other organs
        are included only for noble gases; contributions from
        remaining radionuclides are not considered. Noble gas dose
        factors for thyroid, lung, bone, and liver are entered as
        inhalation dose factors.  This is consistent with the way
        they were treated in earlier versions of TACT5, CONHAB, and
        HABIT.  Apparently, the dose factors were divided by values
        that are of the order of magnitude of breathing rate.

        All of the dose factors for many of the radionuclides in
        this file are zero.  This is consistent with the previous
        files.

History:      Created October 23, 1997 at Pacific Northwest National
        Laboratory.  Based on the MLWRICRP.30 file included
        with HABIT 1.0.

Note:         The order of the noble gas and halogen radionuclide groups
        has been reversed in this file compared with the previous
        files on which this file was based.

Format:       HABIT Version 1.1

STARTDATA:
```

When the programs reading the radionuclide data files encounter the keyword STARTDATA:, they begin reading data used in computations. This section of radionuclide data files is also divided into two parts. The first part contains information that is used to control program execution. It also contains names for element groups, organs, and element forms. The remainder of the section contains the information on specific isotopes

Here is an example of the first part of the second section of a radionuclide data file.

```
STARTDATA:
      5       6       3
NobleGasHalogens  Solids SodiumsPlutoniums
      2       1       3       3       3
WHOLEBDY    SKIN THYROID    LUNG    BONE   LIVER
      0       0       1       1       1       1
      1       0       0       0       0       0
 1.00000 0.00000 0.03000 0.12000 0.12000 0.12000
   ELEM.    ORG.   PART.
```

The first record following the STARTDATA: keyword must contain three integers. The first integer is the number of element groups; the second integer is the number of organs, and the third integer is the number of isotopic forms. In the current versions of TACT5 and CONHAB, the maximum number of element groups is nine, and the maximum number of organs is 11. TACT5 and CONHAB recognize three physical and chemical forms for isotopes; therefore, the third integer should be a three. The integers must be separated by spaces. However, there are no other format requirements. If three integers are not included in the first record, the programs will not run.

The second record contains the element group names. It must include a name for each group. Group names are eight-character strings. These strings are not separated by spaces. The third record contains an integer flag for each group that is used in determining filter effectiveness in portions of CONHAB. Setting the flag for a group to 1 indicates that the elements in the group are halogens and may exist in elemental, organic, or particulate form. Setting a flag to 2 indicates that the elements in the group are noble gases, which are not affected by filters, and setting a flag to 3 indicates that the elements in the group will occur as particles. A flag must be included for each group.

The fourth record in the second section of the radionuclide data file contains the names of the organs for which doses may be computed. These names are eight character strings, which are not separated by spaces. A name must be included for each organ.

The fifth through seventh records contain information used in dose calculations. The first of these three records contains flags that controls which of the dose factors are used for calculating organ doses. Submersion dose factors are used if the flag for an organ is zero. Inhalation dose factors are used if the flag is one, and both submersion and inhalation dose factors are used if the flag is two. A dose factor flag must be included for each organ. The second record in this group of three records contains volume correction flags that are used in calculation of submersion doses in CONHAB. Submersion dose factors supplied with HABIT V1.1 assume exposure to a semi-infinite cloud. If the flag for an organ in this record is one, CONHAB will apply a correction factor in submersion dose calculations to account for the finite volume of the control room. If the flag is zero the correction for finite volume will not be made. A volume correction flag must be entered for each organ. The last of the three records related to organ doses contains the weighting factor for the organ in calculation of CEDE. A weight of one should be entered for TEDE, CEDE, and deep dose, and a weight of zero should be entered for skin and other organs not included in CEDE. A weighting factor must be entered for each organ.

The last record in the first part of the second section of radionuclide data files lists the names of the forms in which material may exist in TACT5 and CONHAB. An eight-character name must be entered for each form. The names are not separated by spaces. Filter efficiencies and depletion factors for each form and group are entered manually as needed in TACT5 and CONHAB.

The remainder of the radionuclide data files contains isotope specific information. A set of six records is used to enter the information for each isotope. Data may be entered for a maximum of 130 isotopes. Here are extracts of data for several isotopes from the MLWR_TID.30 data file.

```
KR  85M
          1  4.38500e-05  1.29700e+04
 2.31000e-02  4.97000e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.91900e+00  0.00000e+00  0.00000e+00
          1  KR  85       2.11000e-01

KR  85
          1  2.04200e-09  4.10200e+02
 3.31000e-04  4.84000e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.41600e+00  0.00000e+00  0.00000e+00
          0

I  131
          2  9.96400e-07  2.50800e+04
 5.59000e-02  3.07000e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  1.10000e+06  0.00000e+00  3.14900e+03  4.47000e+03
          1  XE 131M      1.10000e-02

XE 131M
          1  6.68000e-07  2.59500e+02
 1.25000e-03  1.33000e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.40000e+00  0.00000e+00  0.00000e+00
          0

TE 131
          3  4.62000e-04  2.74100e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  1.17000e-03  1.74000e+02  1.39000e-03  7.44000e-04
          1  I  131       1.00000e+00

TE 131M
          3  6.41600e-06  4.80000e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  6.87900e+00  1.82300e+04  8.74300e+00  5.45000e+00
          2  I  131       7.78000e-01  TE 131       2.22000e-01

I  132
          2  8.26900e-05  3.80600e+04
 3.55000e-01  1.10000e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  6.30000e+03  0.00000e+00  1.44700e+02  4.07000e+02
          0
```

The first record in each isotope data set is skipped. It may a blank line, or it may contain information not otherwise needed. However, the line must be included or the programs will not run. The second line in the set contains the isotope name. The name is an eight-character string. If the isotope is listed as daughter for another isotope, then an identical eight-character string must be used in both places. The third line in the isotope data set starts with an integer that specifies the element group, and continues with the decay constant for the isotope (s^{-1}) and the normalized core inventory (Ci/MW_t). These three entries must be separated by spaces.

The fourth and fifth lines of the isotope data set contain dose factors. Submersion dose factors, by organ, are contained in the fourth line. The deepdose or wholebody dose factor for the isotope should be also entered for TEDE if TEDE is included as an organ. Inhalation dose factors are entered in the fifth line of the set. If TEDE is included as an organ, the CEDE dose factor should be included as the inhalation dose

factor for TEDE. Dose factor entries must be separated by spaces. There must be both a submersion dose factor and an inhalation dose factor for each organ, although both dose factors may be zero.

The sixth and last record in the isotope data set contains decay chain information. The first entry in the record is an integer giving the number of daughter isotopes. This integer is followed by a pair of entries for each daughter. The first element in each pair is the eight-character name of the daughter isotope, and the second element is the fractional yield of the daughter. The entries are separated by spaces.

Appendices B through E list the radionuclide data files that are included with HABIT V1.1.

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Appendix B MLWR_TID.02 File

FILENAME: MLWR_TID.02

Organs: Whole Body, Skin, Thyroid, Lung, Bone, Liver

Source Term: TID 14844 groups.

The core specific activities (Ci/Mwt) in the file are the same as listed in NUREG/CR-5106. The core specific activities for I-131, I-132, I-133, I-134, and I-135 come directly from Table I of TID-14844. Those for the isotopes of Xe, Kr-85m and Kr-88 appear to have been calculated from the data in Table IV. of TID-14844. The origin of the remaining specific activities is uncertain. However, they may be based on data published by Blomeke and Todd in 1958 (TID-14844 reference 11).

Note that except for the iodines and noble gases, there were significant changes in specific activities from the radionuclide library associated with TACT3 (NUREG/CR-3287) to the library for TACT5 published in NUREG/CR-5106.

Dose Factors: ICRP 2 Methodology

Inhalation dose factors are generally consistent with the adult inhalation dose factors in Regulatory Guide 1.109 (Table E-7). The primary exceptions are the thyroid dose factors for the iodines. Regulatory Guide 1.109 contains many dose factors that are not included in this file, and the file contains dose factors for radionuclides that are not listed in the regulatory guide. The inhalation dose factor for liver in the file is a factor of 100 higher than the dose factor in the regulatory guide.

Wholebody dose factors for the noble gases are consistent with the dose factors listed in Table B-1 of Regulatory Guide 1.109, except for Kr-83m. The Kr-83m dose factor in the file is approximately a factor of 2 higher than the comparable value derived from the regulatory guide.

Submersion dose factors for skin and other organs are only included for noble gases; contributions to the dose from remaining radionuclides are not considered. Noble gas dose factors for thyroid, lung, bone, and liver are entered as inhalation dose factors. This is consistent with the way they were treated in earlier versions of TACT5, CONHAB, and HABIT. Apparently, the dose factors were divided by values that are of the order of magnitude of breathing rate.

All of the dose factors for many of the radionuclides in this file are zero. This is consistent with the previous files.

History: Created October 23, 1997 at Pacific Northwest National Laboratory. Based on the MLWRICRP.02 file contained in HABIT 1.0.

Notes: The order of the halogens and noble gases has been reversed in this file compared to the order in the original HABIT 1.0 file.

Format: HABIT Version 1.1

HABIT V1.1

```
STARTDATA:
      5       6       3
NobleGasHalogens  Solids SodiumsPlutonms
      2       1       3       3       3
WHOLEBDY    SKIN THYROID    LUNG    BONE   LIVER
      0       0       1       1       1       1
      1       0       0       0       0       0
 1.00000 0.00000 0.03000 0.12000 0.12000 0.12000
   ELEM.    ORG.   PART.

 NA  22
           4  8.44800e-09  2.38400e-06
  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
  0.00000e+00  0.00000e+00  1.30000e+04  1.30000e+04  1.30000e+04  1.30000e+04
           0

 NA  24
           4  1.27300e-05  1.42900e+00
  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
  0.00000e+00  0.00000e+00  1.27800e+03  1.27800e+03  1.27800e+03  1.28000e+03
           0

 GE  77
           3  1.70300e-05  3.76100e+01
  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
           0

 SE  79
           3  3.38100e-13  6.92100e-03
  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
  0.00000e+00  0.00000e+00  0.00000e+00  4.47000e+04  0.00000e+00  3.83000e+02
           0

 BR  82
           2  5.45600e-06  6.90500e+01
  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
           0

 KR  83M
           1  1.03500e-04  4.15200e+03
  5.02000e-06  1.14800e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
  0.00000e+00  0.00000e+00  0.00000e+00  5.20100e-01  0.00000e+00  0.00000e+00
           0

 BR  83
           2  8.02100e-05  2.93000e+03
  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
           0

 BR  84
           2  3.64600e-04  4.33900e+03
  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
           0

 KR  85M
           1  4.38500e-05  1.29700e+04
  3.72000e-02  1.18900e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
  0.00000e+00  0.00000e+00  0.00000e+00  2.91900e+00  0.00000e+00  0.00000e+00
           1  KR  85       2.11000e-01
```

```
KR  85
          1  2.04200e-09  4.10200e+02
 5.25000e-04  6.88100e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.41600e+00  0.00000e+00  0.00000e+00
          0

BR  85
          2  3.85000e-03  4.92300e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          0

RB  86
          3  4.28900e-07  1.32400e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  1.69000e+04
          0

KR  87
          1  1.51900e-04  2.33500e+04
 1.87000e-01  5.96100e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.53700e+01  0.00000e+00  0.00000e+00
          0

KR  88
          1  6.87500e-05  3.20000e+04
 4.64000e-01  6.62700e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  3.13600e+01  0.00000e+00  0.00000e+00
          1  RB  88       1.00000e+00

RB  88
          3  6.46800e-04  1.20000e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  4.84000e+01
          0

KR  89
          1  3.63000e-03  3.97900e+04
 5.25000e-01  9.22220e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          0

RB  89
          3  3.62900e-03  1.53800e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  3.20000e+01
          1  SR  89       1.00000e+00

SR  89
          3  1.58800e-07  1.55200e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.74900e+05  3.80100e+04  0.00000e+00
          0

RB  90
          3  3.98200e-03  1.33500e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          0

SR  90
          3  8.02100e-10  7.40100e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.19600e+06  1.24400e+07  0.00000e+00
          1  Y   90       1.00000e+00
```

```
Y   90
          3  2.99300e-06  7.88700e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.12000e+04  2.61200e+02  0.00000e+00
          0

SR  91
          3  2.00500e-05  2.11800e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.55700e+03  7.74100e+00  0.00000e+00
          2  Y   91M      5.74000e-01  Y   91       4.26000e-01

Y   91M
          3  2.29200e-04  1.23000e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.40200e+02  3.26400e-02  0.00000e+00
          1  Y   91       1.00000e+00

Y   91
          3  1.38300e-07  2.12100e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.13000e+05  5.78100e+04  0.00000e+00
          0

SR  92
          3  7.29200e-05  2.50800e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.06100e+03  8.43100e-01  0.00000e+00
          1  Y   92       1.00000e+00

Y   92
          3  5.34700e-05  2.53500e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.96100e+03  1.29200e+00  0.00000e+00
          0

SR  93
          3  1.44400e-03  3.01700e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          0

Y   93
          3  1.90900e-05  3.16300e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  6.06200e+03  1.18200e+01  0.00000e+00
          1  ZR  93       1.00000e+00

ZR  93
          3  2.00600e-14  2.45900e-02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.12900e+04  5.22300e+04  2.92000e+03
          0

ZR  95
          3  1.26700e-07  3.85800e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.21400e+05  1.33900e+04  4.30000e+03
          0

NB  95
          3  2.29200e-07  3.84200e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  6.31100e+04  1.75800e+03  9.77000e+02
          0
```

```
ZR  97
          3  1.12900e-05  4.19700e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  9.83900e+03  1.21400e+01  2.45000e+00
          2  NB  97M      1.00000e+00  NB  97       5.30000e-02

NB  97M
          3  1.15500e-02  3.98700e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          1  NB  97       1.00000e+00

NB  97
          3  1.57300e-04  4.23500e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.99500e+02  2.77700e-02  7.03000e-03
          0

MO  99
          3  2.87400e-06  4.88600e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.14000e+04  0.00000e+00  1.51000e+03
          1  TC  99M      8.86000e-01

TC  99M
          3  3.18300e-05  4.27800e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  9.54600e+01  1.28700e-04  3.64000e-04
          0

TC  99
          3  1.04200e-13  2.53400e-01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.01100e+05  3.13200e+01  4.64000e+01
          0

TC 101
          3  8.25000e-04  5.18800e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.98500e+01  5.21500e-06  7.52000e-06
          0

RU 103
          3  2.02500e-07  5.38100e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  6.31200e+04  1.90600e+02  0.00000e+00
          0

RU 105
          3  4.22100e-05  4.05100e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.37500e+03  9.87700e-02  0.00000e+00
          1  RH 105       1.00000e+00

RU 106
          3  2.19700e-08  2.27000e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.17400e+06  8.64300e+03  0.00000e+00
          1  RH 106       1.00000e+00

RH 106
          3  2.31000e-02  2.27200e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          0
```

```
PD 107
         3  3.13900e-15  3.97500e-03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  9.47200e+03  0.00000e+00  8.27000e+01
         0

RH 109
         3  1.92500e-04  1.22300e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
         0

PD 109
         3  1.40700e-05  1.27700e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.85200e+03  0.00000e+00  4.63000e-01
         0

AG 111
         3  1.06900e-06  3.15900e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.33300e+04  4.25300e+01  1.78000e+01
         0

IN 115M
         3  4.22000e-05  9.01500e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  1.11400e+01  0.00000e+00  5.88800e+01  0.00000e+00
         0

SN 123
         3  2.75000e-04  1.83200e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  5.66500e+02  2.87800e+05  3.01500e+04  6.67000e+02
         0

SN 125
         3  8.44300e-07  5.69800e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  2.58800e+01  7.36700e+04  1.16200e+03  3.12000e+01
         1  SB 125       1.00000e+00

SB 125
         3  9.15800e-09  6.10300e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  6.74700e+00  2.17500e+05  6.66500e+03  7.44000e+01
         1  TE 125M      2.31000e-01

TE 125M
         3  1.38300e-07  1.25300e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  1.31300e+02  3.91900e+04  4.26800e+02  1.98000e+02
         0

SB 126
         3  6.41600e-07  9.70700e+01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  2.74600e+00  9.56900e+04  4.49700e+02  9.13000e+00
         0

SB 127
         3  2.06900e-06  4.52700e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  3.96800e-01  2.04800e+04  3.29900e+01  7.22000e-01
         2  TE 127       8.31000e-01  TE 127M      1.69000e-01
```

```
TE 127M
          3  7.63800e-08  6.11400e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  4.11000e+02  1.20000e+05  1.57500e+03  7.21000e+02
          1  TE 127       9.76000e-01

TE 127
          3  2.05600e-05  4.50100e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  1.32500e-01  8.13700e+02  1.75400e-01  8.03000e-02
          0

I  129
          2  1.29400e-15  0.00000e+00
 3.02000e-03  2.43500e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  5.54200e+06  0.00000e+00  2.47600e+03  2.11000e+03
          0

TE 129M
          3  2.35900e-07  1.66800e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  4.29700e+02  1.44800e+05  1.21900e+03  5.84000e+02
          1 TE 129       6.29000e-01

TE 129
          3  1.57300e-04  1.11100e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  4.87200e-03  2.41800e+02  6.21900e-03  2.99000e-03
          0

I  131
          2  9.96400e-07  2.50800e+04
 8.72000e-02  1.65500e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  1.48500e+06  0.00000e+00  3.14900e+03  4.47000e+03
          1  XE 131M      1.10000e-02

XE 131M
          1  6.68000e-07  2.59500e+02
 2.92000e-03  3.99500e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.40000e+00  0.00000e+00  0.00000e+00
          0

TE 131
          3  4.62000e-04  2.74100e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  1.17000e-03  1.74000e+02  1.39000e-03  7.44000e-04
          1  I  131       1.00000e+00

TE 131M
          3  6.41600e-06  4.80000e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  6.87900e+00  1.82300e+04  8.74300e+00  5.45000e+00
          2  I  131       7.78000e-01  TE 131       2.22000e-01

I  132
          2  8.26900e-05  3.80600e+04
 5.13700e-01  7.92700e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  5.35300e+04  0.00000e+00  1.44700e+02  4.07000e+02
          0

TE 132
          3  2.50600e-06  4.11500e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  2.36600e+01  3.59800e+04  3.25300e+01  2.69000e+01
          1  I  132       1.00000e+00
```

```
I  133
          2  9.21900e-06  5.62200e+04
 1.55100e-01  3.12000e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  3.97000e+05  0.00000e+00  1.07700e+03  1.85000e+03
          2  XE 133       9.71000e-01  XE 131M      2.90000e-02

XE 133M
          1  3.49000e-06  1.38400e+03
 8.00000e-03  5.39100e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.89000e+00  0.00000e+00  0.00000e+00
          1  XE 133       1.00000e+00

XE 133
          1  1.52200e-06  5.62200e+04
 9.33000e-03  5.45400e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.57300e+00  0.00000e+00  0.00000e+00
          0

TE 133M
          3  2.31000e-04  1.78900e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  6.26900e-03  5.50600e+02  7.24400e-03  5.40000e-03
          0

I  134
          2  2.22800e-04  6.57500e+04
 5.32700e-01  8.59300e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  2.53700e+04  0.00000e+00  8.04700e+01  2.16000e+02
          0

TE 134
          3  2.75000e-04  3.99900e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  3.43700e-03  4.37700e+02  3.84300e-03  3.22000e-03
          1  I  134       1.00000e+00

CS 134
          3  9.55100e-09  1.01900e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.21600e+04  4.66200e+04  1.06000e+05
          0

I  135
          2  2.86400e-05  5.10300e+04
 4.21700e-01  5.80300e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  1.23500e+05  0.00000e+00  3.35400e+02  8.73000e+02
          2  XE 135       8.35000e-01  XE 135M      1.65000e-01

XE 135M
          1  7.40000e-04  1.55700e+04
 9.92000e-02  1.48400e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.23100e+00  0.00000e+00  0.00000e+00
          1  XE 135       1.00000e+00

XE 135
          1  2.09200e-05  5.36300e+04
 5.72000e-02  1.62000e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.06100e+00  0.00000e+00  0.00000e+00
          0

CS 135
          3  7.29300e-15  2.90900e-02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.56600e+03  1.45900e+04  1.29000e+04
          0
```

```
I  136
           2  8.34900e-03  0.00000e+00
 6.78600e-01  1.30000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
           0

CS 136
           3  6.16000e-07  1.66700e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.50000e+03  4.87900e+03  1.83000e+04
           0

XE 137
           1  2.96100e-03  5.10300e+04
 4.53000e-02  5.67600e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.74800e+01  0.00000e+00  0.00000e+00
           0

CS 137
           3  7.29200e-10  1.90700e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  9.40000e+03  5.97700e+04  7.76000e+04
           1  BA 137M      1.00000e+00

BA 137M
           3  4.52900e-03  1.81100e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
           0

XE 138
           1  6.79600e-04  4.77500e+04
 2.81000e-01  4.24900e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.44500e+01  0.00000e+00  0.00000e+00
           1  CS 138       1.00000e+00

CS 138
           3  3.58700e-04  4.87800e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  6.06600e+00  4.13700e+01  7.76000e+01
           0

CS 139
           3  1.21600e-03  4.47800e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.83700e+00  2.55700e+01  3.63000e+01
           0

BA 139
           3  1.39300e-04  4.60400e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.69700e+02  1.16700e-01  8.32000e-05
           0

BA 140
           3  6.26600e-07  4.27400e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.58700e+05  4.88400e+03  6.13000e+00
           1  LA 140       1.00000e+00

LA 140
           3  4.77400e-06  4.34200e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.70100e+04  4.30100e+01  2.17000e+01
           0
```

```
BA 141
         3  6.41600e-04  4.34500e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.41900e+02  1.24700e-02  9.41000e-06
         1  LA 141       1.00000e+00

LA 141
         3  4.93600e-05  4.37100e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.34500e+03  5.34200e-01  1.66000e-01
         1  CE 141       1.00000e+00

CE 141
         3  2.50600e-07  4.38700e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.51700e+04  2.49400e+03  1.69000e+03
         0

BA 142
         3  1.05000e-03  3.76200e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.48700e+02  3.29400e-03  3.38000e-06
         1  LA 142       1.00000e+00

LA 142
         3  1.25500e-04  3.88300e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  7.90700e+02  8.53600e-02  3.88000e-02
         0

CE 143
         3  6.03000e-06  3.55200e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  9.97200e+03  2.33400e+01  1.72000e+01
         1  PR 143       1.00000e+00

PR 143
         3  5.85400e-07  3.46700e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  3.50600e+04  1.16800e+03  4.69000e+02
         0

CE 144
         3  2.76600e-08  2.29400e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  9.71600e+05  4.28600e+05  1.79000e+05
         1  PR 144       9.86000e-01

PR 144
         3  6.67600e-04  2.30200e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.27200e+02  3.76300e-03  1.56000e-03
         0

ND 147
         3  7.09800e-07  1.73300e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.75900e+04  6.59200e+02  7.62000e+02
         1  PM 147       1.00000e+00

PM 147
         3  8.71800e-09  4.88100e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  6.60200e+04  8.36800e+04  7.87000e+03
         0
```

```
ND 149
         3  9.66500e-05  1.12100e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  3.67600e+02  0.00000e+00
         0

PM 149
         3  3.62500e-06  1.12200e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  7.20600e+03  3.43900e+01  4.87000e+00
         0

PM 151
         3  6.87500e-06  6.82800e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  3.93900e+03  8.49600e+00  1.42000e+00
         0

SM 151
         3  2.16800e-10  7.22600e+01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.45400e+04  8.58900e+04  1.48000e+04
         0

EU 155
         3  1.29200e-08  2.97300e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  9.46300e+04  1.00500e+05  1.43000e+04
         0

EU 156
         3  5.34700e-07  1.57500e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  8.55600e+04  1.92700e+03  1.48000e+03
         0

GD 159
         3  1.06900e-05  3.08300e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  6.47800e+02  0.00000e+00
         0

U  235
         3  3.09600e-17  9.16900e-05
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.89600e+07  1.00100e+07  0.00000e+00
         0

U  237
         3  1.18800e-06  3.45600e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.02000e+04  3.67300e+01  0.00000e+00
         1  NP 237       1.00000e+00

NP 237
         3  1.02700e-14  2.15000e-03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  5.21500e+07  1.69300e+09  1.47000e+08
         0

PU 238
         5  2.43100e-10  2.77500e+01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.82500e+08  2.73700e+09  3.87000e+08
         0
```

```
NP 238
          3  3.81900e-06  7.74100e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.01600e+04  2.96200e+02  8.00000e+00
          1  PU 238       1.00000e+00

PU 239
          5  9.01200e-13  1.22700e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.71600e+08  3.18800e+09  4.31000e+08
          1  U  235       1.00000e+00

U  239
          3  4.91600e-04  8.92800e+05
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          1  NP 239       1.00000e+00

NP 239
          3  3.44200e-06  8.29300e+05
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.70200e+03  2.86600e+01  2.82000e+00
          1  PU 239       1.00000e+00

PU 240
          5  3.34200e-12  7.23500e+01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.71600e+08  3.18300e+09  4.30000e+08
          0

PU 241
          5  1.67100e-09  3.77900e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.51700e+05  6.40700e+07  3.28000e+06
          1  AM 241       1.00000e+00

AM 241
          3  4.80300e-11  1.57100e+01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  6.06200e+07  1.01300e+09  3.59000e+08
          1  NP 237       1.00000e+00

PU 242
          5  5.81200e-14  2.11000e-02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.65100e+08  2.95400e+09  4.15000e+08
          0

CM 242
          3  4.93600e-08  9.01800e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  3.92300e+07  1.48300e+07  1.51000e+07
          1  PU 238       1.00000e+00

AM 242M
          3  1.43200e-10  1.45700e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.44300e+07  1.01900e+09  3.46000e+08
          0

CM 243
          3  6.85500e-10  3.52800e-01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  6.31200e+07  7.85600e+08  2.97000e+08
          1  PU 239       1.00000e+00
```

```
AM 243
          3  2.76600e-12  5.30600e-02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  5.74700e+07  1.01300e+09  3.47000e+08
          1  NP 239       1.00000e+00

CM 244
          3  1.24800e-09  1.49700e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  6.06200e+07  5.90400e+08  2.54000e+08
          1  PU 240       1.00000e+00

AM 244
          3  4.43100e-04  3.18600e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  2.98500e+03  0.00000e+00
          1  CM 244       1.00000e+00
```

Appendix C MLWR_TID.30 File

FILENAME: MLWR_TID.30

Organs: Whole Body, Skin, Thyroid, Lung, Bone, Liver

Source Term: TID 14844 groups.

The core specific activities (Ci/Mwt) in the file are the same as listed in NUREG/CR-5106. The core specific activities for I-131, I-132, I-133, I-134, and I-135 come directly from Table I of TID-14844. Those for the isotopes of Xe, Kr-85m and Kr-88 appear to have been calculated from the data in Table IV. of TID-14844. The origin of the remaining specific activities is uncertain. However, they may be based on data published by Blomeke and Todd in 1958 (TID-14844 reference 11).

Note that except for the iodines and noble gases, there were significant changes in specific activities from the radionuclide library associated with TACT3 (NUREG/CR-3287) to the library for TACT5 published in NUREG/CR-5106.

Dose Factors: ICRP 30 Methodology.

Submersion dose factors are for the skin and other organs are included only for noble gases; contributions from remaining radionuclides are not considered. Noble gas dose factors for thyroid, lung, bone, and liver are entered as inhalation dose factors. This is consistent with the way they were treated in earlier versions of TACT5, CONHAB, and HABIT. Apparently, the dose factors were divided by values that are of the order of magnitude of breathing rate.

All of the dose factors for many of the radionuclides in this file are zero. This is consistent with the previous files.

History: Created October 23, 1997 at Pacific Northwest National Laboratory. Based on the MLWRICRP.30 file included with HABIT 1.0.

Note: The order of the noble gas and halogen radionuclide groups has been reversed in this file compared with the previous files on which this file was based.

Format: HABIT Version 1.1

```
STARTDATA:
      5       6       3
NobleGasHalogens  Solids SodiumsPlutonms
      2       1       3       3       3
WHOLEBDY    SKIN THYROID    LUNG    BONE   LIVER
      0       0       1       1       1       1
      1       0       0       0       0       0
 1.00000 0.00000 0.03000 0.12000 0.12000 0.12000
   ELEM.    ORG.   PART.

 NA  22
          4  8.44800e-09  2.38400e-06
  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
  0.00000e+00  0.00000e+00  1.30000e+04  1.30000e+04  1.30000e+04  1.30000e+04
          0
```

```
NA  24
           4  1.27300e-05  1.42900e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  1.27800e+03  1.27800e+03  1.27800e+03  1.28000e+03
           0

GE  77
           3  1.70300e-05  3.76100e+01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
           0

SE  79
           3  3.38100e-13  6.92100e-03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.47000e+04  0.00000e+00  3.83000e+02
           0

BR  82
           2  5.45600e-06  6.90500e+01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
           0

KR  83M
           1  1.03500e-04  4.15200e+03
 1.27000e-05  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  5.20100e-01  0.00000e+00  0.00000e+00
           0

BR  83
           2  8.02100e-05  2.93000e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
           0

BR  84
           2  3.64600e-04  4.33900e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
           0

KR  85M
           1  4.38500e-05  1.29700e+04
 2.31000e-02  4.97000e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.91900e+00  0.00000e+00  0.00000e+00
           1  KR  85       2.11000e-01

KR  85
           1  2.04200e-09  4.10200e+02
 3.31000e-04  4.84000e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.41600e+00  0.00000e+00  0.00000e+00
           0

BR  85
           2  3.85000e-03  4.92300e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
           0


RB  86
           3  4.28900e-07  1.32400e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  1.69000e+04
           0
```

```
KR  87
           1  1.51900e-04  2.33500e+04
 1.33000e-01  3.36000e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.53700e+01  0.00000e+00  0.00000e+00
           0

KR  88
           1  6.87500e-05  3.20000e+04
 3.38000e-01  7.76000e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  3.13600e+01  0.00000e+00  0.00000e+00
           1  RB  88       1.00000e+00

RB  88
           3  6.46800e-04  1.20000e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  4.84000e+01
           0

KR  89
           1  3.63000e-03  3.97900e+04
 3.03000e-01  3.47000e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
           0

RB  89
           3  3.62900e-03  1.53800e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  3.20000e+01
           1  SR  89       1.00000e+00

SR  89
           3  1.58800e-07  1.55200e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.74900e+05  3.80100e+04  0.00000e+00
           0

RB  90
           3  3.98200e-03  1.33500e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
           0

SR  90
           3  8.02100e-10  7.40100e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.19600e+06  1.24400e+07  0.00000e+00
           1  Y   90       1.00000e+00

Y   90
           3  2.99300e-06  7.88700e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.12000e+04  2.61200e+02  0.00000e+00
           0

SR  91
           3  2.00500e-05  2.11800e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.55700e+03  7.74100e+00  0.00000e+00
           2  Y   91M      5.74000e-01  Y   91       4.26000e-01


Y   91M
           3  2.29200e-04  1.23000e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.40200e+02  3.26400e-02  0.00000e+00
           1  Y   91       1.00000e+00
```

```
Y   91
          3  1.38300e-07  2.12100e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.13000e+05  5.78100e+04  0.00000e+00
          0

SR  92
          3  7.29200e-05  2.50800e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.06100e+03  8.43100e-01  0.00000e+00
          1  Y   92        1.00000e+00

Y   92
          3  5.34700e-05  2.53500e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.96100e+03  1.29200e+00  0.00000e+00
          0

SR  93
          3  1.44400e-03  3.01700e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          0

Y   93
          3  1.90900e-05  3.16300e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  6.06200e+03  1.18200e+01  0.00000e+00
          1  Zr  93        1.00000e+00

ZR  93
          3  2.00600e-14  2.45900e-02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.12900e+04  5.22300e+04  2.92000e+03
          0

ZR  95
          3  1.26700e-07  3.85800e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.21400e+05  1.33900e+04  4.30000e+03
          0

NB  95
          3  2.29200e-07  3.84200e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  6.31100e+04  1.75800e+03  9.77000e+02
          0

ZR  97
          3  1.12900e-05  4.19700e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  9.83900e+03  1.21400e+01  2.45000e+00
          2  NB  97M       1.00000e+00  NB  97        5.30000e-02

NB  97M
          3  1.15500e-02  3.98700e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          1 NB  97       1.00000e+00


NB  97
          3  1.57300e-04  4.23500e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.99500e+02  2.77700e-02  7.03000e-03
          0
```

```
MO  99
          3  2.87400e-06  4.88600e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.14000e+04  0.00000e+00  1.51000e+03
          1  TC  99M      8.86000e-01

TC  99M
          3  3.18300e-05  4.27800e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  9.54600e+01  1.28700e-04  3.64000e-04
          0

TC  99
          3  1.04200e-13  2.53400e-01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.01100e+05  3.13200e+01  4.64000e+01
          0

TC 101
          3  8.25000e-04  5.18800e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.98500e+01  5.21500e-06  7.52000e-06
          0

RU 103
          3  2.02500e-07  5.38100e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  6.31200e+04  1.90600e+02  0.00000e+00
          0

RU 105
          3  4.22100e-05  4.05100e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.37500e+03  9.87700e-02  0.00000e+00
          1  RH 105       1.00000e+00

RU 106
          3  2.19700e-08  2.27000e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.17400e+06  8.64300e+03  0.00000e+00
          1  RH 106       1.00000e+00

RH 106
          3  2.31000e-02  2.27200e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          0

PD 107
          3  3.13900e-15  3.97500e-03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  9.47200e+03  0.00000e+00  8.27000e+01
          0

RH 109
          3  1.92500e-04  1.22300e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          0

PD 109
          3  1.40700e-05  1.27700e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.85200e+03  0.00000e+00  4.63000e-01
          0
```

```
AG 111
         3  1.06900e-06  3.15900e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.33300e+04  4.25300e+01  1.78000e+01
         0

IN 115M
         3  4.22000e-05  9.01500e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  1.11400e+01  0.00000e+00  5.88800e+01  0.00000e+00
         0

SN 123
         3  2.75000e-04  1.83200e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  5.66500e+02  2.87800e+05  3.01500e+04  6.67000e+02
         0

SN 125
         3  8.44300e-07  5.69800e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  2.58800e+01  7.36700e+04  1.16200e+03  3.12000e+01
         1  SB 125       1.00000e+00

SB 125
         3  9.15800e-09  6.10300e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  6.74700e+00  2.17500e+05  6.66500e+03  7.44000e+01
         1  TE 125M      2.31000e-01

TE 125M
         3  1.38300e-07  1.25300e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  1.31300e+02  3.91900e+04  4.26800e+02  1.98000e+02
         0

SB 126
         3  6.41600e-07  9.70700e+01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  2.74600e+00  9.56900e+04  4.49700e+02  9.13000e+00
         0

SB 127
         3  2.06900e-06  4.52700e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  3.96800e-01  2.04800e+04  3.29900e+01  7.22000e-01
         2  TE 127       8.31000e-01  TE 172M      1.69000e-01

TE 127M
         3  7.63800e-08  6.11400e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  4.11000e+02  1.20000e+05  1.57500e+03  7.21000e+02
         1  TE 127       9.82000e-01

TE 127
         3  2.05600e-05  4.50100e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  1.32500e-01  8.13700e+02  1.75400e-01  8.03000e-02
         0

I  129
         2  1.29400e-15  0.00000e+00
 3.02000e-03  2.43500e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  5.54200e+06  0.00000e+00  2.47600e+03  2.11000e+03
         0
```

```
TE 129M
          3  2.35900e-07  1.66800e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  4.29700e+02  1.44800e+05  1.21900e+03  5.84000e+02
          1  TE 129       6.92000e-01

TE 129
          3  1.57300e-04  1.11100e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  4.87200e-03  2.41800e+02  6.21900e-03  2.99000e-03
          0

I  131
          2  9.96400e-07  2.50800e+04
 5.59000e-02  3.07000e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  1.10000e+06  0.00000e+00  3.14900e+03  4.47000e+03
          1  XE 131M      1.10000e-02

XE 131M
          1  6.68000e-07  2.59500e+02
 1.25000e-03  1.33000e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.40000e+00  0.00000e+00  0.00000e+00
          0

TE 131
          3  4.62000e-04  2.74100e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  1.17000e-03  1.74000e+02  1.39000e-03  7.44000e-04
          1  I  131       1.00000e+00

TE 131M
          3  6.41600e-06  4.80000e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  6.87900e+00  1.82300e+04  8.74300e+00  5.45000e+00
          2  I  131       7.78000e-01  TE 131       2.22000e-01

I  132
          2  8.26900e-05  3.80600e+04
 3.55000e-01  1.10000e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  6.30000e+03  0.00000e+00  1.44700e+02  4.07000e+02
          0

TE 132
          3  2.50600e-06  4.11500e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  2.36600e+01  3.59800e+04  3.25300e+01  2.69000e+01
          1  I  132       1.00000e+00

I  133
          2  9.21900e-06  5.62200e+04
 9.11000e-02  8.90000e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  1.80000e+05  0.00000e+00  1.07700e+03  1.85000e+03
          2  XE 133       9.70000e-01  XE 133M      2.90000e-02

XE 133M
          1  3.49000e-06  1.38400e+03
 4.29000e-03  2.96000e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.89000e+00  0.00000e+00  0.00000e+00
          1  XE 133       1.00000e+00

XE 133
          1  1.52200e-06  5.62200e+04
 4.96000e-03  9.67000e-03  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.57300e+00  0.00000e+00  0.00000e+00
          0
```

```
TE 133M
          3  2.31000e-04  1.78900e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  6.26900e-03  5.50600e+02  7.24400e-03  5.40000e-03
          0

I  134
          2  2.22800e-04  6.57500e+04
 4.11000e-01  1.42000e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  1.10000e+03  0.00000e+00  8.04700e+01  2.16000e+02
          0

TE 134
          3  2.75000e-04  3.99900e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  3.43700e-03  4.37700e+02  3.84300e-03  3.22000e-03
          1  I  134       1.00000e+00

CS 134
          3  9.55100e-09  1.01900e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.21600e+04  4.66200e+04  1.06000e+05
          0

I  135
          2  2.86400e-05  5.10300e+04
 2.49000e-01  7.86000e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  3.10000e+04  0.00000e+00  3.35400e+02  8.73000e+02
          2  XE 135       8.35000e-01  XE 135M      1.65000e-01

XE 135M
          1  7.40000e-04  1.55700e+04
 6.37000e-02  2.14000e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.23100e+00  0.00000e+00  0.00000e+00
          1 XE 135       1.00000e+00

XE 135
          1  2.09200e-05  5.36300e+04
 3.59000e-02  6.32000e-02  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.06100e+00  0.00000e+00  0.00000e+00
          0

CS 135
          3  7.29300e-15  2.90900e-02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.56600e+03  1.45900e+04  1.29000e+04
          0

I  136
          2  8.34900e-03  0.00000e+00
 6.78600e-01  1.30000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          0

CS 136
          3  6.16000e-07  1.66700e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.50000e+03  4.87900e+03  1.83000e+04
          0

XE 137
          1  2.96100e-03  5.10300e+04
 2.83000e-02  4.59000e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.74800e+01  0.00000e+00  0.00000e+00
          0
```

```
CS 137
          3  7.29200e-10  1.90700e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  9.40000e+03  5.97700e+04  7.76000e+04
          1  BA 137M      1.00000e+00

BA 137M
          3  4.52900e-03  1.81100e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          0

XE 138
          1  6.79600e-04  4.77500e+04
 1.87000e-01  1.47000e-01  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.44500e+01  0.00000e+00  0.00000e+00
          1  CS 138       1.00000e+00

CS 138
          3  3.58700e-04  4.87800e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  6.06600e+00  4.13700e+01  7.76000e+01
          0

CS 139
          3  1.21600e-03  4.47800e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.83700e+00  2.55700e+01  3.63000e+01
          0

BA 139
          3  1.39300e-04  4.60400e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.69700e+02  1.16700e-01  8.32000e-05
          0

BA 140
          3  6.26600e-07  4.27400e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.58700e+05  4.88400e+03  6.13000e+00
          1  LA 140       1.00000e+00

LA 140
          3  4.77400e-06  4.34200e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.70100e+04  4.30100e+01  2.17000e+01
          0

BA 141
          3  6.41600e-04  4.34500e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.41900e+02  1.24700e-02  9.41000e-06
          1  LA 141       1.00000e+00

LA 141
          3  4.93600e-05  4.37100e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.34500e+03  5.34200e-01  1.66000e-01
          1  CE 141       1.00000e+00

CE 141
          3  2.50600e-07  4.38700e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.51700e+04  2.49400e+03  1.69000e+03
          0
```

```
BA 142
          3  1.05000e-03  3.76200e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.48700e+02  3.29400e-03  3.38000e-06
          1  LA 142       1.00000e+00

LA 142
          3  1.25500e-04  3.88300e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  7.90700e+02  8.53600e-02  3.88000e-02
          0

CE 143
          3  6.03000e-06  3.55200e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  9.97200e+03  2.33400e+01  1.72000e+01
          1  PR 143       1.00000e+00

PR 143
          3  5.85400e-07  3.46700e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  3.50600e+04  1.16800e+03  4.69000e+02
          0

CE 144
          3  2.76600e-08  2.29400e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  9.71600e+05  4.28600e+05  1.79000e+05
          1  PR 144       9.86000e-01

PR 144
          3  6.67600e-04  2.30200e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.27200e+02  3.76300e-03  1.56000e-03
          0

ND 147
          3  7.09800e-07  1.73300e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.75900e+04  6.59200e+02  7.62000e+02
          1  PM 147       1.00000e+00

PM 147
          3  8.71800e-09  4.88100e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  6.60200e+04  8.36800e+04  7.87000e+03
          0

ND 149
          3  9.66500e-05  1.12100e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  3.67600e+02  0.00000e+00
          0

PM 149
          3  3.62500e-06  1.12200e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  7.20600e+03  3.43900e+01  4.87000e+00
          0

PM 151
          3  6.87500e-06  6.82800e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  3.93900e+03  8.49600e+00  1.42000e+00
          0
```

```
SM 151
          3  2.16800e-10  7.22600e+01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.45400e+04  8.58900e+04  1.48000e+04
          0

EU 155
          3  1.29200e-08  2.97300e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  9.46300e+04  1.00500e+05  1.43000e+04
          0

EU 156
          3  5.34700e-07  1.57500e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  8.55600e+04  1.92700e+03  1.48000e+03
          0

GD 159
          3  1.06900e-05  3.08300e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  6.47800e+02  0.00000e+00
          0

U  235
          3  3.09600e-17  9.16900e-05
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.89600e+07  1.00100e+07  0.00000e+00
          0

U  237
          3  1.18800e-06  3.45600e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.02000e+04  3.67300e+01  0.00000e+00
          1  NP 237       1.00000e+00

NP 237
          3  1.02700e-14  2.15000e-03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  5.21500e+07  1.69300e+09  1.47000e+08
          0

PU 238
          5  2.43100e-10  2.77500e+01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.82500e+08  2.73700e+09  3.87000e+08
          0

NP 238
          3  3.81900e-06  7.74100e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.01600e+04  2.96200e+02  8.00000e+00
          1  PU 238       1.00000e+00

PU 239
          5  9.01200e-13  1.22700e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.71600e+08  3.18800e+09  4.31000e+08
          1  U  235       1.00000e+00

U  239
          3  4.91600e-04  8.92800e+05
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          1  NP 239       1.00000e+00
```

```
NP 239
         3  3.44200e-06  8.29300e+05
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  4.70200e+03  2.86600e+01  2.82000e+00
         1  PU 239       1.00000e+00

PU 240
         5  3.34200e-12  7.23500e+01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.71600e+08  3.18300e+09  4.30000e+08
         0

PU 241
         5  1.67100e-09  3.77900e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.51700e+05  6.40700e+07  3.28000e+06
         1  AM 241       1.00000e+00

AM 241
         3  4.80300e-11  1.57100e+01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  6.06200e+07  1.01300e+09  3.59000e+08
         1  NP 237       1.00000e+00

PU 242
         5  5.81200e-14  2.11000e-02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  1.65100e+08  2.95400e+09  4.15000e+08
         0

CM 242
         3  4.93600e-08  9.01800e+02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  3.92300e+07  1.48300e+07  1.51000e+07
         1  PU 238       1.00000e+00

AM 242M
         3  1.43200e-10  1.45700e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  2.44300e+07  1.01900e+09  3.46000e+08
         0

CM 243
         3  6.85500e-10  3.52800e-01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  6.31200e+07  7.85600e+08  2.97000e+08
         1  PU 239       1.00000e+00

AM 243
         3  2.76600e-12  5.30600e-02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  5.74700e+07  1.01300e+09  3.47000e+08
         1  NP 239       1.00000e+00

CM 244
         3  1.24800e-09  1.49700e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  6.06200e+07  5.90400e+08  2.54000e+08
         1  PU 240       1.00000e+00

AM 244
         3  4.43100e-04  3.18600e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  2.98500e+03  0.00000e+00
         1  CM 244       1.00000e+00
```

Appendix D MLWR1465.BWR File

```
FILENAME:      MLWR1465.bwr

Organs:        TEDE, Deep Dose, CEDE, Skin, Thyroid,
               Lung, R Marrow, Bone Sfc, Gonad, Breast

Source Term:   NUREG-1465 groups.

               Core specific activities (Ci/Mw) are for a 3578 Mw BWR and are
               from NUREG/CR-4467.

Dose Factors:  FGR 11 and FGR 12.

               Dose factors follow the FGR 11 & 12 format, e.g. division between
               external and internal pathways. Clearance class for inhalation
               dose factors was selected by isotope as the clearance class
               giving the highest dose factor.

History:       Created October 23, 1997 at the Pacific Northwest National
               Laboratory.

Note:          Decay constants are from FGR 12 Appendix A.

Format:        HABIT Version 1.1

STARTDATA:
       9      10       3
NobleGasHalogens Alk_Met TellursBar-Stro Nob_Met Lanthan  Cerium   Other
       2       1       3       3       3       3       3       3       3
    TEDEDEEPDOSE COMMEDE    SKIN THYROID    LUNGR MARROWBONESURF   GONAD  BREAST
       2       0       1       0       1       1       1       1       1       1
       1       1       0       0       0       0       0       0       0       0
 1.00000 1.00000 1.00000 0.00000 0.03000 0.12000 0.12000 0.03000 0.25000 0.15000
   ELEM.     ORG.    PART.

 CO  58
           6  1.13310e-07  1.52600e+02
  1.76120e-01  1.76120e-01  0.00000e+00  2.06460e-01  1.76490e-01  1.71680e-01  1.67610e-01  2.74170e-01  1.72420e-01  1.96100e-01
  1.08780e+04  0.00000e+00  1.08780e+04  0.00000e+00  3.22640e+03  5.92000e+04  3.41510e+03  2.56410e+03  2.28290e+03  3.46690e+03
           0
```

```
CO  60
          6  4.16990e-09  1.82800e+02
 4.66200e-01  4.66200e-01  0.00000e+00  5.36500e-01  4.69900e-01  4.58800e-01  4.55100e-01  6.58600e-01  4.55100e-01  5.14300e-01
 2.18670e+05  0.00000e+00  2.18670e+05  0.00000e+00  5.99400e+04  1.27650e+06  6.36400e+04  4.99500e+04  1.76120e+04  6.80800e+04
          0

KR  85M
          1  4.29780e-05  9.14000e+03
 2.76760e-02  2.76760e-02  0.00000e+00  8.28800e-02  2.71210e-02  2.60480e-02  2.37910e-02  6.95600e-02  2.70470e-02  3.11170e-02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          1  KR  85       2.11000e-01

KR  85
          1  2.05030e-09  2.50800e+02
 4.40300e-04  4.40300e-04  0.00000e+00  4.88400e-02  4.36600e-04  4.21800e-04  4.03300e-04  8.14000e-04  4.32900e-04  4.95800e-04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e-00  0.00000e+00  0.00000e+00  0.00000e-00  0.00000e+00  0.00000e+00
          0

KR  87
          1  1.51410e-04  1.65400e+04
 1.52440e-01  1.52440e-01  0.00000e+00  5.06900e-01  1.52810e-01  1.49480e-01  1.48000e-01  2.22740e-01  1.48000e-01  1.66500e-01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          0  RB  87       1.00000e+00

KR  88
          1  6.77960e-05  2.23600e+04
 3.77400e-01  3.77400e-01  0.00000e+00  4.99500e-01  3.81100e-01  3.73700e-01  3.70000e-01  5.14300e-01  3.66300e-01  4.10700e-01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          0  RB  88       1.00000e+00

RB  86
          3  4.29930e-07  1.40500e+01
 1.77970e-02  1.77970e-02  0.00000e+00  1.79450e-01  1.79080e-02  1.74270e-02  1.71680e-02  2.60850e-02  1.74270e-02  1.97580e-02
 6.62300e+03  0.00000e+00  6.62300e+03  0.00000e+00  4.92100e+03  1.22100e+04  8.58400e+03  1.57990e+04  4.95800e+03  4.92100e+03
          0

SR  89
          5  1.58860e-07  2.77200e+04
 2.86010e-04  2.86010e-04  0.00000e+00  1.36530e-01  2.81200e-04  2.61960e-04  2.36430e-04  7.17800e-04  2.86010e-04  3.35960e-04
 4.14400e+04  0.00000e+00  4.14400e+04  0.00000e+00  2.94520e+01  3.08950e+05  3.95900e+02  5.88300e+02  2.94150e+01  2.94520e+01
          0

SR  90
          5  7.54790e-10  1.96400e+03
 2.78610e-05  2.78610e-05  0.00000e+00  3.40400e-02  2.71210e-05  2.38280e-05  2.01280e-05  8.43600e-05  2.87860e-05  3.51130e-05
 1.29870e+06  0.00000e+00  1.29870e+06  0.00000e+00  9.95300e+02  1.05820e+07  1.21360e+05  2.62330e+05  9.95300e+02  9.95300e+02
          1  Y   90       1.00000e+00
```

```
SR  91
          5 2.02670e-05 3.60300e+04
 1.27650e-01 1.27650e-01 0.00000e+00 3.01180e-01 1.28390e-01 1.24690e-01 1.22470e-01 1.92400e-01 1.25060e-01 1.41710e-01
 1.66130e+03 0.00000e+00 1.66130e+03 0.00000e+00 3.56680e+01 7.88100e+03 8.25100e+01 4.69900e+01 2.09050e+02 6.43800e+01
          1 Y   91      4.22000e-01 Y   91M     5.78000e-01

SR  92
          5 7.10480e-05 3.77700e+04
 2.51230e-01 2.51230e-01 0.00000e+00 3.16720e-01 2.52340e-01 2.46790e-01 2.44940e-01 3.51130e-01 2.44570e-01 2.76760e-01
 8.06600e+02 0.00000e+00 8.06600e+02 0.00000e+00 1.45040e+01 3.88500e+03 2.58260e+01 1.61320e+01 3.77400e+01 2.40130e+01
          1 Y   92      1.00000e+00

Y   90
          7 3.00850e-06 2.10000e+03
 7.03000e-04 7.03000e-04 0.00000e+00 2.30880e-01 6.91900e-04 6.54900e-04 5.99400e-04 1.64280e-03 6.99300e-04 8.14000e-04
 8.43600e+03 0.00000e+00 8.43600e+03 0.00000e+00 1.91290e+00 3.44470e+04 5.62400e+01 5.58700e+01 1.91290e+00 1.91290e+00
          0

Y   91
          7 1.37110e-07 3.38400e+04
 9.62000e-04 9.62000e-04 0.00000e+00 1.42450e-01 9.62000e-04 9.25000e-04 8.91700e-04 1.68720e-03 9.47200e-04 1.08410e-03
 4.88400e+04 0.00000e+00 4.88400e+04 0.00000e+00 3.14500e+01 3.65190e+05 1.18030e+03 1.17660e+03 3.03400e+01 3.30040e+01
          0

Y   92
          7 5.43900e-05 3.77700e+04
 4.81000e-02 4.81000e-02 0.00000e+00 4.21800e-01 4.81000e-02 4.69900e-02 4.62500e-02 7.21500e-02 4.69900e-02 5.32800e-02
 7.80700e+02 0.00000e+00 7.80700e+02 0.00000e+00 3.88500e+00 4.58800e+03 7.65900e+00 5.58700e+00 9.65700e+00 5.55000e+00
          0

Y   93
          7 1.90630e-05 4.30600e+04
 1.77600e-02 1.77600e-02 0.00000e+00 3.14500e-01 1.77230e-02 1.73160e-02 1.69460e-02 2.80460e-02 1.72790e-02 1.96100e-02
 2.15340e+03 0.00000e+00 2.15340e+03 0.00000e+00 3.42620e+00 9.32400e+03 1.49480e+01 1.16180e+01 1.96470e+01 6.43800e+00
          0 ZR  93      1.00000e+00

ZR  95
          7 1.25390e-07 4.45700e+04
 1.33200e-01 1.33200e-01 0.00000e+00 1.66500e-01 1.33570e-01 1.29870e-01 1.26910e-01 2.07940e-01 1.30610e-01 1.48370e-01
 2.36430e+04 0.00000e+00 2.36430e+04 0.00000e+00 5.32800e+03 8.02900e+03 4.81000e+04 3.81100e+05 6.95600e+03 7.06700e+03
          1 NB  95      9.93000e-01 NB  95M     7.00000e-03

ZR  97
          7 1.13930e-05 4.59300e+04
 3.33740e-02 3.33740e-02 0.00000e+00 2.05350e-01 3.34110e-02 3.25970e-02 3.19680e-02 5.10600e-02 3.25600e-02 3.69630e-02
 4.32900e+03 0.00000e+00 4.32900e+03 0.00000e+00 8.54700e+01 1.51700e+04 2.35690e+02 1.29500e+02 6.80800e+02 1.73900e+02
          0 NB  97M     9.47000e-01 NB  97      5.30000e-02
```

```
NB  95
         7  2.28240e-07  4.21500e+04
 1.38380e-01  1.38380e-01  0.00000e+00  1.59100e-01  1.38750e-01  1.35050e-01  1.31720e-01  2.14230e-01  1.35420e-01  1.53920e-01
 5.80900e+03  0.00000e+00  5.80900e+03  0.00000e+00  1.32460e+03  3.07840e+04  1.63540e+03  1.89814e+03  1.59840e+03  1.50590e+03
         0

MO  99
         6  2.91730e-06  4.86500e+04
 2.69360e-02  2.69360e-02  0.00000e+00  1.16180e-01  2.68990e-02  2.61220e-02  2.52340e-02  4.58800e-02  2.63810e-02  3.00810e-02
 3.95900e+03  0.00000e+00  3.95900e+03  0.00000e+00  5.62400e+01  1.58730e+04  1.93880e+02  1.52810e+02  3.51870e+02  1.01750e+02
         1  TC  99M      8.76000e-01  TC  99       1.24000e-01

TC  99M
         6  3.19840e-05  4.19200e+04
 2.17930e-02  2.17930e-02  0.00000e+00  2.64180e-02  2.12750e-02  2.03130e-02  1.81670e-02  6.03100e-02  2.12750e-02  2.46050e-02
 3.25600e+01  0.00000e+00  3.25600e+01  0.00000e+00  1.85370e+02  8.43600e+01  1.24320e+01  9.69400e+00  1.02490e+01  7.95500e+00
         0  TC  99       1.00000e+00

RU 103
         6  2.04240e-07  3.68600e+04
 8.32500e-02  8.32500e-02  0.00000e+00  1.02490e-01  8.28800e-02  8.06600e-02  7.77000e-02  1.43930e-01  8.10300e-02  9.28700e-02
 8.95400e+03  0.00000e+00  8.95400e+03  0.00000e+00  9.50900e+02  5.77200e+04  1.18030e+03  8.76900e+02  1.13590e+03  1.15070e+03
         0  RH 103M      9.97000E-01

RU 105
         6  4.33650e-05  2.45500e+04
 1.40970e-01  1.40970e-01  0.00000e+00  2.49010e-01  1.40600e-01  1.36900e-01  1.32830e-01  2.32360e-01  1.37640e-01  1.56880e-01
 4.55100e+02  0.00000e+00  4.55100e+02  0.00000e+00  1.53550e+01  2.12010e+03  2.84900e+01  1.70940e+01  5.88300e+01  2.44570e+01
         1  RH 105       1.00000e+00

RU 106
         6  2.17890e-08  1.00500e+04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 4.77300e+05  0.00000e+00  4.77300e+05  0.00000e+00  6.36400e+03  3.84800e+06  6.51200e+03  5.95700e+03  4.81000e+03  6.58600e+03
         0  RH 106       1.00000e+00

RH 105
         6  5.44520e-06  1.83600e+04
 1.37640e-02  1.37640e-02  0.00000e+00  3.95900e-02  1.36160e-02  1.32090e-02  1.25060e-02  2.78610e-02  1.34680e-02  1.53920e-02
 9.54600e+02  0.00000e+00  9.54600e+02  0.00000e+00  1.06560e+01  3.54460e+03  2.87490e+01  1.65020e+01  7.80700e+01  2.07570e+01
         0

SB 127
         4  2.08380e-06  2.32700e+03
 1.23210e-01  1.23210e-01  0.00000e+00  2.06460e-01  1.23210e-01  1.19880e-01  1.16180e-01  2.04240e-01  1.20620e-01  1.37640e-01
 6.03100e+03  0.00000e+00  6.03100e+03  0.00000e+00  2.27550e+02  2.56780e+04  5.95700e+02  4.95800e+02  9.32400e+02  3.37440e+02
         2  TE 127       8.24000e-01  TE 127M      1.76000e-01
```

```
SB 129
          4  4.45700e-05  8.08200e+03
 2.64180e-01  2.64180e-01  0.00000e+00  3.88500e-01  2.64920e-01  2.58260e-01  2.53820e-01  3.95900e-01  2.57890e-01  2.92670e-01
 6.43800e+02  0.00000e+00  6.43800e+02  0.00000e+00  3.59640e+01  3.32260e+03  6.29000e+01  5.40200e+01  7.95500e+01  4.73600e+01
          2  TE 129       7.75000e-01  TE 129M      2.25000e-01

TE 127M
          4  7.36010e-08  3.02900e+02
 5.43900e-04  5.43900e-04  0.00000e+00  3.14130e-03  5.55000e-04  2.81940e-04  2.37910e-04  1.45780e-03  7.03000e-04  9.95300e-04
 2.14970e+04  0.00000e+00  2.14970e+04  0.00000e+00  3.57420e+02  1.23580e+05  1.98320e+04  7.54800e+04  4.07000e+02  4.07000e+02
          1  TE 127       9.76000e-01

TE 127
          4  2.05930e-05  2.25100e+03
 8.95400e-04  8.95400e-04  0.00000e+00  4.21800e-02  8.88000e-04  8.58400e-04  8.17700e-04  1.72050e-03  8.76900e-04  1.01010e-03
 3.18200e+02  0.00000e+00  3.18200e+02  0.00000e+00  6.80800e+00  1.57990e+03  1.51330e+01  1.51330e+01  7.47400e+00  6.95600e+00
          0

TE 129M
          4  2.38770e-07  1.98700e+03
 5.73500e-03  5.73500e-03  0.00000e+00  5.51300e-02  5.77200e-03  5.40200e-03  5.25400e-03  9.62000e-03  5.77200e-03  6.69700e-03
 2.39390e+04  0.00000e+00  2.39390e+04  0.00000e+00  5.77200e+02  1.49110e+05  1.14700e+04  2.60850e+04  6.58600e+02  6.25300e+02
          1  TE 129       6.50000e-01  I  129       3.50000e-01

TE 129
          4  1.65980e-04  7.55400e+03
 1.01750e-02  1.01750e-02  0.00000e+00  1.32090e-01  1.01380e-02  9.76800e-03  9.39800e-03  1.80560e-02  1.00270e-02  1.15440e-02
 8.95400e+01  0.00000e+00  8.95400e+01  0.00000e+00  6.03100e+00  4.92100e+02  7.28900e+00  7.51100e+00  6.47500e+00  6.21600e+00
          0  I  129       1.00000e+00

TE 131M
          4  6.41800e-06  3.82200e+03
 2.59370e-01  2.59370e-01  0.00000e+00  3.27450e-01  2.59740e-01  2.52710e-01  2.47160e-01  4.03300e-01  2.53450e-01  2.87860e-01
 6.40100e+03  0.00000e+00  6.40100e+03  0.00000e+00  1.33570e+05  8.25100e+03  5.21700e+02  8.39900e+02  8.65800e+02  3.42250e+02
          1  I  131       7.78000e-01  TE 131       2.22000e-01

TE 132
          4  2.46220e-06  3.73200e+04
 3.81100e-02  3.81100e-02  0.00000e+00  5.14300e-02  3.77400e-02  3.57050e-02  3.31150e-02  8.95400e-02  3.77400e-02  4.36600e-02
 9.43500e+03  0.00000e+00  9.43500e+03  0.00000e+00  2.32360e+05  6.17900e+03  1.57990e+03  2.63440e+03  1.53550e+03  1.34310e+03
          1  I  132       1.00000e+00

I  131
          2  9.97830e-07  2.58300e+04
 6.73400e-02  6.73400e-02  0.00000e+00  1.10260e-01  6.69700e-02  6.51200e-02  6.21600e-02  1.27650e-01  6.58600e-02  7.54800e-02
 3.28930e+04  0.00000e+00  3.28930e+04  0.00000e+00  1.08040e+06  2.43090e+03  2.31620e+02  2.12010e+02  9.36100e+01  2.91560e+02
          0  XE 131M      1.11000e-02
```

```
I  132
         2 8.37130e-05 3.79200e+04
4.14400e-01 4.14400e-01 0.00000e+00 5.84600e-01 4.14400e-01 4.03300e-01 3.95900e-01 6.40100e-01 4.03300e-01 4.58800e-01
3.81100e+02 0.00000e+00 3.81100e+02 0.00000e+00 6.43800e+03 1.00270e+03 5.18000e+01 4.58800e+01 3.68150e+01 5.21700e+01
         0

I  133
         2 9.25680e-06 5.41600e+04
1.08780e-01 1.08780e-01 0.00000e+00 2.15710e-01 1.08410e-01 1.05820e-01 1.02490e-01 1.80190e-01 1.06190e-01 1.21360e-01
5.84600e+03 0.00000e+00 5.84600e+03 0.00000e+00 1.79820e+05 3.03400e+03 1.00640e+02 9.32400e+01 7.21500e+01 1.08780e+02
         1 XE 133      9.71000e-01 XE 133M     2.90000e-02

I  134
         2 2.19630e-04 5.93000e+04
4.81000e-01 4.81000e-01 0.00000e+00 6.91900e-01 4.81000e-01 4.69900e-01 4.62500E-01 7.25200e-01 4.69900e-01 5.32800e-01
1.31350e+02 0.00000e+00 1.31350e+02 0.00000e+00 1.06560e+03 5.29100e+02 2.24960e+01 1.96470e+01 1.57250e+01 2.28290e+01
         0

I  135
         2 2.91290e-05 5.09900e+04
2.95260e-01 2.95260e-01 0.00000e+00 4.10700e-01 2.96370e-01 2.90080e-01 2.87120e-01 4.18100e-01 2.87490e-01 3.25230e-01
1.22840e+03 0.00000e+00 1.22840e+03 0.00000e+00 3.13020e+04 1.63170e+03 8.28800e+01 7.43700e+01 6.29000e+01 8.65800e+01
         1 XE 135      8.46000e-01 XE 135M     1.54000e-01

XE 133
         1 1.52960e-06 5.42400e+04
5.77200e-03 5.77200e-03 0.00000e+00 1.83890e-02 5.58700e-03 4.88400e-03 3.95900e-03 1.89810e-02 5.95700e-03 7.25200e-03
0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00
         0

XE 135
         1 2.11820e-05 1.29200e+04
4.40300e-02 4.40300e-02 0.00000e+00 1.15440e-01 4.36600e-02 4.18100e-02 3.95900e-02 9.50900e-02 4.32900e-02 4.92100e-02
0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00 0.00000e+00
         0 CS 135      1.00000e+00

CS 134
         3 1.06590e-08 4.22300e+03
2.80090e-01 2.80090e-01 0.00000e+00 3.49650e-01 2.80090e-01 2.72690e-01 2.66030e-01 4.44000e-01 2.73800e-01 3.11910e-01
4.62500e+04 0.00000e+00 4.62500e+04 0.00000e+00 4.10700e+04 4.36600e+04 4.36600e+04 4.07000e+04 4.81000e+04 3.99600e+04
         0
CS 136
         3 6.12410e-07 1.13300e+03
3.92200e-01 3.92200e-01 0.00000e+00 4.62500e-01 3.95900e-01 3.84800e-01 3.73700e-01 6.14200e-01 3.84800e-01 4.36600e-01
7.32600e+03 0.00000e+00 7.32600e+03 0.00000e+00 6.40100e+03 8.58400e+03 6.88200e+03 6.29000e+03 6.95600e+03 6.17900e+03
         0
```

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CS 137
         3  7.32650e-10  2.53100e+03
 2.86380e-05  2.86380e-05  0.00000e+00  3.19310e-02  2.79350e-05  2.47160e-05  2.10900e-05  8.47300e-05  2.94520e-05  3.57790e-05
 3.19310e+04  0.00000e+00  3.19310e+04  0.00000e+00  2.93410e+04  3.26340e+04  3.07100e+04  2.93780e+04  3.24120e+04  2.90080e+04
         0  BA 137M      9.46000e-01

BA 139
         5  1.39690e-04  5.00010e+04
 8.02900e-03  8.02900e-03  0.00000e+00  2.27920e-01  7.88100e-03  7.51100e-03  6.91900e-03  1.95730e-02  7.88100e-03  9.06500e-03
 1.71680e+02  0.00000e+00  1.71680e+02  0.00000e+00  8.88000e+00  9.36100e+02  1.26170e+01  9.21300e+00  9.47200e+00  9.10200e+00
         0

BA 140
         5  6.29710e-07  4.92500e+04
 3.17460e-02  3.17460e-02  0.00000e+00  9.32400e-02  3.15610e-02  3.05990e-02  2.93410e-02  5.73500e-02  3.11170e-02  3.56680e-02
 3.73700e+03  0.00000e+00  3.73700e+03  0.00000e+00  9.47200e+02  6.14200e+03  4.77300e+03  8.91700e+03  1.59100e+03  1.06190e+03
         1  LA 140       1.00000e+00

LA 140
         7  4.78100e-06  5.03100e+04
 4.32900e-01  4.32900e-01  0.00000e+00  6.14200e-01  4.36600e-01  4.25500e-01  4.21800e-01  6.25300e-01  4.21800e-01  4.77300e-01
 4.84700e+03  0.00000e+00  4.84700e+03  0.00000e+00  2.54190e+02  1.55770e+04  7.91800e+02  5.21700e+02  1.67980e+03  5.36500e+02
         0

LA 141
         7  4.89930e-05  4.63800e+04
 8.84300e-03  8.84300e-03  0.00000e+00  2.43460e-01  8.84300e-03  8.65800e-03  8.54700e-03  1.29130e-02  8.62100e-03  9.76800e-03
 5.80900e+02  0.00000e+00  5.80900e+02  0.00000e+00  3.47800e+01  2.39020e+03  1.08410e+02  4.44000e+02  3.73700e+01  3.64080e+01
         1  CE 141       1.00000e+00

LA 142
         7  1.24890e-04  4.47200e+04
 5.32800e-01  5.32800e-01  0.00000e+00  7.99200e-01  5.36500e-01  5.25400e-01  5.25400e-01  7.21500e-01  5.18000e-01  5.80900e-01
 2.53080e+02  0.00000e+00  2.53080e+02  0.00000e+00  3.23380e+01  1.11370e+03  5.03200e+01  4.10700e+01  6.14200e+01  4.18100e+01
         0

CE 141
         8  2.46840e-07  4.47200e+04
 1.26910e-02  1.26910e-02  0.00000e+00  3.77400e-02  1.23950e-02  1.17290e-02  1.04710e-02  3.48170e-02  1.25060e-02  1.45410e-02
 8.95400e+03  0.00000e+00  8.95400e+03  0.00000e+00  9.43500e+01  6.17900e+04  3.31520e+02  9.39800e+02  2.04980e+02  1.65020e+02
         0
CE 143
         8  5.83460e-06  4.35100e+04
 4.77300e-02  4.77300e-02  0.00000e+00  1.46520e-01  4.73600e-02  4.55100e-02  4.32900e-02  9.32400e-02  4.73600e-02  5.43900e-02
 3.38920e+03  0.00000e+00  3.38920e+03  0.00000e+00  2.30510e+01  1.43560e+04  1.09520e+02  6.06800e+01  2.78610e+02  6.14200e+01
         1  PR 143       1.00000e+00
```

CE 144
8 2.82190e-08 2.90100e+04
3.15610e-03 3.15610e-03 0.00000e+00 1.08410e-02 3.08210e-03 2.84530e-03 2.47160e-03 9.21300e-03 3.15610e-03 3.73700e-03
3.73700e+05 0.00000e+00 3.73700e+05 0.00000e+00 1.08040e+03 2.92670e+06 1.06560e+04 1.74640e+04 8.84300e+02 1.28760e+03
0 PR 144 9.82200e-01 PR 144M 1.78000e-02

PR 143
7 5.91630e-07 4.26000e+04
7.77000e-05 7.77000e-05 0.00000e+00 6.51200e-02 7.58500e-05 6.88200e-05 5.99400e-05 2.19410e-04 7.88100e-05 9.43500e-05
8.10300e+03 0.00000e+00 8.10300e+03 0.00000e+00 6.21600e-06 4.92100e+04 5.47600e+01 5.51300e+01 1.61690e-05 8.21400e-06
0

ND 147
7 7.30650e-07 1.90400e+04
2.29030e-02 2.29030e-02 0.00000e+00 7.21500e-02 2.26440e-02 2.15340e-02 1.99800e-02 4.88400e-02 2.26810e-02 2.63440e-02
6.84500e+03 0.00000e+00 6.84500e+03 0.00000e+00 6.73400e+01 3.92200e+04 3.40030e+02 1.20620e+03 3.11170e+02 1.27650e+02
0 PM 147 1.00000e+00

NP 239
8 3.40660e-06 5.68000e+05
2.84530e-02 2.84530e-02 0.00000e+00 5.92000e-02 2.78240e-02 2.65660e-02 2.40500e-02 7.40000e-02 2.78610e-02 3.23010e-02
2.50860e+03 0.00000e+00 2.50860e+03 0.00000e+00 2.81940e+01 8.73200e+03 7.69600e+02 7.51100e+03 2.75650e+02 6.03100e+01
1 PU 239 1.00000e+00

PU 238
8 2.50500e-10 3.95100e+01
1.80560e-05 1.80560e-05 0.00000e+00 1.51330e-04 1.48370e-05 3.92200e-06 6.21600e-06 3.44100e-05 2.42720e-05 4.69900e-05
3.92200e+08 0.00000e+00 3.92200e+08 0.00000e+00 3.55940e+03 6.80800e+07 5.62400e+08 7.03000e+09 1.03600e+08 3.70000e+03
0 U 234 1.00000e+00

PU 239
8 9.13340e-13 9.97100e+00
1.56880e-05 1.56880e-05 0.00000e+00 6.88200e-05 1.43560e-05 9.80500e-06 9.87900e-06 3.50390e-05 1.79080e-05 2.79350e-05
4.29200e+08 0.00000e+00 4.29200e+08 0.00000e+00 3.34110e+03 6.40100e+07 6.25300e+08 7.80700e+09 1.17660e+08 3.41140e+03
0 U 235 1.00000e+00

PU 240
8 3.36230e-12 1.25400e+01
1.75750e-05 1.75750e-05 0.00000e+00 1.45040e-04 1.45040e-05 4.03300e-06 6.10500e-06 3.42620e-05 2.35320e-05 4.55100e-05
4.29200e+08 0.00000e+00 4.29200e+08 0.00000e+00 3.34850e+03 6.40100e+07 6.25300e+08 7.80700e+09 1.17660e+08 3.51870e+03
0 U 236 1.00000e+00

PU 241
8 1.52640e-09 2.16000e+03
2.68250e-07 2.68250e-07 0.00000e+00 4.32900e-07 2.58260e-07 2.39760e-07 2.08310e-07 8.10300e-07 2.66030e-07 3.20790e-07
8.25100e+06 0.00000e+00 8.25100e+06 0.00000e+00 4.58800e+01 2.74540e+04 1.24320e+07 1.55400e+08 2.52340e+06 1.13220e+02
1 AM 241 1.00000e+00

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AM 241
         7  5.08550e-11  2.19100e+00
 3.02660e-03  3.02660e-03  0.00000e+00  4.73600e-03  2.89710e-03  2.49380e-03  1.92770e-03  1.06190e-02  3.17460e-03  3.95900e-03
 4.44000e+08  0.00000e+00  4.44000e+08  0.00000e+00  5.92000e+03  6.80800e+07  6.43800e+08  8.02900e+09  1.20250e+08  9.87900e+03
            0  NP 237       1.00000e+00

CM 242
         7  4.92780e-08  5.79400e+02
 2.10530e-05  2.10530e-05  0.00000e+00  1.58730e-04  1.81670e-05  4.18100e-06  6.99300e-06  3.92200e-05  2.89710e-05  5.47600e-05
 1.72970e+07  0.00000e+00  1.72790e+07  0.00000e+00  3.48170e+03  5.73500e+07  1.44300e+07  1.80190e+08  2.10900e+06  3.49280e+03
            1  PU 238       1.00000e+00

CM 244
         7  1.21370e-09  3.12700e+01
 1.81670e-05  1.81670e-05  0.00000e+00  1.44670e-04  1.55030e-05  2.61960e-06  5.40200e-06  3.26340e-05  2.55300e-05  4.92100e-05
 2.47900e+08  0.00000e+00  2.47900e+08  0.00000e+00  3.73700e+03  7.14100e+07  3.47060e+08  4.32900e+09  5.88300e+07  3.84800e+03
            1  PU 240       1.00000e+00
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Appendix E MLWR1465.PWR File

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FILENAME:      MLWR1465.pwr

Organs:        TEDE, Deep Dose, CEDE, Skin, Thyroid,
               Lung, R Marrow, Bone Sfc, Gonad, Breast

Source Term:   NUREG-1465 groups.

               Core specific activities (Ci/Mw) are for a 3412 Mw PWR and are
               from NUREG/CR-4467.

Dose Factors:  FGR 11 and FGR 12.

               Dose factors follow FGR 11 & 12 format, e.g. division between
               external and internal pathways. Clearance class for inhalation
               dose factors was selected by isotope as the clearance class
               giving highest dose factor.

History:       Created October 23, 1997 at the Pacific Northwest National
               Laboratory.

Note:          Decay constants are from FGR 12 Appendix A.

Format:        HABIT Version 1.1

STARTDATA:
      9      10       3
NobleGasHalogens Alk_Met TellursBar-Stro Nob_Met Lanthan  Cerium   Other
      2       1       3       3       3       3       3       3       3
   TEDEDEEPDOSE COMMEDE    SKIN THYROID    LUNGR MARROWBONESURF   GONAD  BREAST
      2       0       1       0       1       1       1       1       1       1
      1       1       0       0       0       0       0       0       0       0
1.00000 1.00000 1.00000 0.00000 0.03000 0.12000 0.12000 0.03000 0.25000 0.15000
  ELEM.    ORG.   PART.

CO  58
          6  1.13310e-07  2.70100e+02
 1.76120e-01  1.76120e-01  0.00000e+00  2.06460e-01  1.76490e-01  1.71680e-01  1.67610e-01  2.74170e-01  1.72420e-01  1.96100e-01
 1.08780e+04  0.00000e+00  1.08780e+04  0.00000e+00  3.22640e+03  5.92000e+04  3.41510e+03  2.56410e+03  2.28290e+03  3.46690e+03
          0
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CO  60
          6  4.16990e-09  1.98000e+02
 4.66200e-01  4.66200e-01  0.00000e+00  5.36500e-01  4.69900e-01  4.58800e-01  4.55100e-01  6.58600e-01  4.55100e-01  5.14300e-01
 2.18670e+05  0.00000e+00  2.18670e+05  0.00000e+00  5.99400e+04  1.27650e+06  6.36400e+04  4.99500e+04  1.76120e+04  6.80800e+04
          0

KR  85M
          1  4.29780e-05  9.18900e+03
 2.76760e-02  2.76760e-02  0.00000e+00  8.28800e-02  2.71210e-02  2.60480e-02  2.37910e-02  6.95600e-02  2.70470e-02  3.11170e-02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          1  KR  85       2.11000e-01

KR  85
          1  2.05030e-09  1.94900e+02
 4.40300e-04  4.40300e-04  0.00000e+00  4.88400e-02  4.36600e-04  4.21800e-04  4.03300e-04  8.14000e-04  4.32900e-04  4.95800e-04
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e-00  0.00000e+00  0.00000e+00  0.00000e-00  0.00000e+00  0.00000e+00
          0

KR  87
          1  1.51410e-04  1.67100e+04
 1.52440e-01  1.52440e-01  0.00000e+00  5.06900e-01  1.52810e-01  1.49480e-01  1.48000e-01  2.22740e-01  1.48000e-01  1.66500e-01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          0  RB  87       1.00000e+00

KR  88
          1  6.77960e-05  2.25000e+04
 3.77400e-01  3.77400e-01  0.00000e+00  4.99500e-01  3.81100e-01  3.73700e-01  3.70000e-01  5.14300e-01  3.66300e-01  4.10700e-01
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
          0  RB  88       1.00000e+00

RB  86
          3  4.29930e-07  1.41000e+01
 1.77970e-02  1.77970e-02  0.00000e+00  1.79450e-01  1.79080e-02  1.74270e-02  1.71680e-02  2.60850e-02  1.74270e-02  1.97580e-02
 6.62300e+03  0.00000e+00  6.62300e+03  0.00000e+00  4.92100e+03  1.22100e+04  8.58400e+03  1.57990e+04  4.95800e+03  4.92100e+03
          0

SR  89
          5  1.58860e-07  2.80400e+04
 2.86010e-04  2.86010e-04  0.00000e+00  1.36530e-01  2.81200e-04  2.61960e-04  2.36430e-04  7.17800e-04  2.86010e-04  3.35960e-04
 4.14400e+04  0.00000e+00  4.14400e+04  0.00000e+00  2.94520e+01  3.08950e+05  3.95900e+02  5.88300e+02  2.94150e+01  2.94520e+01
          0

SR  90
          5  7.54790e-10  1.51300e+03
 2.78610e-05  2.78610e-05  0.00000e+00  3.40400e-02  2.71210e-05  2.38280e-05  2.01280e-05  8.43600e-05  2.87860e-05  3.51130e-05
 1.29870e+06  0.00000e+00  1.29870e+06  0.00000e+00  9.95300e+02  1.05820e+07  1.21360e+05  2.62330e+05  9.95300e+02  9.95300e+02
          1  Y   90       1.00000e+00
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SR  91
          5  2.02670e-05  3.62800e+04
 1.27650e-01  1.27650e-01  0.00000e+00  3.01180e-01  1.28390e-01  1.24690e-01  1.22470e-01  1.92400e-01  1.25060e-01  1.41710e-01
 1.66130e+03  0.00000e+00  1.66130e+03  0.00000e+00  3.56680e+01  7.88100e+03  8.25100e+01  4.69900e+01  2.09050e+02  6.43800e+01
          1  Y   91       4.22000e-01  Y   91M      5.78000e-01

SR  92
          5  7.10480e-05  3.77800e+04
 2.51230e-01  2.51230e-01  0.00000e+00  3.16720e-01  2.52340e-01  2.46790e-01  2.44940e-01  3.51130e-01  2.44570e-01  2.76760e-01
 8.06600e+02  0.00000e+00  8.06600e+02  0.00000e+00  1.45040e+01  3.88500e+03  2.58260e+01  1.61320e+01  3.77400e+01  2.40130e+01
          1  Y   92       1.00000e+00

Y   90
          7  3.00850e-06  1.62400e+03
 7.03000e-04  7.03000e-04  0.00000e+00  2.30880e-01  6.91900e-04  6.54900e-04  5.99400e-04  1.64280e-03  6.99300e-04  8.14000e-04
 8.43600e+03  0.00000e+00  8.43600e+03  0.00000e+00  1.91290e+00  3.44470e+04  5.62400e+01  5.58700e+01  1.91290e+00  1.91290e+00
          0

Y   91
          7  1.37110e-07  3.42200e+04
 9.62000e-04  9.62000e-04  0.00000e+00  1.42450e-01  9.62000e-04  9.25000e-04  8.91700e-04  1.68720e-03  9.47200e-04  1.08410e-03
 4.88400e+04  0.00000e+00  4.88400e+04  0.00000e+00  3.14500e+01  3.65190e+05  1.18030e+03  1.17660e+03  3.03400e+01  3.30040e+01
          0

Y   92
          7  5.43900e-05  3.79400e+04
 4.81000e-02  4.81000e-02  0.00000e+00  4.21800e-01  4.81000e-02  4.69900e-02  4.62500e-02  7.21500e-02  4.69900e-02  5.32800e-02
 7.80700e+02  0.00000e+00  7.80700e+02  0.00000e+00  3.88500e+00  4.58800e+03  7.65900e+00  5.58700e+00  9.65700e+00  5.55000e+00
          0

Y   93
          7  1.90630e-05  4.30900e+04
 1.77600e-02  1.77600e-02  0.00000e+00  3.14500e-01  1.77230e-02  1.73160e-02  1.69460e-02  2.80460e-02  1.72790e-02  1.96100e-02
 2.15340e+03  0.00000e+00  2.15340e+03  0.00000e+00  3.42620e+00  9.32400e+03  1.49480e+01  1.16180e+01  1.96470e+01  6.43800e+00
          0  ZR  93       1.00000e+00

ZR  95
          7  1.25390e-07  4.35700e+04
 1.33200e-01  1.33200e-01  0.00000e+00  1.66500e-01  1.33570e-01  1.29870e-01  1.26910e-01  2.07940e-01  1.30610e-01  1.48370e-01
 2.36430e+04  0.00000e+00  2.36430e+04  0.00000e+00  5.32800e+03  8.02900e+03  4.81000e+04  3.81100e+05  6.95600e+03  7.06700e+03
          1  NB  95       9.93000e-01  NB  95M      7.00000e-03

ZR  97
          7  1.13930e-05  4.57800e+04
 3.33740e-02  3.33740e-02  0.00000e+00  2.05350e-01  3.34110e-02  3.25970e-02  3.19680e-02  5.10600e-02  3.25600e-02  3.69630e-02
 4.32900e+03  0.00000e+00  4.32900e+03  0.00000e+00  8.54700e+01  1.51700e+04  2.35690e+02  1.29500e+02  6.80800e+02  1.73900e+02
          0  NB  97M      9.47000e-01  NB  97       5.30000e-02
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NB  95
         7  2.28240e-07  4.11100e+04
 1.38380e-01  1.38380e-01  0.00000e+00  1.59100e-01  1.38750e-01  1.35050e-01  1.31720e-01  2.14230e-01  1.35420e-01  1.53920e-01
 5.80900e+03  0.00000e+00  5.80900e+03  0.00000e+00  1.32460e+03  3.07840e+04  1.63540e+03  1.89814e+03  1.59840e+03  1.50590e+03
         0

MO  99
         6  2.91730e-06  4.84800e+04
 2.69360e-02  2.69360e-02  0.00000e+00  1.16180e-01  2.68990e-02  2.61220e-02  2.52340e-02  4.58800e-02  2.63810e-02  3.00810e-02
 3.95900e+03  0.00000e+00  3.95900e+03  0.00000e+00  5.62400e+01  1.58730e+04  1.93880e+02  1.52810e+02  3.51870e+02  1.01750e+02
         1  TC  99M      8.76000e-01  TC  99       1.24000e-01

TC  99M
         6  3.19840e-05  4.12800e+04
 2.17930e-02  2.17930e-02  0.00000e+00  2.64180e-02  2.12750e-02  2.03130e-02  1.81670e-02  6.03100e-02  2.12750e-02  2.46050e-02
 3.25600e+01  0.00000e+00  3.25600e+01  0.00000e+00  1.85370e+02  8.43600e+01  1.24320e+01  9.69400e+00  1.02490e+01  7.95500e+00
         0  TC  99       1.00000e+00

RU 103
         6  2.04240e-07  3.65200e+04
 8.32500e-02  8.32500e-02  0.00000e+00  1.02490e-01  8.28800e-02  8.06600e-02  7.77000e-02  1.43930e-01  8.10300e-02  9.28700e-02
 8.95400e+03  0.00000e+00  8.95400e+03  0.00000e+00  9.50900e+02  5.77200e+04  1.18030e+03  8.76900e+02  1.13590e+03  1.15070e+03
         0  RH 103M      9.97000E-01

RU 105
         6  4.33650e-05  2.40800e+04
 1.40970e-01  1.40970e-01  0.00000e+00  2.49010e-01  1.40600e-01  1.36900e-01  1.32830e-01  2.32360e-01  1.37640e-01  1.56880e-01
 4.55100e+02  0.00000e+00  4.55100e+02  0.00000e+00  1.53550e+01  2.12010e+03  2.84900e+01  1.70940e+01  5.88300e+01  2.44570e+01
         1  RH 105       1.00000e+00


RU 106
         6  2.17890e-08  8.47600e+03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
 4.77300e+05  0.00000e+00  4.77300e+05  0.00000e+00  6.36400e+03  3.84800e+06  6.51200e+03  5.95700e+03  4.81000e+03  6.58600e+03
         0  RH 106       1.00000e+00

RH 105
         6  5.44520e-06  1.63200e+04
 1.37640e-02  1.37640e-02  0.00000e+00  3.95900e-02  1.36160e-02  1.32090e-02  1.25060e-02  2.78610e-02  1.34680e-02  1.53920e-02
 9.54600e+02  0.00000e+00  9.54600e+02  0.00000e+00  1.06560e+01  3.54460e+03  2.87490e+01  1.65020e+01  7.80700e+01  2.07570e+01
         0
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SB 127
         4  2.08380e-06  2.26500e+03
 1.23210e-01  1.23210e-01  0.00000e+00  2.06460e-01  1.23210e-01  1.19880e-01  1.16180e-01  2.04240e-01  1.20620e-01  1.37640e-01
 6.03100e+03  0.00000e+00  6.03100e+03  0.00000e+00  2.27550e+02  2.56780e+04  5.95700e+02  4.95800e+02  9.32400e+02  3.37440e+02
         2  TE 127       8.24000e-01  TE 127M      1.76000e-01

SB 129
         4  4.45700e-05  7.92100e+03
 2.64180e-01  2.64180e-01  0.00000e+00  3.88500e-01  2.64920e-01  2.58260e-01  2.53820e-01  3.95900e-01  2.57890e-01  2.92670e-01
 6.43800e+02  0.00000e+00  6.43800e+02  0.00000e+00  3.59640e+01  3.32260e+03  6.29000e+01  5.40200e+01  7.95500e+01  4.73600e+01
         2  TE 129       7.75000e-01  TE 129M      2.25000e-01

TE 127M
         4  7.36010e-08  2.88300e+02
 5.43900e-04  5.43900e-04  0.00000e+00  3.14130e-03  5.55000e-04  2.81940e-04  2.37910e-04  1.45780e-03  7.03000e-04  9.95300e-04
 2.14970e+04  0.00000e+00  2.14970e+04  0.00000e+00  3.57420e+02  1.23580e+05  1.98320e+04  7.54800e+04  4.07000e+02  4.07000e+02
         1  TE 127       9.76000e-01

TE 127
         4  2.05930e-05  2.18600e+03
 8.95400e-04  8.95400e-04  0.00000e+00  4.21800e-02  8.88000e-04  8.58400e-04  8.17700e-04  1.72050e-03  8.76900e-04  1.01010e-03
 3.18200e+02  0.00000e+00  3.18200e+02  0.00000e+00  6.80800e+00  1.57990e+03  1.51330e+01  1.51330e+01  7.47400e+00  6.95600e+00
         0

TE 129M
         4  2.38770e-07  1.96400e+03
 5.73500e-03  5.73500e-03  0.00000e+00  5.51300e-02  5.77200e-03  5.40200e-03  5.25400e-03  9.62000e-03  5.77200e-03  6.69700e-03
 2.39390e+04  0.00000e+00  2.39390e+04  0.00000e+00  5.77200e+02  1.49110e+05  1.14700e+04  2.60850e+04  6.58600e+02  6.25300e+02
         1  TE 129       6.50000e-01  I  129       3.50000e-01

TE 129
         4  1.65980e-04  7.47000e+03
 1.01750e-02  1.01750e-02  0.00000e+00  1.32090e-01  1.01380e-02  9.76800e-03  9.39800e-03  1.80560e-02  1.00270e-02  1.15440e-02
 8.95400e+01  0.00000e+00  8.95400e+01  0.00000e+00  6.03100e+00  4.92100e+02  7.28900e+00  7.51100e+00  6.47500e+00  6.21600e+00
         0  I  129       1.00000e+00

TE 131M
         4  6.41800e-06  3.75500e+03
 2.59370e-01  2.59370e-01  0.00000e+00  3.27450e-01  2.59740e-01  2.52710e-01  2.47160e-01  4.03300e-01  2.53450e-01  2.87860e-01
 6.40100e+03  0.00000e+00  6.40100e+03  0.00000e+00  1.33570e+05  8.25100e+03  5.21700e+02  8.39900e+02  8.65800e+02  3.42250e+02
         1  I  131       7.78000e-01  TE 131       2.22000e-01

TE 132
         4  2.46220e-06  3.71500e+04
 3.81100e-02  3.81100e-02  0.00000e+00  5.14300e-02  3.77400e-02  3.57050e-02  3.31150e-02  8.95400e-02  3.77400e-02  4.36600e-02
 9.43500e+03  0.00000e+00  9.43500e+03  0.00000e+00  2.32360e+05  6.17900e+03  1.57990e+03  2.63440e+03  1.53550e+03  1.34310e+03
         1  I  132       1.00000e+00
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I  131
         2  9.97830e-07  2.55900e+04
 6.73400e-02  6.73400e-02  0.00000e+00  1.10260e-01  6.69700e-02  6.51200e-02  6.21600e-02  1.27650e-01  6.58600e-02  7.54800e-02
 3.28930e+04  0.00000e+00  3.28930e+04  0.00000e+00  1.08040e+06  2.43090e+03  2.31620e+02  2.12010e+02  9.36100e+01  2.91560e+02
         0  XE 131M      1.11000e-02

I  132
         2  8.37130e-05  3.77000e+04
 4.14400e-01  4.14400e-01  0.00000e+00  5.84600e-01  4.14400e-01  4.03300e-01  3.95900e-01  6.40100e-01  4.03300e-01  4.58800e-01
 3.81100e+02  0.00000e+00  3.81100e+02  0.00000e+00  6.43800e+03  1.00270e+03  5.18000e+01  4.58800e+01  3.68150e+01  5.21700e+01
         0

I  133
         2  9.25680e-06  5.38600e+04
 1.08780e-01  1.08780e-01  0.00000e+00  2.15710e-01  1.08410e-01  1.05820e-01  1.02490e-01  1.80190e-01  1.06190e-01  1.21360e-01
 5.84600e+03  0.00000e+00  5.84600e+03  0.00000e+00  1.79820e+05  3.03400e+03  1.00640e+02  9.32400e+01  7.21500e+01  1.08780e+02
         1  XE 133       9.71000e-01  XE 133M      2.90000e-02

I  134
         2  2.19630e-04  5.90900e+04
 4.81000e-01  4.81000e-01  0.00000e+00  6.91900e-01  4.81000e-01  4.69900e-01  4.62500E-01  7.25200e-01  4.69900e-01  5.32800e-01
 1.31350e+02  0.00000e+00  1.31350e+02  0.00000e+00  1.06560e+03  5.29100e+02  2.24960e+01  1.96470e+01  1.57250e+01  2.28290e+01
         0

I  135
         2  2.91290e-05  5.08500e+04
 2.95260e-01  2.95260e-01  0.00000e+00  4.10700e-01  2.96370e-01  2.90080e-01  2.87120e-01  4.18100e-01  2.87490e-01  3.25230e-01
 1.22840e+03  0.00000e+00  1.22840e+03  0.00000e+00  3.13020e+04  1.63170e+03  8.28800e+01  7.43700e+01  6.29000e+01  8.65800e+01
         1  XE 135       8.46000e-01  XE 135M      1.54000e-01

XE 133
         1  1.52960e-06  5.39400e+04
 5.77200e-03  5.77200e-03  0.00000e+00  1.83890e-02  5.58700e-03  4.88400e-03  3.95900e-03  1.89810e-02  5.95700e-03  7.25200e-03
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
         0

XE 135
         1  2.11820e-05  1.10900e+04
 4.40300e-02  4.40300e-02  0.00000e+00  1.15440e-01  4.36600e-02  4.18100e-02  3.95900e-02  9.50900e-02  4.32900e-02  4.92100e-02
 0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00  0.00000e+00
         0  CS 135       1.00000e+00

CS 134
         3  1.06590e-08  3.69900e+03
 2.80090e-01  2.80090e-01  0.00000e+00  3.49650e-01  2.80090e-01  2.72690e-01  2.66030e-01  4.44000e-01  2.73800e-01  3.11910e-01
 4.62500e+04  0.00000e+00  4.62500e+04  0.00000e+00  4.10700e+04  4.36600e+04  4.36600e+04  4.07000e+04  4.81000e+04  3.99600e+04
         0
```

```
CS 136
         3  6.12410e-07  1.14900e+03
 3.92200e-01  3.92200e-01  0.00000e+00  4.62500e-01  3.95900e-01  3.84800e-01  3.73700e-01  6.14200e-01  3.84800e-01  4.36600e-01
 7.32600e+03  0.00000e+00  7.32600e+03  0.00000e+00  6.40100e+03  8.58400e+03  6.88200e+03  6.29000e+03  6.95600e+03  6.17900e+03
         0

CS 137
         3  7.32650e-10  1.91700e+03
 2.86380e-05  2.86380e-05  0.00000e+00  3.19310e-02  2.79350e-05  2.47160e-05  2.10900e-05  8.47300e-05  2.94520e-05  3.57790e-05
 3.19310e+04  0.00000e+00  3.19310e+04  0.00000e+00  2.93410e+04  3.26340e+04  3.07100e+04  2.93780e+04  3.24120e+04  2.90080e+04
         0  BA 137M      9.46000e-01

BA 139
         5  1.39690e-04  4.98200e+04
 8.02900e-03  8.02900e-03  0.00000e+00  2.27920e-01  7.88100e-03  7.51100e-03  6.91900e-03  1.95730e-02  7.88100e-03  9.06500e-03
 1.71680e+02  0.00000e+00  1.71680e+02  0.00000e+00  8.88000e+00  9.36100e+02  1.26170e+01  9.21300e+00  9.47200e+00  9.10200e+00
         0

BA 140
         5  6.29710e-07  4.92700e+04
 3.17460e-02  3.17460e-02  0.00000e+00  9.32400e-02  3.15610e-02  3.05990e-02  2.93410e-02  5.73500e-02  3.11170e-02  3.56680e-02
 3.73700e+03  0.00000e+00  3.73700e+03  0.00000e+00  9.47200e+02  6.14200e+03  4.77300e+03  8.91700e+03  1.59100e+03  1.06190e+03
         1  LA 140       1.00000e+00

LA 140
         7  4.78100e-06  5.03000e+04
 4.32900e-01  4.32900e-01  0.00000e+00  6.14200e-01  4.36600e-01  4.25500e-01  4.21800e-01  6.25300e-01  4.21800e-01  4.77300e-01
 4.84700e+03  0.00000e+00  4.84700e+03  0.00000e+00  2.54190e+02  1.55770e+04  7.91800e+02  5.21700e+02  1.67980e+03  5.36500e+02
         0

LA 141
         7  4.89930e-05  4.39600e+04
 8.84300e-03  8.84300e-03  0.00000e+00  2.43460e-01  8.84300e-03  8.65800e-03  8.54700e-03  1.29130e-02  8.62100e-03  9.76800e-03
 5.80900e+02  0.00000e+00  5.80900e+02  0.00000e+00  3.47800e+01  2.39020e+03  1.08410e+02  4.44000e+02  3.73700e+01  3.64080e+01
         1  CE 141       1.00000e+00

LA 142
         7  1.24890e-04  4.45200e+04
 5.32800e-01  5.32800e-01  0.00000e+00  7.99200e-01  5.36500e-01  5.25400e-01  5.25400e-01  7.21500e-01  5.18000e-01  5.80900e-01
 2.53080e+02  0.00000e+00  2.53080e+02  0.00000e+00  3.23380e+01  1.11370e+03  5.03200e+01  4.10700e+01  6.14200e+01  4.18100e+01
         0

CE 141
         8  2.46840e-07  4.47500e+04
 1.26910e-02  1.26910e-02  0.00000e+00  3.77400e-02  1.23950e-02  1.17290e-02  1.04710e-02  3.48170e-02  1.25060e-02  1.45410e-02
 8.95400e+03  0.00000e+00  8.95400e+03  0.00000e+00  9.43500e+01  6.17900e+04  3.31520e+02  9.39800e+02  2.04980e+02  1.65020e+02
         0
```

```
CE 143
         8  5.83460e-06  4.34900e+04
 4.77300e-02  4.77300e-02  0.00000e+00  1.46520e-01  4.73600e-02  4.55100e-02  4.32900e-02  9.32400e-02  4.73600e-02  5.43900e-02
 3.38920e+03  0.00000e+00  3.38920e+03  0.00000e+00  2.30510e+01  1.43560e+04  1.09520e+02  6.06800e+01  2.78610e+02  6.14200e+01
         1  PR 143       1.00000e+00

CE 144
         8  2.82190e-08  2.68500e+04
 3.15610e-03  3.15610e-03  0.00000e+00  1.08410e-02  3.08210e-03  2.84530e-03  2.47160e-03  9.21300e-03  3.15610e-03  3.73700e-03
 3.73700e+05  0.00000e+00  3.73700e+05  0.00000e+00  1.08040e+03  2.92670e+06  1.06560e+04  1.74640e+04  8.84300e+02  1.28760e+03
         0  PR 144       9.82200e-01  PR 144M      1.78000e-02

PR 143
         7  5.91630e-07  4.26200e+04
 7.77000e-05  7.77000e-05  0.00000e+00  6.51200e-02  7.58500e-05  6.88200e-05  5.99400e-05  2.19410e-04  7.88100e-05  9.43500e-05
 8.10300e+03  0.00000e+00  8.10300e+03  0.00000e+00  6.21600e-06  4.92100e+04  5.47600e+01  5.51300e+01  1.61690e-05  8.21400e-06
         0

ND 147
         7  7.30650e-07  1.90900e+04
 2.29030e-02  2.29030e-02  0.00000e+00  7.21500e-02  2.26440e-02  2.15340e-02  1.99800e-02  4.88400e-02  2.26810e-02  2.63440e-02
 6.84500e+03  0.00000e+00  6.84500e+03  0.00000e+00  6.73400e+01  3.92200e+04  3.40030e+02  1.20620e+03  3.11170e+02  1.27650e+02
         0  PM 147       1.00000e+00

NP 239
         8  3.40660e-06  5.43400e+05
 2.84530e-02  2.84530e-02  0.00000e+00  5.92000e-02  2.78240e-02  2.65660e-02  2.40500e-02  7.40000e-02  2.78610e-02  3.23010e-02
 2.50860e+03  0.00000e+00  2.50860e+03  0.00000e+00  2.81940e+01  8.73200e+03  7.69600e+02  7.51100e+03  2.75650e+02  6.03100e+01
         1  PU 239       1.00000e+00

PU 238
         8  2.50500e-10  3.43000e+01
 1.80560e-05  1.80560e-05  0.00000e+00  1.51330e-04  1.48370e-05  3.92200e-06  6.21600e-06  3.44100e-05  2.42720e-05  4.69900e-05
 3.92200e+08  0.00000e+00  3.92200e+08  0.00000e+00  3.55940e+03  6.80800e+07  5.62400e+08  7.03000e+09  1.03600e+08  3.70000e+03
         0  U  234       1.00000e+00

PU 239
         8  9.13340e-13  7.56500e+00
 1.56880e-05  1.56880e-05  0.00000e+00  6.88200e-05  1.43560e-05  9.80500e-06  9.87900e-06  3.50390e-05  1.79080e-05  2.79350e-05
 4.29200e+08  0.00000e+00  4.29200e+08  0.00000e+00  3.34110e+03  6.40100e+07  6.25300e+08  7.80700e+09  1.17660e+08  3.41140e+03
         0  U  235       1.00000e+00

PU 240
         8  3.36230e-12  8.47600e+00
 1.75750e-05  1.75750e-05  0.00000e+00  1.45040e-04  1.45040e-05  4.03300e-06  6.10500e-06  3.42620e-05  2.35320e-05  4.55100e-05
 4.29200e+08  0.00000e+00  4.29200e+08  0.00000e+00  3.34850e+03  6.40100e+07  6.25300e+08  7.80700e+09  1.17660e+08  3.51870e+03
         0  U  236       1.00000e+00
```

```
PU 241
         8  1.52640e-09  1.59200e+03
 2.68250e-07  2.68250e-07  0.00000e+00  4.32900e-07  2.58260e-07  2.39760e-07  2.08310e-07  8.10300e-07  2.66030e-07  3.20790e-07
 8.25100e+06  0.00000e+00  8.25100e+06  0.00000e+00  4.58800e+01  2.74540e+04  1.24320e+07  1.55400e+08  2.52340e+06  1.13220e+02
            1  AM 241       1.00000e+00

AM 241
         7  5.08550e-11  1.06100e+00
 3.02660e-03  3.02660e-03  0.00000e+00  4.73600e-03  2.89710e-03  2.49380e-03  1.92770e-03  1.06190e-02  3.17460e-03  3.95900e-03
 4.44000e+08  0.00000e+00  4.44000e+08  0.00000e+00  5.92000e+03  6.80800e+07  6.43800e+08  8.02900e+09  1.20250e+08  9.87900e+03
            0  NP 237       1.00000e+00

CM 242
         7  4.92780e-08  4.02400e+02
 2.10530e-05  2.10530e-05  0.00000e+00  1.58730e-04  1.81670e-05  4.18100e-06  6.99300e-06  3.92200e-05  2.89710e-05  5.47600e-05
 1.72970e+07  0.00000e+00  1.72790e+07  0.00000e+00  3.48170e+03  5.73500e+07  1.44300e+07  1.80190e+08  2.10900e+06  3.49280e+03
            1  PU 238       1.00000e+00

CM 244
         7  1.21370e-09  2.48700e+01
 1.81670e-05  1.81670e-05  0.00000e+00  1.44670e-04  1.55030e-05  2.61960e-06  5.40200e-06  3.26340e-05  2.55300e-05  4.92100e-05
 2.47900e+08  0.00000e+00  2.47900e+08  0.00000e+00  3.73700e+03  7.14100e+07  3.47060e+08  4.32900e+09  5.88300e+07  3.84800e+03
            1  PU 240       1.00000e+00
```

Appendix F HABIT V1.1 Worksheets

The following pages contain worksheets that may be used to collect and organize data for TACT5 and CONHAB data entry. The data forms are arranged in the order in which data are entered if the data entry order of the user interface is followed. However, not all data have to be entered in this order. If another data organization seems more reasonable, the forms may be adapted as desired. It is a good practice to use these forms, or similar forms, to document the intended input to TACT5 and CONHAB. It is also a good quality practice to annotate the forms with the sources for each entry as the form should be retained for verification under quality assurance programs.

Failure to enter data in the proper units is a common error in use of TACT5 and CONHAB. Sample Problem 2 in which a filter efficiency was entered as a fraction rather than in percent shows good example of this type error. Therefore, the forms list the engineering units required for TACT5 data entry and common units for data entry for CONHAB. The data entry interface for CONHAB includes a unit conversion utility so data may generally be entered in the units in which they are obtained. This utility does not exist for TACT5.

HABIT V1.1

TACT5 Data Worksheet Date _____

Problem Identification _____ Page _____

Problem Description

_____

_____

_____

_____

_____

_____

TACT5 Time-Independent Data

Node Node Name _____ Volume (ft^3)

1 _____ _____

2 _____ _____

3 _____ _____

4 _____ _____

Reactor Power (MW_t) _____

Delay Time (hr) _____

	Noble Gases	Halogen	Alkali Metals	Te Group	Ba/Sr	Noble Metals	La Group	Ce Group	Other
Release Fraction									
Plate-out Factor									
Elemental Fraction									
Organic Fraction									
Particulate Fraction									

TACT5 Data Worksheet Date _____

Problem Identification _____ Page _____

TACT5 Release Data

Initial Activity Distribution (Core Fraction or Ci)

Time (hr)	Group	Node 1	Node 2	Node 3	Node 4

Continuous Release (Core Fraction/hr or Ci/hr)

Time (hr)	Group	Node 1	Node 2	Node 3	Node 4

HABIT V1.1

TACT5 Data Worksheet Date _____

Problem Identification _____ Page _____

TACT5 Transfer Rate Data

		Unfiltered Transfer Rate (%/day) to				
Time (hr)	Source Node	Environment	Node 1	Node 2	Node 3	Node 4

		Filtered Transfer Rate (cfm) to				
Time (hr)	Source Node	Environment	Node 1	Node 2	Node 3	Node 4

TACT5 Data Worksheet Date _____

Problem Identification _____ Page _____

TACT5 Removal Rate/Filter Efficiency Data

			Removal Rate (hr^{-1})			
Time (hr)	Group	Form	Node 1	Node 2	Node 3	Node 4

				Filter Efficiency (%)				
Time (hr)	Source	Group	Form	Environ.	Node 1	Node 2	Node 3	Node 4

HABIT V1.1

TACT5 Data Worksheet Date _____

Problem Identification _____ Page _____

TACT5 Dilution Factors and Breathing Rate Data

	Dilution Factors (X/Q) [(Ci/m^3)/(Ci/s)]		
Time (hr)	EAB	LPZ	Other

	Breathing Rate (m^3/s)				
Time (hr)	EAB	LPZ	Other		
			Initial	Occupancy Factor	Final

CONHAB Data Worksheet Date _____

Problem Identification _____ Page _____

Time-Independent Plant Data

Control Room Volume _____ (m^3 or ft^3)

(Only if FPFP_2 input used)

Reactor Power (Mw_t) _____

Release Fractions

	Noble Gases	Halogen	Alkali Metals	Te Group	Ba/Sr	Noble Metals	La Group	Ce Group	Other
Release Fraction									
Plate-out Factor									
Elemental Fraction									
Organic Fraction									
Particulate Fraction									

(The following data are required only if X/Qs are not entered directly and TACT5 input used.

Release Vert. Vel. _____ (m/s) or (ft/min) Release Flow _____ (m^3/s) or (cfm)

Release Ht. _____ (m) or (ft) Building Ht _____ (m) or (ft)

Building Area _____ (m^2) or (ft^2) Distance to Intake _____ (m) or (ft)

Intake Height _____ (m) or (ft)

X/Qs , Meteorology , and Time-Dependent Plant Data

Time (hr)	X/Q (s/m^3)	Release Vert. Vel*. (m/s)	Release Flow* (m3/s)	Wind Speed* (m/s)	Stability Class*	
					Horizontal	Vertical

* Required only if TACT5 input is used and X/Q is not entered.

HABIT V1.1

CONHAB Data Worksheet Date _____

Problem Identification _____ Page _____

Time- Dependent Control Room Data

Time _____ Occupancy Factor _____
Time _____ Occupancy Factor _____
Time _____ Occupancy Factor _____
Time _ _____ Occupancy Factor _____

CONHAB Flow and Filter Data

Time:		Filtered Inlet 1	Filtered Inlet 2	Recirc. Filter	Unfiltered Inlet 1	Unfiltered Inlet 1	Bottled Air
Flow (m^3/s)							
Filter Efficiency (%)	Elemental				NA	NA	NA
	Organic				NA	NA	NA
	Particles				NA	NA	NA

Time:		Filtered Inlet 1	Filtered Inlet 2	Recirc. Filter	Unfiltered Inlet 1	Unfiltered Inlet 1	Bottled Air
Flow (m^3/s)							
Filter Efficiency (%)	Elemental				NA	NA	NA
	Organic				NA	NA	NA
	Particles				NA	NA	NA

Time:		Filtered Inlet 1	Filtered Inlet 2	Recirc. Filter	Unfiltered Inlet 1	Unfiltered Inlet 1	Bottled Air
Flow (m^3/s)							
Filter Efficiency (%)	Elemental				NA	NA	NA
	Organic				NA	NA	NA
	Particles				NA	NA	NA

Appendix G HABIT V1.1 Files

The following pages present tables that describe the files that are part of HABIT V1.1. There are six tables. The 6 tables are:

- HABIT V1.1 batch files
- HABIT V1.1 permanent data files
- HABIT V1.1 case data files
- HABIT V1.1 temporary data files
- HABIT V1.1 computational programs
- HABIT V1.1 Visual Basic and miscellaneous files.

The batch files that are used to control program execution are the first group of files. HABIT.BAT is the batch file that controls the HABIT user interface, while the remaining batch files control execution of the individual computational programs. These files must be modified to reflect the directory structure of HABIT V1.1 installation, if the directory structure differs from the default structure. Instructions for modifying these files were presented in Section 1.3

Table G-1 HABIT V1.1 batch files

FILE	DIRECTORY	TYPE	CONTENT
CB.BAT	HABIT11	ASCII	Batch file to run CONHAB from HABIT.
CH.BAT	HABIT11	ASCII	Batch file to run CHEM from HABIT.
EX.BAT	HABIT11	ASCII	Batch file to run EXTRAN from HABIT.
FP.BAT	HABIT11	ASCII	Batch file to run FPFP_2 from HABIT.
HABIT.BAT	HABIT11	ASCII	Batch file to start HABIT V1.1.
T5.BAT	HABIT11	ASCII	Batch file to run TACT5 from HABIT.

The second table presents the permanent data files used in HABIT V1.1. These files include the disclaimer (DISCLAIM), which must be present for program execution, the name and location of the last HABIT run (SPECDESI), the nominal range limits for variables (RANGES.SET), and the output control file (OUTOPT.DAT). It also includes the MLWR.DAT and the radionuclide data files described in Appendix A, which are used by TACT5 and CONHAB, and the CHEMICAL.DAT file, which is used EXTRAN. Finally, includes the DEFLT.DSG, DEFLTT5A.INP, and DEFLTT5A.NUC provide default information used to create new designs.

Table G-2 HABIT V1.1 Permanent Data Files

FILE	DIRECTORY	TYPE	CONTENT
CHEMICAL.DAT	HABIT11	ASCII	Chemical data used in EXTRAN.
DEFLT.DSG	HABIT11\dsgn_fls	ASCII	Template for file names for all HABIT V1.1 programs. Used to create case-specific file names when CREATE NEW DESIGN is selected in the Design Edit Window activated from the HABIT V1.1 main screen.
DEFLTT5A.INP	HABIT11\dsgn_fls	ASCII	Default design parameters used when CREATE NEW DESIGN is selected.
DEFLTT5A.NUC	HABIT11\dsgn_fls	ASCII	Default radionuclide data used when CREATE NEW DESIGN is selected.
DISCLAIM	HABIT11	ASCII	Code identification and disclaimer (required for program execution)
MLWR.DAT	HABIT11	ASCII	List of available radionuclide data files.
MLWR_TID.02	HABIT11\nfls	ASCII	Radionuclide data file from TACT5 with TID-14844 source term data and ICRP-2 dose factors.
MLWR_TID.30	HABIT11\nfls	ASCII	Radionuclide data file from TACT5 with TID-14844 source term data and ICRP-30 dose factors.
MLWR1465.BWR	HABIT11\nfls	ASCII	Radionuclide data file with NUREG-1465 radionuclide groups, NUREG/CR-4467 core specific activities for a BWR, and Federal Guidance Report 11 & 12 dose factors.
MLWR1465.PWR	HABIT11\nfls	ASCII	Radionuclide data file with NUREG-1465 radionuclide groups, NUREG/CR-4467 core specific activities for a PWR, and Federal Guidance Report 11 & 12 dose factors.
OUTOPT.DAT	HABIT11	ASCII	Output controls.
RANGES.SET	HABIT11	ASCII	Variable ranges for checking user input.
SPECDESI	HABIT11	ASCII	Lists the data path and design specification for the last HABIT run. Deleting this file may solve the problem if HABIT V1.1 won't run.

Table G-3 lists the data files created and used by HABIT. These are the case data files. Each file name begins with the five-character string entered as the case name when the case is created, whether it is created as a new design or by copying an existing design. In the table, the case name is shown as "Name-". CONHAB permits evaluation of doses from radionuclides entering the control room from two "filtered" intakes and two "unfiltered" intakes simultaneously. The filtered intakes assume a path through the environment; these paths are defined in TACT5. The unfiltered intakes are assumed to be internal paths; they are defined in FPFP_2. Table G-3 only shows the files for one TACT5 and one FPFP_2 path. In each case, files for the second path would be indicated by a "B" as the eighth character in the file name rather than an "A".

Table G-3 HABIT V1.1 Case Data Files

FILE	DIRECTORY	TYPE	CONTENT
Name-T5A.INP	HABIT11\dsg_fls	ASCII	TACT5 design file for release path A contributing to doses at EAB, LPZ, and concentrations and doses at control room filtered intake #1
Name-T5A.NUC	HABIT11\dsg_fls	ASCII	Case-specific radionuclide data file used by TACT5 for release path A
Name-T5A.RUN	HABIT11\dsg_fls	ASCII	List of TACT5 input and output files for release path A
Name-T5A.TAB	HABIT11\dsg_fls	ASCII	Primary output file for TACT5 for release path A
Name-T5A.CNX	HABIT11\dsg_fls	ASCII	TACT5 output file for release path A containing CONHAB input for filtered intake #1
Name-T5A.SUM	HABIT11\dsg_fls	ASCII	TACT5 output file containing summary of doses for release path A
Name-T5A.SPD	HABIT11\dsg_fls	ASCII	TACT5 output file containing summary of doses release path A in "quote and comma" delimited format for input to a spreadsheet
Name-T5A.CR1	HABIT11\dsg_fls	ASCII	TACT5 output file containing dose chronology at EAB for release path A.
Name-T5A.CR2	HABIT11\dsg_fls	ASCII	TACT5 output file containing dose chronology at EAB for release path A in "quote and comma" delimited format for input to a spreadsheet
Name-FPA.INP	HABIT11\dsg_fls	ASCII	FPFP_2 design file for internal path A to control room

FILE	DIRECTORY	TYPE	CONTENT
Name-FPA.RUN	HABIT11\dsg_fls	ASCII	List of FPFP_2 input and output files for internal path A
Name-FPA.TAB	HABIT11\dsg_fls	ASCII	FPFP_2 primary output file for internal path A to control room
Name-FPA.CNX	HABIT11\dsg_fls	ASCII	FPFP_2 output file for internal path A to control room containing CONHAB input for unfiltered input # 1
Name-FPA.SPD	HABIT11\dsg_fls	ASCII	FPFP_2 output file for internal path A to control room in "quote and comma" delimited format for input to a spreadsheet
Name-CB.INP	HABIT11\dsg_fls	ASCII	Input file containing control room design, dispersion factors, and occupancy factors used by CONHAB and CHEM
Name-CB.RUN	HABIT11\dsg_fls	ASCII	List of input and output files for CONHAB
Name-CB.TAB	HABIT11\dsg_fls	ASCII	CONHAB primary output file
Name-CB.CNX	HABIT11\dsg_fls	ASCII	CONHAB output file containing dose chronology in the control room
Name-CB.SPD	HABIT11\dsg_fls	ASCII	CONHAB output file containing dose chronology in the control room in "quote and comma" delimited format for input to a spreadsheet
Name-EX.INP	HABIT11\dsg_fls	ASCII	EXTRAN release design file
Name-EX.RUN	HABIT11\dsg_fls	ASCII	List of input and output files for EXTRAN
Name-EX.TAB	HABIT11\dsg_fls	ASCII	EXTRAN primary output file
Name-EX.CNX	HABIT11\dsg_fls	ASCII	EXTRAN output file containing the control room intake concentration chronology
Name-EX.MB	HABIT11\dsg_fls	ASCII	EXTRAN output file containing the mass balance by time step
Name-EX.SPD	HABIT11\dsg_fls	ASCII	
Name-CH.RUN	HABIT11\dsg_fls	ASCII	List of input and output files for CHEM
Name-CH.TAB	HABIT11\dsg_fls	ASCII	CHEM primary output file
Name-CH.SPD	HABIT11\dsg_fls	ASCII	

TACT5 and CONHAB make use of several temporary files. The files remain after the program is run. They may be deleted to free additional disk space, or the may be left intact. If they are left intact, the files will be overwritten the next time the program is run. Table G-4 lists the temporary file names.

Table G-4 HABIT V1.1 Temporary Files

FILE	DIRECTORY	TYPE	CONTENT
CONHAB.DBA	HABIT11	BINARY	Temporary file containing CONHAB design data.
EAB_DOSE.TMP	HABIT11	BINARY	Temporary TACT5 file containing EAB doses by organ and time step.
JTAPE	HABIT11	BINARY	Temporary file containing TACT5 computational results at every time step.
LTAPE	HABIT11	BINARY	Temporary file containing TACT5 design data.
MTAPE	HABIT11	BINARY	Temporary file containing TACT5 computational results at user-defined time steps.

The computational portion of HABIT V1.1 consists of five FORTRAN programs. The program names are listed in Table G-5.

Table G-5 HABIT V1.1 Computational Programs

FILE	DIRECTORY	TYPE	CONTENT
CHEM.EXE	HABIT11	BINARY	Computational program for CHEM (FORTRAN)
CONHAB.EXE	HABIT11	BINARY	Computational program for CONHAB (FORTRAN)
EXTRAN.EXE	HABIT11	BINARY	Computational program for EXTRAN (FORTRAN)
FPFP_2.EXE	HABIT11	BINARY	Computational program for FPFP_2 (FORTRAN)
TACT5.EXE	HABIT11	BINARY	Computational program for TACT5 (FORTRAN)

The last group of files is listed in Table G-6. This group includes the Visual Basic file that comprises the HABIT V1.1 user interface. It also includes the HELP file, which has not been updated for HABIT V1.1, and three utility programs used by HABIT, GETKEY.EXE, RUNPROG.EXE, and RUNPROG2.EXE. The remaining file, DOSXMSF.EXE, is used (required) by the FORTRAN computational program. It permits them to address extended memory.

Table G-6 HABIT V1.1 Visual Basic and Miscellaneous Files

FILE	DIRECTORY	TYPE	CONTENT
DOSXMSF.EXE	HABIT11	BINARY	DOS extension program to permit access to more than 640 kilobytes of memory
GETKEY.EXE	HABIT11	BINARY	Utility program to read from the keyboard.
HABIT.HLP	HABIT11	BINARY	HABIT help file.
QTACT5.EXE	HABIT11	BINARY	TACT5 radionuclide data entry program
RUNPROG.EXE	HABIT11	BINARY	Visual Basic program used in executing computational programs
RUNPROG2.EXE	HABIT11	BINARY	Visual Basic program used to call computational programs and return to data entry programs
STACT5.EXE	HABIT11	BINARY	TACT5 time-dependent data base program
VBDRT10E.EXE	HABIT11	BINARY	Visual Basic system program
XCHEM.EXE	HABIT11	BINARY	CHEM data entry program
XCONHAB.EXE	HABIT11	BINARY	CONHAB data entry program
XEXTRAN.EXE	HABIT11	BINARY	EXTRAN data entry program
XFPFP2.EXE	HABIT11	BINARY	FPFP_2 data entry program
XHABIT.EXE	HABIT11	BINARY	HABIT V1.1 main program
XTACT5.EXE	HABIT11	BINARY	TACT5 main data entry program

Appendix H ConvH10 Utility Program

Preparation of the design files for TACT5 can be time consuming when the design involves several filtered pathways. The utility program ConvH10 was developed to assist in conversion of TACT5 design files created in HABIT V1.0 to design files that may be used in HABIT V1.1. The ConvH10 utility program is located in the C:\habit11\dsgn_fls folder.

Assume that a HABIT V1.0 TACT5 design file to be converted to a HABIT V1.1 format is OLD--T5A.INP, and the new file is to be NEW--T5A.INP. The procedure for using ConvH10 is as follows:

1) Using HABIT V1.1, create a new design with the name NEW. The design file will be NEW--.dsg.

2) Enter the desired header information in the HABIT V1.1 main screen.

3) Select the appropriate radionuclide data file and radionuclide. Note that selecting a different set of radionuclide groups and different radionuclides can create internal inconsistencies in the design that must be addressed before TACT5 can be run in HABIT V1.1 with the old design.

4) Go to TACT5, click on Save Design, and then click on Done. This will create a file named NEW--T5A.INP and save it in the folder with the rest of the design files.

5) Switch applications to the Windows 3.1 File Manager, Windows95 Explorer, etc., and rename the NEW--T5A.INP file to TEMP-T5A.INP. The OLD--T5A.INP and TEMP-T5A.INP files will be used by ConvH10 to create a new NEW--T5A.INP file that contains the heading information from TEMP-T5A.INP and the design information from OLD--T5A.INP.

6) Determine whether the order of the noble gas and halogen radionuclide groups in the radionuclide file to be used with HABIT V1.1 is different from the order in the file used with HABIT V1.0. In general, the order should be reversed. If the order is reversed, ConvH10 will transpose the order of the groups when it creates the new TACT5 design file.

7) Run the ConvH10 program. ConvH10 can be run from the Run command on the Start Menu in Windows95 or the Files Menu in Windows 3.1 File Manager. It may also be run from a DOS Command Line. The command to run ConvH10 is

   ConvH10 OLD--T5A.INP TEMP-T5A.INP NEW--T5A.INP T

   where the file names are separated by spaces and the T at the end of the command line is a switch that tells ConvH10 to transpose the noble gas and halogen radionuclide groups in the output file.

8) Delete the TEMP-T5A.INP file.

9) Return to HABIT and continue with the problem. It should be possible to run TACT5 without any additional data entry. If results of running TACT5 with OLD--T5A.INP are available and the HABIT V1.1 radionuclide file corresponding to the original file is used, rerunning TACT5 without changing NEW--T5A.INP is a good test of the file conversion.

Appendix I EXTRAN: Modifications and Comments

A programming error has been discovered in the version of EXTRAN in HABIT V1.0 (Stage 1996). This error, which is in the calculation of virtual distances for use in estimating dispersion in building wakes, did not exist in earlier EXTRAN versions. The error has been corrected in the EXTRAN program included with HABIT V1.1. An additional inconsistency was identified in the building wake calculation related to the use of virtual distances. After reviewing the EXTRAN code in HABIT V1.0 and the implementation of the same building wake dispersion model in the ARCON96 computer code (Ramsdell and Simonen 1997), the inconsistency was resolved by making the EXTRAN code consistent with the ARCON96 code. Now both codes use virtual distances in the calculation of normal dispersion coefficients and use the actual distance in calculation of building wake corrections to be applied to those coefficients.

The following table compares computational results of EXTRAN V1.2 , the version of EXTRAN included with HABIT V1.0, and the version of EXTRAN included with HABIT V1.1 for the examples problems in NUREG/CR-5656 (Ramsdell 1991). Note that the building wake model changed from EXTRAN V1.2 to the version in HABIT V1.0.

Example	Code	Delay (sec)	2-minute average concentration	Time to peak (sec)	Peak concentration
1	EXTRAN V1.2	50	1.93 E-01 g/m^3	30	6.12 E-01 g/m^3
	HABIT V1.0	55	8.30 E-02 g/m^3	25	3.39 E-01 g/m^3
	HABIT V1.1	40	8.37 E-02 g/m^3	40	1.64 E-01 g/m^3
2	EXTRAN V1.2	69	2.69 E-02 ppm	120	5.11 E-02 ppm
	HABIT V1.0	66	1.55 E-02 ppm	120	3.07 E-02 ppm
	HABIT V1.1	50	2.07 E-02 ppm	120	4.49 E-01 ppm
3	EXTRAN V1.2	55	7.74 E+03 ppm	40	2.77 E+04 ppm
	HABIT V1.0	55	6.40 E+03 ppm	35	2.03 E+04 ppm
	HABIT V1.1	35	2.63 E+03 ppm	40	5.24 E+03 ppm
4	EXTRAN V1.2	95	1.21 E+03 ppm	120	1.97 E+03 ppm
	HABIT V1.0	105	6.31 E+02 ppm	120	9.47 E+02 ppm
	HABIT V1.1	60	2.11 E+02 ppm	120	4.81 E+02 ppm
5	EXTRAN V1.2	10	1.93 E-01 mCi/m^3	115	2.23 E-01 mCi/m^3
	HABIT V1.0	12	1.05 E-00 mCi/m^3	64	1.13 E-00 mCi/m^3
	HABIT V1.1	5	2.99 E-01 mCi/m^3	120	3.33 E-01 mCi/m^3

It can be seen from the results in the table that the effect of correcting the programming error and inconsistency depends upon the specific scenario.

In addition to the changes to EXTRAN just described, users should be aware of the following comments that have been received related to models implemented in EXTRAN.

1) The physical model for releases of liquified gases approximated by EXTRAN is that a portion of the liquified gas being released to the atmosphere flashes as it enters the atmosphere and the remainder of the liquified gas forms a liquid pool near the release point. This is the model described in NUREG-0570 (Wing 1979). More recent modeling guidance from the Environmental Protection Agency (EPA 1992; EPA 1993) makes a more conservative assumption for screening purposes. It assumes that the liquid portion of the release is entrained with the vapor as an aerosol. A similar effect may be achieved in EXTRAN by modeling release of liquified gases as gaseous releases rather than as liquid releases. As with any computer model, it is the user's responsibility to ensure that the physical model represented in the computer code is acceptable for the user's application.

2) It has been pointed out that the physical model used for liquified gases in EXTRAN is not correct for liquified carbon dioxide (CO_2) leaks or spills. Carbon dioxide can not exist as liquid at atmospheric pressures as assumed in EXTRAN. EXTRAN probably underestimates the fraction of CO_2 that flashes under most circumstances. Treating liquified CO_2 releases as gaseous releases will provide an upper limit for the concentrations at air intakes.

3) The algorithm used in EXTRAN to estimate the fraction of liquified gases that flashes when material is released to the atmosphere is based on the equation given in NUREG-0570 (Wing 1979). The discussions this algorithm in NUREG/CR-6210 (Stage 1996) and NUREG/CR-5656 state that the initial temperature (T_a) for the gas should be the air temperature. This is incorrect; the correct temperature should be the temperature of the liquid in the storage tank.

4) Although EXTRAN uses a simple Gaussian dispersion model, the concentrations predicted by the model no longer vary inversely with the wind speed for all wind speeds because building wake correction is not a linear function of wind speed. In addition, the building wake corrections are not particularly sensitive to atmospheric stability. Consequently, F stability class and a wind speed of 1 m/s do not give 95th percentile atmospheric dilution factors for ground-level releases and receptors. When 95th percentile atmospheric dilution factors are desired for use in EXTRAN, they should be estimated using a method such as the ARCON96 computer code (Ramsdell and Simonen 1997). Typically, the 95th percentile dilution factors are associated with wind speed of 3 to 4 m/s.

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NRC FORM 335 (2-89) NRCM 1102 3201, 3202

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

NUREGCR6210SUP1

1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.)
NUREG/CR-6210
PNNL 10496
Supplement 1

2. TITLE AND SUBTITLE
Computer Codes for Evaluation of Control Room Habitability (HABIT V1.1)

3. DATE REPORT PUBLISHED
MONTH: October
YEAR: 1998

4. FIN OR GRANT NUMBER
J2028

5. AUTHOR(S)
J.V. Ramsdell, Jr./PNNL
S.A. Stage/IEM

6. TYPE OF REPORT
Technical

7. PERIOD COVERED (Inclusive Dates)

8. PERFORMING ORGANIZATION – NAME AND ADDRESS (If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)

Pacific Northwest National Laboratory
P.O. Box 999
Richland, WA 99352

Subcontractor:
Innovative Emergency Management
Baton Rouge, LA 70809

9. SPONSORING ORGANIZATION – NAME AND ADDRESS (If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)
Division of Reactor Program Management
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)

Over the years the U.S. Nuclear Regulatory Commission has developed computational tools for use in evaluation of control room habitability in the event of postulated accidents at nuclear reactors. Five of these tools, which were developed individually, were combined in a single Control Room Habitability software package called HABIT. Advances in understanding of the reactor source terms and changes in regulations have expanded the arena in which two of the codes, TACI5 and CONHAB, may be applied. Consequently, these codes and the HABIT user interface were modified to simplify control room habitability assessments in the current regulatory environment. This report describes the changes made to HABIT, TACI5, and CONHAB. It supplements, but does not replace, the original description of HABIT.

The changes include modifications (1) to permit calculation of doses using updated source term insights from NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants," (2) to permit calculation of total effective dose equivalent (TEDE) and maximum two-hour dose discussed in recent revisions to 10 CFR Parts 50 and 100, and (3) to limit routine output to doses of interest. In addition, new radionuclide data files were prepared to permit dose calculations using dose factors from Federal Guidance Reports 11 and 12.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)
Control room habitability, dose estimates, design basis accidents, atmospheric releases, release pathways

13. AVAILABILITY STATEMENT
Unlimited

14. SECURITY CLASSIFICATION
(This Page) Unclassified
(This Report) Unclassified

15. NUMBER OF PAGES

16. PRICE